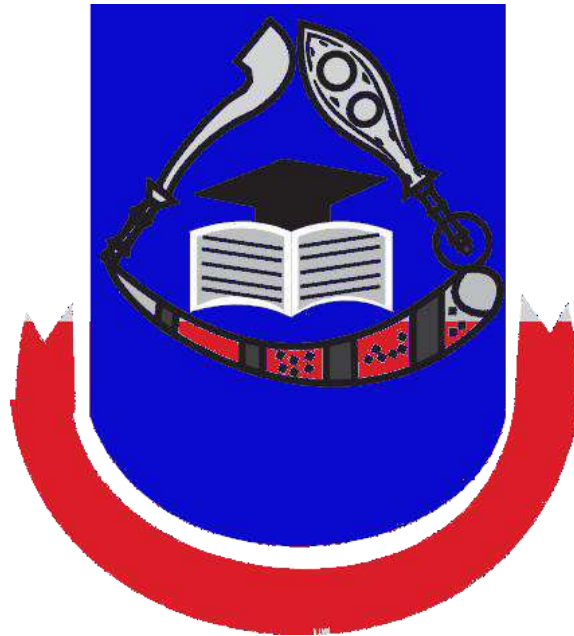


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TABLE OF CONTENTS

Paper Title	Authors	Page Number
Adoption of Artificial Intelligence for Improving Administrative Efficiency in Business Education Faculties in Public Universities in Edo and Delta States	UGURU, T. O. Ph.D	1
AI-Driven Career Counselling: Emerging Trends, Challenges and Opportunities in the Digital Age	OMI-UJUANBI, G. O. Ph.D.; & OBIYAN, D. O.	11
AI-Driven Innovation and Pedagogical Applications Transforming Teaching and Learning in Digital Age: Leveraging AI Applications for Efficient Educational Management	OKAN, S., Ph.D.; IDONIJE, I. O. Ph.D.; OFEIMU, J. Ph.D.; & ANOLU, C. O.	21
Application of Artificial Intelligence in Educational Assessment Among Postgraduate Students' at Nasarawa State University, Keffi, Nigeria	LEGA, A. E. Ph.D.; WAPA, R. J.; & PROF. ANIKWEZE, C.M.	28
Artificial Intelligence and Administrative Effectiveness in Higher Education: Repositioning Institutional Governance for the Digital Age	OGIEVA, A. E. Ph.D; & OKWORI, F.O.	36
Artificial Intelligence Awareness and Digital Competencies Among Carpentry and Joinery Craft Teachers' in Technical Colleges in Edo State	AIGBODUWA, S. A.; & PROF. OVIAWE, J.I.	45
Artificial Intelligence Literacy and Digital Resilience as Predictors of Business Education Students' Cyberpreneurial Intention in Edo State	Kennedy EDIAGBONYA, Ph.D	52
Artificial Intelligence Tools and Their Influence on Students' Academic Performance in Tertiary Institution	OGBEIDE-AKUGBE, M.; & ELAMAH A, N.	59
Data-Driven Sports: The Challenges of Artificial Intelligence in Global Sports Management	ETAGHENE, G. O.; & OKONIGENE, E. D.	69
Exploring Academic Staff Perceptions and Acceptability of AI in Instructional Delivery in TVET Programmes in Federal Universities in South-South Nigeria	OGBEBOR, S. O. Ph.D; & AGBATA, I. V. N.	84
From Chalkboard to Algorithm: Historical Shifts in Teacher Authority in the Digital Age	OYELADE, T. J. Ph.D; ALABEKEE, V.C. C. Ph.D; & NWOKORIE, C. Q.	91
Impact of AI-Driven Simulations on Teaching Chemistry and Scientific Concepts in Public Secondary Schools in Ekpoma, Edo State, Nigeria	BRAIMAH, G. O.; & ITAMAN, P. I.	99
Influence of Artificial Intelligence Computerized Multiple Choice Adaptive Achievement Test (AI-CAT) on Academic Performance of Undergraduates in Lagos State University of Education, Lagos State, Nigeria	IBEREDEM, T. I. Ph.D; & UDOFIA, I. G. Ph.D	108
Influence of Teachers' Professional Development on Instructional Delivery and Perceived Academic Performance of Pupils in Primary Schools in Esan Central Local Government Area, Edo State	ISERE, I.G. & ASIKA, M.O. Ph.D	115
Leveraging Blockchain and Big Data for Transparent and Efficient Financial Reporting: Evidence from Nigerian Listed Firms	IKHAREHON, F. H.; & PROF. OSEMWEGIE-ERO, J.	124
Optimizing School Facilities and Infrastructure Through Artificial Intelligence in Public Secondary Schools in Edo South Senatorial District	OSAGIE, C.I. Ph.D; AIGUOBARUEGHIAN, G.O. Ph.D; & UHUNOMA, E.	136
Path-Analytic Study of Students' Academic Capability and Completion Rate of Ph.D. Programmes in Southwestern Nigeria Public Universities	OLAGUNDOYE, O.D. Ph.D.; & ADEYEMO, E.O. Ph.D	144
Principals' Efficiency Towards Utilization of AI-Driven Applications for Sustainable School Management in the Digital Age in Delta State	EZUGOH, T. C. Ph.D	151
Role of Artificial Intelligence in English Language Acquisition and Pedagogy Among Secondary School Students and Teachers in Edo State	IDIAKHOA, A. Ph.D.; BALOGUN, K.E.; & OGBEIDE, E.O.	164
Stakeholders' Awareness, Perceptions, Utilization and Observed Challenges of Artificial Intelligence Integration in Building Construction Education in Technical Colleges in Edo State	ENESI, F.; & PROF. OVIAWE, J.I.	173
Technological Utilization and Secondary School Records Management Performance	OSAGIE, C.I. Ph.D; & AIGUOBARUEGHIAN, G.O. Ph.D	186
The Role of Artificial Intelligence in Business Education Assessment and Evaluation	ODIBO, G. D.	194
Undergraduate Students' Awareness, Utilization, and Perceived Effectiveness of AI-Chatbots for Counselling Services Delivery in a Nigerian University	OJUGO, A.I. Ph.D; & OBIYAN, D. O.	202
Use of Artificial Intelligence in Enhancing Counselling Service Delivery in Educational Institutions: Evidence from Private Universities in Edo State, Nigeria	OMI-UJUANBI, G. O. Ph.D; & ALUEDE, O. Ph.D	215

Paper Title	Authors	Page Number
Using Artificial Intelligence Tools to Strengthen the Quality, Efficiency and Integrity of Educational Research in Higher Education	PROF. OMOREGIE, E.O.; PROF. JIMOH, B.; & OMOZUAWO, E.S.	225

ADOPTION OF ARTIFICIAL INTELLIGENCE FOR IMPROVING ADMINISTRATIVE EFFICIENCY IN BUSINESS EDUCATION FACULTIES IN PUBLIC UNIVERSITIES IN EDO AND DELTA STATES

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Abstract

This study examined the adoption of Artificial Intelligence (AI) for improving administrative efficiency in Business Education Faculties of selected public universities in Edo and Delta States, Nigeria. The study was motivated by persistent administrative inefficiencies in Nigerian universities despite global advancements in AI-driven higher education management systems. A descriptive survey research design was adopted. The population comprised academic and administrative staff from Business Education Faculties in the University of Benin (UNIBEN), Ambrose Alli University (AAU), Ekpoma, and Delta State University (DELSU), Abraka. A sample of 180 respondents was selected using stratified random sampling technique. Data were collected using a structured questionnaire titled “Artificial Intelligence and Administrative Efficiency Questionnaire (AIAEQ)”, validated by experts and tested for reliability using Cronbach’s Alpha, yielding a coefficient of .82. Data were analyzed using mean and standard deviation. Findings revealed that the level of AI adoption in administrative tasks is low to moderate, with limited integration of advanced tools such as chatbots, predictive analytics, and data-driven decision systems. However, respondents strongly agreed that AI adoption enhances administrative efficiency by improving service delivery, accuracy of records, communication systems, and reducing workload. The study further identified major constraints to AI adoption, including poor ICT infrastructure, inadequate technical skills, high cost of implementation, resistance to change, and weak institutional policy frameworks. The study concluded that AI adoption in Nigerian Business Education Faculties remains in a transitional stage, characterized by a gap between perceived usefulness and actual implementation. It recommended increased investment in ICT infrastructure, staff capacity building, institutional policy development, and strategic partnerships to enhance sustainable AI integration in university administration.

Keywords: Artificial Intelligence; Administrative Efficiency; Business Education Faculties; Digital Transformation; Higher Education Administration; Nigerian Universities

Introduction

The rapid advancement of digital technologies has continued to reshape the structure, delivery, and management of higher education systems globally. Among these emerging technologies, Artificial Intelligence (AI) has become one of the most transformative forces influencing institutional administration, particularly in areas such as decision-making, data management, workflow automation, and service delivery optimization. In higher education institutions, AI is increasingly deployed to streamline administrative processes through intelligent systems such as machine learning algorithms, predictive analytics, robotic process automation (RPA), and natural language processing tools, thereby enhancing institutional efficiency and responsiveness (Dwivedi et al., 2021; UNESCO, 2023).

In contemporary higher education governance discourse, administrative efficiency has become a critical performance indicator for universities, particularly in an era of increasing student populations, complex academic structures, and rising accountability demands. Administrative

efficiency refers to the extent to which institutions are able to deliver services accurately, promptly, and effectively while minimizing the use of financial, human, and temporal resources. It is reflected in timely processing of academic records, effective communication systems, accurate data management, reduced workload duplication, and improved institutional responsiveness (Okoye & Nwafor, 2022). Within this context, Artificial Intelligence adoption represents the integration and utilization of intelligent digital systems to support or automate administrative functions, thereby improving organizational productivity and decision-making efficiency.

Conceptually, Artificial Intelligence adoption in this study refers to the extent to which AI-driven tools such as chatbots, automated record systems, predictive scheduling platforms, and intelligent data analytics systems are integrated into university administrative processes. These tools are designed to reduce human intervention in repetitive tasks, improve accuracy in record management, and enhance real-time institutional decision-making. Administrative efficiency, on the other hand, is conceptualized as the degree of effectiveness with which Business Education Faculties manage academic and administrative responsibilities, including student records processing, examination coordination, staff workload allocation, and communication flow, with minimal delays and errors.

Despite global advancements in AI integration, the situation in many Nigerian public universities remains largely characterized by partial digitalization rather than full-scale intelligent automation. Empirical evidence suggests that universities in Nigeria still rely heavily on manual administrative systems or semi-digitized platforms that lack intelligent decision-support capabilities (Olorunfemi & Aina, 2023; Eze & Okeke, 2024). In institutions such as the University of Benin (UNIBEN), Ambrose Alli University (AAU), and Delta State University (DELSU), administrative processes within Business Education Faculties are often slowed by inefficiencies such as delayed record processing, duplication of data entry, poor integration of institutional databases, and ineffective communication channels. These challenges are further exacerbated by infrastructural limitations such as unstable electricity supply, inadequate ICT facilities, and insufficient digital literacy among administrative personnel (Akinola & Salawu, 2023).

In contrast, universities in developed economies have successfully integrated AI-enabled Enterprise Resource Planning (ERP) systems that support real-time analytics, automated workflow management, and intelligent student service delivery systems. These systems significantly enhance institutional responsiveness, reduce administrative burden, and improve data-driven decision-making processes (Holmes et al., 2022). The widening gap between developed and developing higher education systems therefore highlights a critical challenge for Nigerian universities in achieving global competitiveness and operational efficiency.

Empirical studies have shown that while awareness of Artificial Intelligence is increasing among academic and administrative staff in Nigerian universities, actual implementation remains limited. For instance, Bali et al. (2024) observed that although AI has the potential to transform higher education administration in Nigeria, its adoption is still in early stages due to infrastructural and policy constraints. Similarly, Olorunfemi and Aina (2023) found that while university staff demonstrate moderate awareness of AI tools, their practical usage remains low due to inadequate institutional support and limited training opportunities. These findings suggest a significant disconnect between technological potential and institutional reality. Furthermore, Mtebe and Kondoro (2022) argued that digital transformation in African higher education is constrained by systemic barriers including poor ICT infrastructure, limited funding, and insufficient human capacity development. In Nigeria, Okoye and Nwafor (2022) emphasized that institutional readiness—including leadership commitment, policy frameworks, and technical capacity—is a key determinant of successful technology adoption in universities. These studies collectively highlight that the adoption of AI in higher education is not solely a technological issue but also an organizational and structural challenge.

Despite the growing body of literature on Artificial Intelligence in education, a significant knowledge gap still exists. First, most existing studies focus primarily on pedagogical applications of AI, such as teaching, learning analytics, and student engagement, with limited attention to

administrative applications within higher education institutions. Second, there is a paucity of empirical studies specifically examining AI adoption within Business Education Faculties, despite their high administrative complexity and data-intensive operations. Third, existing Nigerian studies tend to address general ICT adoption rather than focusing specifically on Artificial Intelligence as a distinct technological innovation with unique capabilities and implications.

Additionally, there is limited empirical evidence on the relationship between AI adoption and administrative efficiency in Nigerian public universities, particularly using structured quantitative approaches that measure adoption levels, perceived efficiency outcomes, and implementation barriers simultaneously. This creates a critical gap in understanding how AI technologies are actually utilized within university administrative systems and the extent to which they contribute to operational effectiveness.

The justification for this study therefore lies in its relevance to contemporary higher education transformation and policy development. In an era where universities are increasingly expected to operate as efficient, data-driven, and technologically enabled institutions, understanding the role of Artificial Intelligence in improving administrative efficiency becomes imperative. The study provides empirical evidence that can inform university administrators, policymakers, and ICT stakeholders on how to effectively integrate AI into administrative systems to enhance service delivery and institutional performance. Moreover, the study contributes to addressing the digital divide between developed and developing higher education systems by providing context-specific insights into the challenges and opportunities of AI adoption in Nigerian universities. It also offers practical recommendations for improving institutional readiness, strengthening ICT infrastructure, and enhancing staff capacity for effective AI utilization. Ultimately, this study is significant in advancing the discourse on digital transformation in African higher education and promoting sustainable administrative efficiency through intelligent technologies.

Theoretical and Empirical Review

This study is anchored on two interrelated theoretical frameworks: the Technology Acceptance Model (TAM) and the Diffusion of Innovation Theory (DOI). The Technology Acceptance Model, originally developed by Davis (1989), posited that an individual's intention to adopt and use a technology is primarily determined by perceived usefulness and perceived ease of use. Within the context of higher education administration, TAM provides a useful lens for understanding how administrative staff in Nigerian universities perceive and adopt AI-based systems. When AI tools are perceived to enhance productivity, reduce workload, and simplify administrative tasks, their likelihood of acceptance increases significantly.

Complementarily, Rogers' Diffusion of Innovation Theory explains the process through which new technologies are communicated and adopted within a social system over time. The theory identifies categories of adopters—innovators, early adopters, early majority, late majority, and laggards—and emphasizes the role of communication channels, social systems, and perceived innovation characteristics in shaping adoption rates. In Nigerian universities, AI adoption remains largely within the early adopter stage, primarily due to infrastructural constraints, institutional inertia, and limited exposure to advanced digital systems (Rogers, 2003; Ojo & Babalola, 2022). Empirical literature increasingly highlights the transformative potential of Artificial Intelligence in higher education administration globally. Dwivedi et al. (2021) observed that AI significantly enhances decision-making accuracy, reduces operational delays, and improves institutional responsiveness in higher education systems. Similarly, UNESCO (2023) reported that AI-driven systems are increasingly being used to improve data management, student engagement, and institutional governance structures across global universities.

Within the African context, digital transformation in higher education remains uneven. Mtebe and Kondoro (2022) argued that many African universities face persistent barriers to AI adoption, including inadequate ICT infrastructure, insufficient funding, and limited digital competence among staff. Their findings emphasize that while policy frameworks exist in some institutions, implementation gaps remain substantial. In Nigeria specifically, empirical studies have begun to

document the gradual emergence of AI awareness within tertiary institutions. Olorunfemi and Aina (2023) found that administrative staff in Nigerian public universities demonstrate moderate awareness of AI tools but exhibit low levels of actual implementation due to inadequate institutional support and lack of structured training programmes. Similarly, Eze, Nwosu, and Chukwu (2024) observed that although universities are increasingly digitizing administrative processes, AI integration remains minimal and largely restricted to basic automation systems rather than advanced intelligent platforms.

Furthermore, Adeoye and Okoli (2024) highlighted that AI-enabled systems such as automated grading software, intelligent scheduling tools, and digital record management systems significantly reduce administrative workload and enhance efficiency in Nigerian tertiary institutions. However, they caution that ethical concerns, including data privacy risks, algorithmic bias, and unequal access to digital infrastructure, pose significant challenges to sustainable AI adoption. In addition, Okoye and Nwafor (2022) emphasized that institutional readiness remains a critical determinant of AI adoption in Nigerian universities. Their study shows that leadership commitment, funding availability, and staff digital literacy collectively influence the successful integration of intelligent systems into administrative processes. Hence, the literature demonstrates a consistent pattern: while the potential benefits of Artificial Intelligence in higher education administration are widely acknowledged, actual adoption—particularly within Business Education Faculties in Nigeria—remains uneven, constrained, and at a formative stage. This gap between potential and practice underscores the relevance of the present study in contributing empirical evidence to guide policy, institutional planning, and technological investment in Nigerian universities.

Research Questions

The following research questions were answered in this study:

1. What is the level of AI adoption for administrative tasks in Business Education Faculties in public universities in Edo and Delta States?
2. What are the perceived effects of AI adoption on administrative efficiency in Business Education Faculties?
3. What are the major challenges limiting the adoption of AI in administrative processes in Business Education Faculties?

Methods

This study adopted a descriptive survey research design, considered appropriate for eliciting systematic, factual, and quantifiable information on existing conditions without manipulating variables. The design is particularly suitable for this investigation as it enables the researcher to obtain the perceptions, experiences, and evaluations of academic and administrative staff regarding the adoption of Artificial Intelligence (AI) and its influence on administrative efficiency in Business Education Faculties. In line with established educational research traditions, the descriptive survey design provides a robust framework for examining relationships and trends within real-life institutional settings, especially in contexts where experimental control is impracticable (Cohen et al., 2022).

The population for this study comprised all academic and administrative staff in the Business Education Faculties of selected public universities in Edo and Delta States, Nigeria, namely the UNIBEN, AAU, Ekpoma, and DELSU, Abraka. These institutions were purposively selected based on their relevance to business and teacher education as well as differences in ICT infrastructure and digital readiness, which provide a suitable context for examining Artificial Intelligence (AI) adoption in administrative processes. The target population included lecturers, faculty officers, departmental secretaries, examination officers, and administrative support staff involved in academic and administrative operations. These groups were considered appropriate due to their direct involvement in record management, student administration, and institutional decision-making processes where AI applications are increasingly relevant. A stratified random sampling

technique was adopted to ensure proportional representation of academic and administrative staff across the three universities. From the accessible population, a total sample size of 180 respondents was selected. Respondents within each stratum were then randomly selected using simple random sampling to ensure equal chance of participation and reduce selection bias. This approach enhanced the representativeness and reliability of the study findings.

A structured questionnaire titled “Artificial Intelligence and Administrative Efficiency Questionnaire (AIAEQ)” was developed by the researcher as the primary instrument for data collection. The instrument was carefully constructed based on extensive literature review on Artificial Intelligence adoption, educational technology integration, and administrative efficiency indicators. The questionnaire was designed using a 4-point scale ranging from Strongly Agree (4), Agree (3), Disagree (2), to Strongly Disagree (1), ensuring the elimination of a neutral midpoint and encouraging decisive responses from respondents.

To ensure content validity, the instrument was subjected to rigorous scrutiny by experts in Business Education, Educational Technology, and Measurement and Evaluation. These experts assessed the clarity, relevance, and adequacy of the items in relation to the research objectives. Their feedback led to the refinement of ambiguous items, improvement in language precision, and alignment of constructs with measurable indicators of AI adoption and administrative efficiency. The reliability of the instrument was established through a pilot test conducted outside the study area, after which the internal consistency of the questionnaire was determined using Cronbach’s Alpha reliability coefficient. The instrument yielded a reliability index of .82, which indicates a high level of internal consistency and confirms that the instrument is sufficiently reliable for data collection in educational research contexts (Nunnally & Bernstein, 2019).

A total of 180 respondents were selected for the study using stratified random sampling technique. This sampling approach was adopted to ensure proportional representation of both academic and administrative staff across the selected universities. Stratification was based on institutional affiliation and staff category, thereby ensuring that the sample adequately reflects the diversity of perspectives within Business Education Faculties. Data collected from respondents were analyzed using descriptive statistics, specifically mean and standard deviation, to answer the research questions. The use of mean scores enabled the determination of average response patterns, while standard deviation provided insights into the degree of consensus or variability among respondents. A decision benchmark of 2.50 on the 4-point Likert scale was adopted; mean scores equal to or above 2.50 were interpreted as agreement or acceptance, while scores below 2.50 were interpreted as disagreement or rejection of the statement.

Results

Research Question 1: What is the level of Artificial Intelligence adoption in administrative tasks in Business Education Faculties of public universities in Edo and Delta States, Nigeria?

Table 1

Level of Artificial Intelligence Adoption in Administrative Tasks in Business Education Faculties

AI Administrative Tools	UNIBEN Mean	AAU Mean	DELSU Mean	Grand Mean	Decision
Automated record systems	2.80	2.60	2.50	2.63	Moderate
AI chatbots for student inquiries	2.40	2.30	2.20	2.30	Low
Predictive scheduling systems	2.55	2.45	2.40	2.47	Low
Digital examination processing	2.90	2.70	2.60	2.73	Moderate
AI-based data analytics tools	2.35	2.20	2.10	2.22	Low

The findings in Table 1 reveal that the overall level of AI adoption is low to moderate, with a cluster of mean scores ranging from 2.22 to 2.73, which is marginally above or below the 2.50 decision threshold. Only two indicators—automated record systems (Grand Mean = 2.63) and

digital examination processing (Grand Mean = 2.73)—fell within the moderate adoption range, indicating partial digitization rather than intelligent automation. The remaining indicators, particularly AI chatbots (2.30) and data analytics tools (2.22), fall clearly below the acceptable threshold, signifying weak integration of advanced AI systems. From a critical standpoint, this pattern suggests that Business Education Faculties in the selected Nigerian universities are operating at a basic digital transformation stage rather than a mature AI-driven administrative ecosystem. The narrow margin between moderate and low adoption further indicates institutional fragility in technological integration. This aligns with the view that AI deployment in Nigerian universities is still largely experimental and fragmented, reflecting systemic infrastructural and capacity constraints rather than strategic institutional adoption.

Research Question 2: What are the perceived effects of Artificial Intelligence adoption on administrative efficiency in Business Education Faculties in public universities in Edo and Delta States, Nigeria?

Table 2

Perceived Effects of Artificial Intelligence Adoption on Administrative Efficiency

Efficiency Indicators	UNIBEN Mean	AAU Mean	DELSU Mean	Grand Mean	Decision
Faster service delivery	3.10	2.95	2.90	2.98	Agreed
Improved accuracy of records	3.20	3.00	2.85	3.02	Agreed
Reduced workload for staff	3.05	2.90	2.80	2.92	Agreed
Enhanced decision-making	3.00	2.85	2.75	2.87	Agreed
Improved communication systems	3.15	3.00	2.90	3.02	Agreed

The data in Table 2 indicate that respondents strongly perceive AI adoption as beneficial to administrative efficiency, with all grand mean scores ranging between 2.87 and 3.02, which are significantly above the 2.50 benchmark. The highest-rated benefits—improved accuracy of records and communication systems (both 3.02)—suggest that AI is particularly valued for enhancing information integrity and institutional coordination. Similarly, faster service delivery (2.98) indicates perceived improvements in turnaround time for administrative processes. From a critical analytical perspective, these findings demonstrate a clear perception–implementation gap, where AI is recognized as highly beneficial despite its relatively low actual adoption (as shown in Research Question 1). This suggests that administrative staff are aware of AI’s transformative potential but are constrained by infrastructural, technical, and policy limitations. The consistency of mean scores across institutions also indicates a shared systemic perception, reinforcing the argument that AI is universally viewed as efficiency-enhancing within Nigerian higher education administration, even if practical integration remains limited.

Research Question 3: What are the challenges limiting the adoption of Artificial Intelligence in administrative processes in Business Education Faculties in public universities in Edo and Delta States, Nigeria?

Table 3

Challenges Limiting Artificial Intelligence Adoption in Business Education Faculties

Challenge Indicators	UNIBEN Mean	AAU Mean	DELSU Mean	Grand Mean	Decision
Lack of technical skills	3.40	3.30	3.25	3.32	Agreed
Poor ICT infrastructure	3.50	3.45	3.40	3.45	Agreed
High cost of AI systems	3.30	3.20	3.10	3.20	Agreed
Resistance to change	3.25	3.10	3.05	3.13	Agreed
Lack of institutional policy	3.35	3.20	3.15	3.23	Agreed

The results in Table 3 reveal a consistently high agreement across all challenge indicators, with grand mean values ranging from 3.13 to 3.45, significantly above the acceptance threshold. The most critical constraint identified is poor ICT infrastructure (3.45), followed closely by lack of

technical skills (3.32). These high mean scores indicate that respondents perceive structural and human-capacity limitations as the dominant barriers to AI adoption. From a critical perspective, the clustering of high mean values suggests that the barriers to AI adoption are not isolated but systemic and interdependent, reinforcing each other in a cycle of underdevelopment. For example, inadequate infrastructure limits exposure to AI tools, which in turn reduces staff competence, while absence of institutional policy further weakens structured implementation. This finding reflects a deeper institutional readiness gap in Nigerian universities, where technological adoption is constrained not only by funding but also by governance, leadership prioritization, and strategic planning deficiencies.

Discussions

The findings of this study reveal that Business Education Faculties in Nigerian public universities are operating within a transitional digital environment, where basic automation systems exist but the deployment of full Artificial Intelligence (AI) capabilities remains limited, uneven, and largely fragmented. Although respondents acknowledged the potential of AI to enhance administrative efficiency, actual implementation remains constrained by infrastructural deficiencies, inadequate technical capacity, institutional inertia, and weak policy frameworks. This situation reflects a broader pattern within the Nigerian higher education system, where digital transformation is often characterized by partial adoption rather than full systemic integration (Olorunfemi & Aina, 2023; Eze & Okeke, 2024).

From a critical standpoint, the results of research question 1 confirm that AI adoption is still in its early-to-moderate stage, with only basic administrative functions such as record systems and examination processing showing partial automation. Advanced AI tools such as chatbots, predictive scheduling systems, and data analytics platforms remain largely underutilized. This finding supports the argument that Nigerian universities are not yet operating within a fully intelligent administrative ecosystem but are instead relying on hybrid systems that combine manual processes with limited digital tools. In practical terms, this indicates that AI integration is still largely experimental, inconsistent, and dependent on isolated departmental initiatives rather than institutional-wide strategy.

Conversely, the findings of Research Question Two demonstrate a strong perception among respondents that AI significantly enhances administrative efficiency. High mean scores across all efficiency indicators suggest that staff clearly recognize the benefits of AI in improving accuracy, reducing workload, and enhancing service delivery. This creates an important paradox: while AI is widely perceived as beneficial, its actual adoption remains low. This disconnect between perception and implementation can be explained by structural constraints within Nigerian universities, including unstable electricity supply, inadequate funding for ICT infrastructure, and limited access to specialized training programmes. In essence, the perceived value of AI is not matched by institutional readiness for implementation.

This outcome both supports and challenges the Technology Acceptance Model (TAM). On one hand, the high perceived usefulness of AI among respondents strongly validates TAM's central assumption that perceived usefulness drives positive attitudes toward technology adoption. On the other hand, the study reveals that perceived usefulness alone is insufficient to guarantee actual adoption in contexts such as Nigeria, where external constraints such as infrastructure, funding, and organizational readiness play a more decisive role. This extends TAM beyond its original behavioural focus, suggesting that in developing economies, adoption is not merely a psychological decision but a structurally constrained process.

Similarly, the findings align with the Diffusion of Innovation Theory (DOI), particularly in relation to the slow pace of AI diffusion within the studied universities. Rogers' assertion that innovation adoption depends on communication channels, institutional readiness, and perceived complexity is clearly reflected in the Nigerian context. The low adoption of advanced AI tools suggests that AI is still perceived as complex, expensive, and technically demanding. Furthermore,

the absence of strong institutional policies and leadership-driven digital transformation strategies slows down the movement of AI from early adopters to the early majority stage. In this sense, Nigerian universities appear to be trapped between awareness and implementation stages of innovation diffusion. However, while the theoretical frameworks adequately explain behavioural acceptance and diffusion patterns, they are less sufficient in capturing the structural inequalities and infrastructural deficits that define the Nigerian higher education system. For instance, even when staff are willing to adopt AI systems, inadequate ICT infrastructure, irregular power supply, and limited institutional funding significantly restrict actual usage. This indicates that technology adoption in Nigerian universities is not only a matter of acceptance or diffusion but also one of systemic capacity and governance readiness.

The findings of Research Question Three further reinforce this argument by identifying poor ICT infrastructure, lack of technical skills, high cost of AI systems, resistance to change, and weak institutional policies as major constraints. Notably, the dominance of infrastructure-related challenges suggests that the problem is less about willingness and more about capability. This aligns with broader African higher education studies which argue that digital transformation is often hindered by foundational systemic weaknesses rather than user resistance alone (Mtebe & Kondoro, 2022). In addition, resistance to change—though moderately rated compared to infrastructure—still indicates a behavioural dimension of the problem. This suggests that while some staff are open to AI adoption, others remain skeptical due to fear of job displacement, lack of familiarity, or inadequate training. This duality reflects a mixed institutional culture where innovation acceptance coexists with technological apprehension.

Finally, the findings reveal a complex interaction between positive perceptions, limited adoption, and structural constraints. While staff recognize the value of AI in improving efficiency, institutional realities significantly limit its practical implementation. This underscores the need to move beyond theoretical acceptance models and incorporate infrastructural, policy, and capacity-building dimensions into understanding technology adoption in Nigerian universities. In doing so, the study contributes to a more context-sensitive interpretation of AI integration in developing economies, where innovation adoption is shaped not only by perception and diffusion processes but also by systemic readiness and institutional capability.

Conclusion and Recommendations

The study concludes that the adoption of Artificial Intelligence (AI) within Business Education Faculties of public universities in Edo and Delta States, Nigeria, is still in an emergent and transitional stage of development. Empirical evidence from the study indicates that while certain administrative functions—particularly automated record systems and digital examination processing—have achieved partial digitization, the integration of more advanced AI tools such as chatbots, predictive analytics, and intelligent decision-support systems remains limited. The findings demonstrate a consistent pattern of moderate to low AI adoption, despite a strong awareness among respondents of its potential to enhance administrative efficiency. This indicates a significant gap between perceived usefulness and actual implementation, largely driven by infrastructural deficiencies, limited technical competencies, high cost of deployment, and weak institutional policy frameworks. Consequently, administrative efficiency in the studied universities remains only partially optimized, suggesting that AI-driven transformation in Nigerian higher education administration is still at a developmental rather than fully operational stage.

The following recommendations were made based on findings:

1. University management and governing councils should prioritize investment in integrated AI-driven administrative platforms such as Enterprise Resource Planning (ERP) systems, intelligent student information systems, and automated workflow management tools. These systems will reduce manual workload, improve data accuracy, and enhance institutional responsiveness.

2. Regular and structured training programmes should be organized for academic and administrative staff to improve AI literacy, digital competence, and system usability skills. Such training should be embedded within staff development policies to ensure continuous professional adaptation to emerging technologies.
3. Government agencies and university authorities should collaboratively invest in robust ICT infrastructure, including stable internet connectivity, cloud-based systems, digital laboratories, and uninterrupted power supply solutions. Without this foundational support, AI adoption will remain superficial and unsustainable.
4. Universities should develop clear policy frameworks guiding the ethical use, implementation, and governance of AI systems in administrative processes. These policies should address data privacy, cybersecurity, algorithmic transparency, and role redefinition within automated environments.
5. To address the high cost of AI implementation, universities should engage in strategic partnerships with technology firms, telecommunications companies, and educational technology providers. Such collaborations can facilitate funding support, technical expertise transfer, and subsidized access to advanced AI solutions.

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AI-DRIVEN CAREER COUNSELLING: EMERGING TRENDS, CHALLENGES AND OPPORTUNITIES IN THE DIGITAL AGE

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Abstract

This paper examined the role of AI in enhancing career counselling services within the context of the digital age. Specifically, it conceptualizes Artificial Intelligence, career counselling, AI-driven career counselling, and career development in the digital era. The paper argued that AI technologies, including machine learning, natural language processing, predictive analytics, recommender systems, and generative AI, enhance career counselling by analyzing learners' interests, competencies, personality traits, academic performance, and labour market trends to provide personalized career recommendations. AI also improves access to career information, facilitates lifelong career planning, and supports evidence-based counselling interventions. Despite these opportunities, AI-driven career counselling presents challenges related to algorithmic bias, data privacy, ethical concerns, digital inequality, limited human interaction, and the need for professional oversight. The paper emphasized that AI should complement rather than replace professional career counsellors because effective career counselling requires empathy, ethical judgment, contextual understanding, and interpersonal relationships that remain uniquely human. The paper concluded that effective integration of AI into career counselling therefore was required to boost robust ethical governance, professional competence, digital inclusion, interdisciplinary collaboration, and continuous evaluation to ensure sustainable, equitable, and human-centered career counselling in the digital age.

Keywords: AI, AI-Driven Career Counselling, Career Counselling, Career Development, Digital Age

Introduction

The 21st century has witnessed unprecedented advances in digital technologies that continue to reshape education, employment, and workforce development across the globe. Among these innovations, Artificial Intelligence (AI) has emerged as one of the most transformative technologies, influencing how individuals learn, communicate, work, and make career decisions. AI has moved beyond industrial automation and computer science to become an integral component of education, business, healthcare, governance, and human resource development, with significant implications for career counselling and lifelong career development (Luckin, 2018; Holmes et al., 2022; UNESCO, 2023).

Career counselling remains a fundamental component of educational and vocational development. It assists individuals in understanding their interests, abilities, values, personality characteristics, and career aspirations while enabling them to make informed educational, occupational, and life decisions. Professional career counsellors provide guidance that promotes career exploration, educational planning, employability skills, career adaptability, and successful transitions into the world of work (National Career Development Association [NCDA], 2021; Niles & Harris-Bowlsbey, 2017). However, globalization, technological disruption, changing labour market demands, and the emergence of new occupations have made career decision-making increasingly complex, creating greater demand for accessible, personalized, and evidence-based career guidance services (OECD, 2021).

Artificial Intelligence offers significant opportunities for transforming career counselling by supporting intelligent career assessment, personalized career recommendations, labour market forecasting, competency mapping, and real-time access to career information. AI-powered technologies can analyze learners' academic performance, interests, skills, personality traits, and labour market data to recommend suitable educational pathways and occupational opportunities. Similarly, generative AI applications such as Chat-GPT, Gemini, Claude, and Microsoft Copilot provide learners with immediate access to career information, résumé development, interview preparation, scholarship opportunities, and career planning resources (Holmes et al., 2022; UNESCO, 2023).

Despite these transformative opportunities, AI-driven career counselling presents important ethical, technological, and professional challenges. Issues relating to algorithmic bias, data privacy, confidentiality, digital inequality, transparency, accountability, and overreliance on automated recommendations have raised concerns regarding the responsible use of AI in career guidance. Furthermore, although AI excels in analyzing large datasets and generating recommendations, it lacks the empathy, emotional intelligence, ethical reasoning, and contextual understanding required for effective counselling relationships (Floridi & Cowls, 2019; UNESCO, 2023).

Consequently, AI should be regarded as a complementary tool that enhances rather than replaces professional career counsellors. Human counsellors remain indispensable in facilitating self-understanding, addressing psychosocial concerns, interpreting career information within individual contexts, and supporting clients through complex career transitions. The integration of AI into career counselling should therefore promote collaborative human-AI interaction that combines technological efficiency with professional expertise and ethical practice.

Against this background, this paper examines AI-driven career counselling in the digital age by conceptualizing Artificial Intelligence, career counselling, AI-driven career counselling, and career development in the digital era while providing a foundation for discussing the applications, opportunities, challenges, and future directions of AI-enabled career guidance.

Concept of Artificial Intelligence

Artificial Intelligence (AI) refers to the branch of computer science concerned with developing intelligent systems capable of performing tasks that normally require human intelligence, including learning, reasoning, problem-solving, language processing, pattern recognition, prediction, and decision-making (Russell & Norvig, 2021). AI technologies employ computational techniques such as machine learning, deep learning, natural language processing, computer vision, and expert systems to analyze large volumes of data, generate insights, and automate complex tasks.

According to UNESCO (2023), Artificial Intelligence encompasses computer systems capable of performing cognitive functions associated with human intelligence through learning from data, recognizing patterns, interpreting language, and supporting intelligent decision-making. Within career counselling, AI facilitates career assessment, labour market analysis, occupational matching, personalized recommendations, and career planning by integrating educational and employment data to support informed career decisions (Holmes et al., 2022).

Recent advances in Generative Artificial Intelligence have significantly expanded AI applications in career development. Large Language Models (LLMs), including ChatGPT, Gemini, Claude, and Microsoft Copilot, generate human-like responses that assist learners with career exploration, résumé writing, interview preparation, scholarship searches, skills identification, and professional development. Nevertheless, AI-generated recommendations require professional validation because they may occasionally produce inaccurate, incomplete, or biased outputs (OpenAI, 2023; UNESCO, 2023). From a career development perspective, AI should be viewed as an intelligent decision-support technology that complements professional expertise by improving access to career information, enhancing labour market intelligence, and facilitating personalized career guidance.

Career Counselling

Career counselling is a systematic professional process through which individuals receive assistance in understanding themselves and the world of work in order to make informed educational, vocational, and occupational decisions. It enables individuals to identify their interests, abilities, values, personality traits, aspirations, and competencies while developing realistic career goals and lifelong career management skills (Niles & Harris-Bowlsbey, 2017; NCDA, 2021).

Career counselling encompasses career assessment, career exploration, educational planning, occupational information, employability development, career decision-making, job search preparation, career transitions, and lifelong career development. Professional career counsellors utilize standardized assessment tools, counselling interviews, labour market information, and evidence-based interventions to support clients in achieving satisfying and productive careers (Brown & Lent, 2020).

In educational settings, career counselling assists learners in selecting appropriate subjects, educational programmes, higher education opportunities, and career pathways that align with their interests, competencies, and future aspirations. It also promotes career adaptability, resilience, lifelong learning, and successful transitions into employment within rapidly changing labour markets.

AI-Driven Career Counselling

AI-driven career counselling refers to the application of Artificial Intelligence technologies to enhance career guidance and counselling through intelligent data analysis, personalized recommendations, predictive analytics, virtual career assistants, and automated decision-support systems. It combines AI capabilities with professional counselling practices to improve the quality, accessibility, efficiency, and effectiveness of career services (OECD, 2021; Holmes et al., 2022).

AI-powered career counselling systems analyze individuals' academic records, interests, personality characteristics, skills, competencies, career aspirations, and labour market trends to recommend suitable educational programmes, occupations, and professional development opportunities. These systems also provide real-time career information, identify emerging occupations, forecast labour market demands, and recommend pathways for skills acquisition and lifelong learning (Luckin, 2018; UNESCO, 2023).

Generative AI applications further enhance career counselling by assisting users with career exploration, résumé development, cover letter writing, interview preparation, networking strategies, and professional communication. However, AI-driven recommendations should always be interpreted within the broader personal, social, cultural, and economic contexts of clients. Consequently, professional career counsellors remain responsible for ethical decision-making, emotional support, contextual interpretation, and individualized career interventions.

Career Development in the Digital Age

Career development in the digital age refers to the continuous process through which individuals acquire the knowledge, skills, competencies, and adaptability required to navigate rapidly evolving educational environments and technology-driven labour markets. The digital revolution has fundamentally transformed the nature of work by introducing automation, artificial intelligence, remote work, digital entrepreneurship, platform economies, and emerging occupations that require continuous risk-taking and lifelong learning (OECD, 2021; World Economic Forum, 2025).

Modern career development emphasizes digital literacy, technological competence, creativity, critical thinking, collaboration, adaptability, emotional intelligence, and lifelong employability. Individuals are increasingly expected to engage in continuous professional development to remain competitive in dynamic labour markets shaped by technological innovation (World Economic Forum, 2025).

Artificial Intelligence plays a pivotal role in supporting career development by providing personalized career planning, labour market forecasting, competency assessment, and adaptive

learning opportunities. Through intelligent career guidance systems, individuals can identify emerging career opportunities, anticipate future skill requirements, monitor labour market trends, and make informed educational and occupational decisions. Consequently, AI has become an essential enabler of lifelong career development in the digital age, provided its implementation remains ethical, equitable, transparent, and centred on the needs of learners and job seekers (Holmes et al., 2022; UNESCO, 2023).

Theoretical Formation

This paper is anchored on the Social Cognitive Career Theory (SCCT), Career Construction Theory (CCT), and the Technology Acceptance Model (TAM), which collectively provide a robust framework for understanding AI-driven career counselling. SCCT explains that career development is influenced by self-efficacy, outcome expectations, and personal goals, suggesting that AI-powered career guidance can strengthen career confidence, enhance self-awareness, and support informed career decision-making through personalized recommendations (Lent et al., 1994; Brown & Lent, 2020; Holmes et al., 2022).

Career Construction Theory emphasizes career adaptability and lifelong career development, highlighting AI's role in providing real-time labour market information, identifying emerging occupations, recommending risk-taking opportunities, and supporting continuous career planning in a dynamic digital economy (Savickas, 2013; UNESCO, 2023; World Economic Forum, 2025).

The Technology Acceptance Model posits that the adoption of AI technologies depends largely on perceived usefulness and perceived ease of use. Accordingly, career counsellors and learners are more likely to embrace AI-driven career guidance systems when they are user-friendly, reliable, accessible, and capable of improving career exploration, educational planning, and employability (Davis, 1989; Venkatesh & Davis, 2000; Holmes et al., 2022). Collectively, these theories demonstrate that successful AI-driven career counselling requires technological acceptance, career adaptability, and professional human support to ensure ethical, personalized, and effective career guidance.

AI-Driven Innovations in Career Counselling

Artificial Intelligence (AI) has transformed career counselling by introducing intelligent technologies that improve the accessibility, accuracy, efficiency, and personalization of career guidance services. Through advanced technologies such as machine learning, natural language processing, predictive analytics, recommender systems, and generative AI, career counsellors are increasingly able to support clients with evidence-based career planning, labour market intelligence, and individualized career development. Rather than replacing professional counsellors, AI serves as an intelligent decision-support tool that enhances career interventions while preserving the indispensable human elements of empathy, ethical judgment, and contextual understanding (OECD, 2021; Holmes et al., 2022; UNESCO, 2023).

Major AI-driven innovations in career counselling include the following:

1. **Intelligent Career Guidance Systems:** Intelligent career guidance systems employ AI algorithms to analyze individuals' interests, abilities, academic achievements, personality characteristics, career aspirations, and labour market trends in order to recommend suitable educational and occupational pathways. These systems provide timely, evidence-based career information that supports informed career decision-making while improving the efficiency and accessibility of career guidance services. They also enable users to explore educational programmes, occupational requirements, scholarship opportunities, and professional development pathways in real time (OECD, 2021; Holmes et al., 2022).
2. **AI-Powered Career Assessment:** AI has enhanced traditional career assessment by integrating psychometric testing with intelligent data analysis. AI-powered assessment systems evaluate individuals' interests, values, personality traits, cognitive abilities, competencies, and career readiness to generate comprehensive career profiles and

personalized occupational recommendations. These systems improve assessment accuracy while enabling counsellors to provide individualized guidance that aligns with clients' strengths and long-term career goals (Niles & Harris-Bowlsbey, 2017; Brown & Lent, 2020).

3. **Machine Learning for Career Prediction:** Machine learning algorithms analyze extensive educational, behavioural, and labour market datasets to identify patterns associated with career success, employability, educational attainment, and workforce demands. These predictive capabilities enable AI systems to forecast suitable career pathways, identify future skill requirements, and recommend educational programmes that align with evolving labour market needs. Such predictive analyses support proactive career planning and improve the quality of career decision-making (Romero & Ventura, 2020; Russell & Norvig, 2021).

4. **Chat-bots and Virtual Career Advisers:** AI-powered chat-bots and virtual career advisers provide immediate and continuous access to career information and guidance. These conversational systems respond to users' enquiries regarding career options, university admissions, scholarship opportunities, internship programmes, professional certifications, resume preparation, and interview techniques. They enhance the accessibility of career counselling services by providing twenty-four-hour support while referring complex career concerns to professional counsellors for personalized intervention (Abd-Alrazaq et al., 2020; Holmes et al., 2022).

5. **Labour Market Analytics:** AI significantly strengthens labour market intelligence by continuously analyzing employment trends, occupational forecasts, salary patterns, industry demands, and emerging professions. Career counsellors and clients can utilize these insights to understand workforce dynamics, identify high-demand occupations, anticipate future employment opportunities, and make evidence-based educational and vocational decisions. Labour market analytics also assists educational institutions in aligning academic programmes with current and future workforce requirements (OECD, 2021; World Economic Forum, 2025).

6. **Generative AI for Career Planning:** Recent advances in generative AI have transformed career planning by enabling learners to interact with intelligent conversational systems such as Chat-GPT, Gemini, Claude, and Microsoft Copilot. These technologies assist users in career exploration, educational planning, résumé writing, cover letter development, interview preparation, networking strategies, scholarship searches, and professional communication. Generative AI also supports counsellors by producing career resources, summarizing labour market information, and facilitating career education. Nevertheless, AI-generated recommendations require professional validation to ensure accuracy, contextual relevance, and ethical appropriateness (Open AI, 2023; UNESCO, 2023).

7. **Personalized Career Recommendations:** AI enables highly personalized career counselling by integrating multiple sources of information, including academic records, interests, personality characteristics, competencies, values, career aspirations, and labour market trends. Intelligent recommender systems analyze these variables to provide individualized career pathways, educational opportunities, skills development programmes, and professional certifications that correspond to each client's unique profile. Such personalized guidance improves career satisfaction, career readiness, and informed occupational decision-making (Luckin, 2018; Holmes et al., 2022).

8. **Resume Optimization and Interview Coaching:** AI-powered career platforms assist individuals in preparing competitive employment documents by analyzing resumes for content quality, keyword relevance, formatting, and alignment with specific job descriptions. AI also provides simulated interview environments that evaluate verbal responses, communication skills, confidence, and behavioural competencies while offering constructive feedback for improvement. These innovations enhance employability and prepare job seekers for increasingly competitive recruitment processes (OpenAI, 2023; World Economic Forum, 2025).

9. **AI-Supported Lifelong Career Development:** Career development has become a continuous lifelong process requiring regular reskilling, upskilling, and career adaptation in

response to technological advancement and changing labour markets. AI supports lifelong career development by monitoring labour market changes, identifying emerging skill requirements, recommending professional development opportunities, and facilitating continuous career planning throughout an individual's working life. Through intelligent career management systems, AI empowers individuals to remain adaptable, competitive, and resilient in the rapidly evolving digital economy (Savickas, 2013; UNESCO, 2023; World Economic Forum, 2025).

Generally, these innovations demonstrate that AI is reshaping career counselling by improving access to career information, strengthening personalized guidance, enhancing labour market intelligence, and supporting evidence-based career decision-making. However, the effectiveness of these technologies depends on ethical governance, digital inclusion, professional oversight, and the continued involvement of qualified career counsellors who provide empathy, contextual interpretation, and ethical judgment. Consequently, AI should be viewed as a strategic partner that enhances rather than replaces the professional expertise of career counsellors.

Emerging AI Innovations in Career Counselling

The rapid advancement of Artificial Intelligence (AI) has introduced innovative technologies that are reshaping career counselling by improving career exploration, employability, career decision-making, and lifelong career development. Recent developments in generative AI, predictive analytics, adaptive learning systems, immersive technologies, and intelligent labour market analytics have expanded the scope and effectiveness of career guidance services (Holmes et al., 2022; UNESCO, 2023). Major emerging innovations include:

1. **Multimodal Generative AI:** AI systems that integrate text, voice, images, and data to generate personalized career plans, résumés, cover letters, interview responses, and career development resources (OpenAI, 2023).
2. **Intelligent Career Recommendation Systems:** AI-powered recommender systems that analyze users' interests, competencies, personality traits, educational background, and labour market trends to suggest suitable career pathways (Luckin, 2018).
3. **Real-Time Labour Market Intelligence:** AI continuously analyses employment trends, salary projections, emerging occupations, and workforce demands, enabling evidence-based career planning (OECD, 2021; World Economic Forum, 2025).
4. **Virtual and Immersive Career Exploration:** Virtual Reality (VR), Augmented Reality (AR), and Extended Reality (XR) technologies enable learners to experience simulated workplaces and occupations before making career decisions (Holmes et al., 2022).
5. **Adaptive Lifelong Career Development Platforms:** Intelligent systems continuously monitor career progression and recommend reskilling, upskilling, certifications, and professional development opportunities throughout an individual's working life (Savickas, 2013; UNESCO, 2023).

These innovations are making career counselling more personalized, accessible, data-driven, and responsive to the rapidly changing digital economy.

Challenges and Ethical Issues

Despite its numerous benefits, AI-driven career counselling presents several ethical, legal, technological, and professional challenges that require careful management (Floridi & Cowls, 2019; UNESCO, 2023). The major challenges include:

1. **Privacy and Data Security:** AI systems collect and process large volumes of sensitive personal, educational, psychological, and career-related information, increasing concerns about confidentiality and cyber-security.

2. **Algorithmic Bias and Fairness:** Biased datasets may produce discriminatory recommendations that disadvantage individuals based on gender, ethnicity, disability, or socioeconomic background.

3. **Lack of Human Empathy:** AI cannot fully replicate empathy, emotional intelligence, ethical reasoning, or cultural sensitivity, which remain fundamental to effective career counselling.

4. **Accuracy and Reliability:** Generative AI systems may occasionally generate inaccurate or misleading career information, making professional verification essential.

5. **Digital Divide:** Unequal access to digital infrastructure and internet connectivity may prevent some learners from benefiting from AI-enabled career services.

6. **Limited AI Literacy:** Many counsellors and clients lack sufficient knowledge and digital competencies to effectively utilize AI technologies.

7. **Ethical and Legal Concerns:** Issues relating to informed consent, transparency, accountability, intellectual property, and responsible AI governance require comprehensive policy frameworks.

8. **Overdependence on AI:** Excessive reliance on automated systems may diminish critical thinking and reduce meaningful human interaction during career counselling.

Opportunities in AI-Driven Career Counselling

Artificial Intelligence presents significant opportunities for improving the effectiveness, accessibility, and quality of career counselling services. When integrated responsibly, AI complements professional practice by enhancing decision-making and supporting individualized career development (Holmes et al., 2022; UNESCO, 2023). The major opportunities include:

1. Greater accessibility through 24-hour online career guidance and virtual counselling platforms.

2. Personalized career guidance based on individual interests, abilities, values, personality traits, and labour market information.

3. Evidence-based decision-making through predictive analytics and real-time workforce intelligence.

4. Improved employability by supporting résumé development, interview preparation, and professional skills enhancement.

5. Enhanced career exploration through intelligent recommendation systems and immersive technologies.

6. Increased administrative efficiency by automating documentation, scheduling, career information retrieval, and routine counselling tasks.

7. Support for lifelong learning through continuous recommendations for reskilling, upskilling, and professional development.

8. Improved institutional planning by enabling educational institutions to align academic programmes with labour market demands.

9. Better career outcomes through early identification of career interests, emerging opportunities, and future workforce needs.

10. Global access to career information by connecting learners with international educational programmes, scholarships, certifications, and employment opportunities.

However, AI provides unprecedented opportunities to transform career counselling into a more personalized, evidence-based, and future-oriented service. Nevertheless, these opportunities can only be fully realized when AI complements professional counsellors and operates within strong ethical, legal, and institutional frameworks.

Future Directions

The future of AI-driven career counselling lies in its ethical, inclusive, and evidence-based integration into professional practice. As Artificial Intelligence continues to evolve, career counselling is expected to become increasingly personalized, predictive, and data-driven while

maintaining the central role of professional counsellors in facilitating meaningful career development (Holmes et al., 2022; UNESCO, 2023). Future developments should focus on:

1. Developing ethical and transparent AI systems that promote fairness, accountability, explainability, and respect for users' privacy and autonomy (Floridi & Cowsls, 2019; UNESCO, 2023).
2. Integrating multimodal AI technologies, including conversational AI, virtual reality, augmented reality, and predictive analytics, to create immersive and interactive career counselling experiences (Holmes et al., 2022).
3. Expanding personalized lifelong career guidance through AI systems capable of continuously monitoring career progression, labour market trends, and emerging skill requirements (World Economic Forum, 2025).
4. Promoting interdisciplinary collaboration among career counsellors, educational technologists, psychologists, computer scientists, policymakers, and AI developers to ensure that AI applications remain educationally relevant and ethically sound (OECD, 2021).
5. Strengthening empirical research on the effectiveness, cultural responsiveness, ethical implications, and long-term impact of AI-assisted career counselling across diverse educational and workplace contexts (Brown & Lent, 2020).
6. Reducing digital inequalities by expanding access to digital infrastructure, AI technologies, and career guidance services for learners in underserved and marginalized communities (UNESCO, 2023).

Collectively, these future directions will promote responsible AI innovation while ensuring that technological advancement enhances rather than diminishes the human-centred nature of career counselling.

Implications for Counsellor Education and Policy

The growing integration of AI into career counselling has significant implications for counsellor education, professional practice, institutional leadership, and public policy. Preparing career counsellors for the digital era requires substantial reforms in training, professional development, ethical governance, and educational policy. The major implications include:

1. Counsellor education programmes should incorporate AI literacy, digital counselling competencies, data analytics, generative AI applications, and technology ethics into pre-service and in-service training.
2. Professional development programmes should provide continuous training to enable practicing counsellors to effectively utilize emerging AI technologies while maintaining ethical and client-centred practice.
3. Professional counselling associations should develop comprehensive ethical guidelines governing the responsible use of AI in career counselling, including standards for privacy, informed consent, transparency, accountability, and professional responsibility.
4. Educational institutions should invest in reliable digital infrastructure, AI-enabled career guidance platforms, cybersecurity systems, and technical support to facilitate effective implementation.
5. Governments and policymakers should formulate national policy frameworks regulating the adoption, monitoring, quality assurance, and ethical governance of AI applications in career counselling.
6. Higher education institutions and research organizations should promote interdisciplinary research to evaluate the effectiveness, fairness, cultural responsiveness, and long-term outcomes of AI-assisted career counselling.
7. Quality assurance agencies should establish monitoring and evaluation mechanisms to ensure that AI technologies improve counselling outcomes without compromising professional standards or students' rights.

Conclusion

Artificial Intelligence has become a transformative force in career counselling by enhancing career exploration, assessment, decision-making, employability, and lifelong career development through intelligent, data-driven technologies. AI-powered tools improve the accessibility, efficiency, and personalization of career guidance, enabling counsellors to provide more responsive and evidence-based services while empowering individuals to make informed educational and occupational decisions. However, challenges relating to privacy, algorithmic bias, transparency, accountability, and digital inequality underscore the need for ethical and responsible AI implementation.

Consequently, AI should complement rather than replace professional career counsellors, whose empathy, ethical judgment, and contextual understanding remain indispensable. The paper therefore suggests that the effective integration of AI into career counselling was required to enhance robust ethical governance, professional competence, digital inclusion, interdisciplinary collaboration, and continuous evaluation to ensure sustainable, equitable, and human-centered career counselling in the digital era.

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AI-DRIVEN INNOVATION AND PEDAGOGICAL APPLICATIONS TRANSFORMING TEACHING AND LEARNING IN DIGITAL AGE: LEVERAGING AI APPLICATIONS FOR EFFICIENT EDUCATIONAL MANAGEMENT

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Abstract

The fast expansion of Artificial Intelligence (AI) is changing the educational environment by introducing new solutions for education, learning and institutional management. This paper, reviewed the use of AI-enabled tools in pedagogy and educational design, with an emphasis on their ability to offer customized learning paths, enhance student engagement, and streamline administrative processes. Key concepts such as AI-enhanced pedagogy, adaptive learning systems, intelligent tutoring, predictive analytics and automated management were examined, as well as their role in fostering lifelong learning and preparing students for a dynamic, technology-driven world. The paper also acknowledged challenges related to the implementation of AI, including data privacy concerns, equitable access, ethical considerations, and the need for training for educators. Strategies for successful adoption are discussed, emphasizing professional development, infrastructure investment, and aligning AI tools with pedagogical objectives. Suggestions were made to strengthen educational systems so that AI applications can support sustainable, inclusive and future-ready learning environments. Institutions may utilize AI to innovate instruction and operate education effectively, rethinking traditional educational models as agile, data-driven, student-centered ecosystems that can respond to global challenges while serving local needs.

Keywords: Artificial Intelligence in Education, AI-driven Pedagogical Innovation, Adaptive and Personalized Learning Systems, Intelligent Tutoring, Predictive Analytics

Introduction

The global education sector is undergoing a transformation of unprecedented scale with Artificial Intelligence (AI) technologies increasingly being integrated into the teaching, learning and administrative processes. The use of AI in education has become a highly relevant issue for addressing challenges such as large class sizes, lack of resources and inconsistent quality of teaching (Olatunji & Adeoye, 2022). Scholars have argued that the use of artificial intelligence can not only transform instructional delivery but also educational management such that a more efficient, data-driven approach to planning and decision-making can be achieved (Adebayo, 2021).

The relevance of the use of AI-driven innovation when considering Nigeria is in the fact that digital infrastructure is growing while educators are looking for tools that can enhance learner engagement and academic performance. Eze et al. (2023) noted that AI-powered platforms like adaptive learning systems, intelligent tutoring and automated assessment tools are starting to close the gaps in personalized education by providing students with a customized learning experience that caters to their unique learning styles and abilities. In a nation where educational inequities continue to exist across regions and socioeconomic groups, such initiatives are essential to improve outcomes.

AI applications are also not just for use in classrooms. Scholars such as Ajayi and Bello (2022) emphasized the significance of AI in strategic planning and educational management. Institutions

can anticipate enrollment trends, allocate resources optimally, and make well-informed decisions about personnel and curriculum design by utilizing predictive analytics. These skills are especially helpful for Nigerian universities and secondary schools, where institutional expansion has historically been hampered by administrative inefficiencies and planning constraints.

Even though AI has the potential to revolutionize education, there are obstacles that must be overcome before it can be widely used in Nigerian classrooms. Recent research has extensively addressed issues including digital literacy among educators, fair access to technology, and ethical concerns about data privacy (Okonkwo & Ibe, 2021). Nigerian academics stress the necessity of strong teacher preparation programs and legislative frameworks to guarantee the ethical, inclusive, and sustainable application of AI.

In Nigeria, AI-driven innovation has the potential to completely transform education administration, teaching, and learning. Scholars and practitioners alike can use technology to boost learner engagement, increase instructional quality, and optimize institutional design by placing global advances in AI within the Nigerian educational system.

This paper examines various options, emphasizing AI applications that have the potential to revolutionize pedagogy and educational administration in the digital era. In light of this, this paper investigates how AI-driven innovations in education might improve instruction, learning, and educational administration in order to create learning environments that are sustainable and ready for the future. It examines the ideas of personalized and lifelong learning, AI-enhanced pedagogy, and the role of technology in transforming education. The article goes on to cover various AI-based educational innovations, the difficulties of incorporating AI into instruction and institutional planning, effective implementation techniques, and suggestions for bolstering educational systems that can handle both local educational realities and global technological trends. The paper seeks to fill the gap in integrated, context-sensitive understanding of how AI can simultaneously transform pedagogy, learning, and educational administration in Nigeria while addressing the practical, ethical, infrastructural, and equity-related challenges associated with its implementation.

AI in Pedagogical Applications

Artificial intelligence (AI) is becoming more widely acknowledged as a revolutionary force in pedagogy that is changing how teachers instruct and students learn. AI offers intriguing options for developing more efficient and customized learning experiences in Nigeria, where issues like big class sizes, a lack of instructional resources, and regional differences in educational outcomes still exist (Olatunji & Adeoye, 2022; Eze, Chukwu & Nwankwo, 2023). The main pedagogical uses of AI are examined in this part, with an emphasis on its applicability and use in Nigerian classrooms.

1. Personalized and Adaptive Learning: The capacity of AI to facilitate tailored learning is among its most important contributions to education. According to Okeke and Lawal (2022), traditional teaching methods in Nigeria sometimes take a "one-size-fits-all" approach that does not take into account the unique learning styles and skills of each student. However, real-time student data can be analyzed by AI-powered adaptive learning platforms to customize training to each learner's needs.

Platforms like intelligent learning management systems (LMS), for instance, can monitor student performance, spot knowledge gaps, and provide personalized learning pathways (Ajayi & Bello, 2022). Pilot programs using adaptive AI software have shown increases in academic accomplishment and student engagement at Nigerian universities, especially in STEM subjects where learners frequently struggle with complex concepts (Ezeani et al., 2023).

Teachers may guarantee that students advance at their own rate, improving comprehension and retention, by utilizing AI-driven customization. Differentiated instruction is crucial for egalitarian education in Nigeria due to the country's diverse learner backgrounds and varying levels of prior knowledge.

2. **Intelligent Tutoring Systems (ITS):** Another important educational use of AI is ITS. By offering prompt feedback, direction, and assistance with problem-solving, ITS are intended to resemble human tutoring (Okonkwo & Ibe, 2021). ITS provides individualized help, guaranteeing that students receive timely assistance, as contrast to typical classroom settings where teacher attention is shared among numerous pupils.

Research by Adebayo (2021) indicated that ITS can significantly improve learning outcomes in subjects such as mathematics and computer science, where students often struggle with abstract concepts. These systems not only guide learners through problem-solving steps but also adapt to their responses, reinforcing weak areas while advancing proficient skills. The implementation of ITS in Nigerian secondary schools has shown potential for reducing failure rates and promoting self-directed learning among students.

3. **AI-Enhanced Assessment and Feedback:** Assessment is a core component of pedagogy, and AI is revolutionizing how evaluation is conducted. Automated grading systems can analyze essays, multiple-choice tests, and even programming assignments, providing immediate feedback to students (Olatunji & Adeoye, 2022). In Nigeria, where teacher-student ratios are often high, AI-assisted assessment reduces the burden of grading while maintaining consistency and objectivity.

Moreover, AI-driven analytics can identify patterns in student performance, allowing educators to intervene proactively. For instance, if a student consistently struggles with specific concepts, AI systems can flag these gaps and recommend remedial exercises (Eze et al., 2023). This approach shifts assessment from a purely evaluative process to a formative tool that actively supports learning.

4. **Enhancing Student Engagement Through AI Tools:** Student engagement is a critical determinant of learning outcomes, and AI offers innovative ways to enhance motivation and participation. Gamified learning platforms, virtual reality (VR), and augmented reality (AR) simulations are increasingly integrated with AI to provide immersive educational experiences (Ajayi & Bello, 2022).

Universities and private e-learning providers have experimented with AI-driven gamification in science and technology courses, where complex experiments can be simulated virtually. These tools not only make learning more interactive but also allow students to practice skills in a safe, controlled environment, improving both understanding and confidence.

5. **Facilitating Collaborative and Peer Learning:** AI technologies also facilitate collaborative learning by connecting students through intelligent platforms that recommend peer groups based on complementary skills and learning styles (Okeke & Lawal, 2022). In classrooms, where collaborative projects are often constrained by logistical challenges, AI-driven collaboration tools enable learners to work together virtually, share resources, and provide peer feedback. This approach fosters critical thinking, problem-solving, and communication skills, which are essential competencies for the 21st century workforce.

6. **Supporting Teachers in Instructional Design:** AI does not replace teachers; rather, it augments their capabilities in instructional design. Nigerian educators are increasingly using AI tools to develop curriculum content, generate lesson plans, and identify optimal teaching strategies (Ezeani et al., 2023). By analyzing student performance data and learning trends, AI provides insights that help teachers focus on areas requiring additional attention. This data-driven approach enhances instructional quality, ensuring that teaching strategies are both efficient and evidence-based.

7. **AI for Educational Management and Planning:** Artificial Intelligence (AI) is not only transforming classroom pedagogy but also redefining educational management and planning. In Nigeria, where educational institutions often face challenges such as inadequate resources, inefficiencies in administrative processes, and difficulties in strategic planning, AI presents a powerful tool for enhancing operational efficiency, decision-

making, and institutional effectiveness (Okonkwo & Ibe, 2021; Adebayo, 2021). This section explores how AI is being leveraged for administrative management, predictive analytics, resource planning, and policy-making in Nigerian education.

8. Streamlining Administrative Processes: Administrative tasks in Nigerian schools, colleges, and universities often consume significant time and human effort. These tasks include student registration, attendance tracking, grading, timetable creation, and reporting. AI-driven automation has the potential to significantly reduce the administrative burden on educators and staff (Olatunji & Adeoye, 2022).

For example, AI-powered student information systems can automatically track attendance and participation, flag irregularities, and maintain comprehensive records. Similarly, AI-assisted grading tools can evaluate multiple-choice and essay-based assessments efficiently, ensuring consistent and timely feedback (Eze et al., 2023). By automating routine tasks, AI allows administrators to focus on strategic activities, while teachers can devote more time to instruction and mentorship.

9. Predictive Analytics for Resource Allocation: AI excels at analyzing large datasets to forecast trends and support evidence-based decision-making. In Nigerian educational institutions, predictive analytics can inform resource allocation by anticipating student enrollment trends, staffing needs, and facility usage (Ajayi & Bello, 2022).

For instance, universities can use AI to predict which courses are likely to experience high demand, enabling administrators to allocate lecturers, classrooms, and learning materials more effectively. Similarly, predictive models can forecast dropout rates, allowing institutions to implement early interventions to retain students (Okonkwo & Ibe, 2021). These applications are particularly relevant in Nigeria, where resource scarcity and growing student populations demand strategic planning for optimal institutional performance.

Intelligent Decision Support Systems

AI-powered decision support systems (DSS) provide actionable insights for educational leaders and policymakers. These systems integrate data from multiple sources including student performance records, financial reports, and infrastructure utilization to inform decisions about curriculum design, staffing, budgeting, and strategic initiatives (Ezeani et al., 2023).

AI-based DSS can aid university management in evaluating program effectiveness, identifying bottlenecks in service delivery, and optimizing operational efficiency. For example, AI can analyze patterns in student performance across departments, enabling administrators to prioritize interventions and policy adjustments where they are most needed. This data-driven approach strengthens institutional accountability and improves outcomes for students and staff alike.

1. Enhancing Financial and Operational Planning: Financial planning is a critical challenge for Nigerian educational institutions, many of which face budgetary constraints and unpredictable funding. AI technologies can support more accurate budgeting and financial forecasting by analyzing historical expenditure data, enrollment trends, and external economic factors (Akinyemi, 2021).

Moreover, operational planning such as managing classroom space, scheduling lectures, and maintaining infrastructure can benefit from AI optimization algorithms. For instance, AI systems can design efficient timetables that minimize classroom conflicts and maximize resource utilization, addressing longstanding logistical challenges in Nigerian schools (Okeke & Lawal, 2022).

2. Improving Quality Assurance and Accreditation Processes: Quality assurance is a cornerstone of educational excellence. AI can assist in monitoring compliance with national standards, accreditation requirements, and internal policies. By analyzing performance data and institutional processes, AI tools can identify gaps in program delivery, assess the effectiveness of teaching methods, and provide recommendations for improvement (Olatunji & Adeoye, 2022).

Regulatory compliance is critical for maintaining institutional credibility, AI-based monitoring systems can streamline audits, reduce manual errors, and provide real-time insights into institutional performance. This ensures that universities and schools meet both national and international benchmarks of quality education.

3. Promoting Equity and Inclusivity in Institutional Planning: AI applications in educational management also promote inclusivity and equity. For example, AI can identify students from marginalized or underserved backgrounds who may require additional support, enabling institutions to allocate scholarships, mentorship programs, or remedial interventions effectively (Ezeani et al., 2023).

Furthermore, AI tools can assist in multilingual curriculum planning, accessibility initiatives for students with disabilities, and digital content adaptation. These applications ensure that institutional planning is inclusive, addressing the diverse needs of Nigerian learners across socio-economic, linguistic, and geographic contexts.

Challenges and Considerations

Despite the transformative potential of AI in education, several challenges hinder its seamless integration into teaching, learning, and institutional management. One of the primary concerns is data privacy and security. AI systems require large volumes of student data, including academic records, behavioral patterns, and sometimes even biometric information, to function effectively. Mishandling this sensitive data could lead to breaches of privacy and misuse of personal information. According to Guan et al. (2023), ensuring robust encryption, anonymization, and ethical data governance is critical to maintaining trust among students, parents, and educational stakeholders. Without proper safeguards, the adoption of AI can lead to legal and ethical complications that overshadow its educational benefits.

Another significant challenge is algorithmic bias and fairness. AI models are trained on historical datasets, which may reflect existing social and educational inequalities. If not carefully monitored, these algorithms can unintentionally reinforce disparities in learning outcomes or marginalize underrepresented student groups. Baker and Hawn (2022) highlighted that biased AI systems in educational settings can perpetuate unequal access to resources and opportunities, emphasizing the need for continuous auditing, diverse training datasets, and inclusive design in AI-powered educational platforms.

The digital divide and accessibility also remain pressing concerns. Not all students or institutions have equal access to AI-driven educational technologies due to socioeconomic disparities, regional infrastructure limitations, or inadequate technical support. As Liu et al. (2024) pointed out, unequal access to AI tools can exacerbate existing educational inequities, leaving marginalized students at a disadvantage. Policymakers and administrators must therefore prioritize inclusive implementation strategies and provide adequate training and resources to bridge these gaps.

Faculty readiness and professional development represent another critical consideration. Integrating AI into pedagogy requires educators to develop technological proficiency, understand data analytics, and adapt teaching strategies accordingly. According to Alimi et al. (2021), lack of adequate training and professional development can result in resistance to AI adoption, underutilization of tools, or misapplication of AI insights in the classroom. Continuous support programs, workshops, and collaborative learning communities are essential to empower educators and ensure successful AI integration.

The ethical and pedagogical implications of AI usage in education demand careful attention. Overreliance on AI-driven decision-making may reduce human judgment in critical areas such as student assessment, curriculum design, and behavioral interventions. Balancing AI automation with human oversight is crucial to maintain educational quality, accountability, and empathy in teaching. Educational institutions must establish ethical frameworks and guidelines to govern AI use, ensuring that technological efficiency does not compromise pedagogical integrity.

Conclusion

AI is no longer merely an auxiliary tool in education it is rapidly becoming a central force in shaping how knowledge is imparted, absorbed, and managed. The transformative potential of AI lies not only in automating routine administrative tasks but in fundamentally enhancing pedagogical strategies, enabling educators to focus on higher-order teaching, critical thinking, and mentorship. By leveraging AI-driven platforms for personalized learning, real-time assessment, and predictive analytics, educational institutions can better identify and support diverse student needs, ultimately improving learning outcomes and fostering lifelong skills.

Furthermore, AI facilitates strategic educational management and planning by enabling data-driven decision-making, optimizing resource allocation, and forecasting future trends in curriculum development. These capabilities allow institutions to operate with increased efficiency and agility, preparing students for rapidly evolving global and technological landscapes. However, the integration of AI in education demands careful attention to ethical considerations, data privacy, and equitable access, ensuring that technological advancements do not exacerbate existing disparities but instead promote inclusive growth.

Looking ahead, AI has the potential to redefine the very nature of teaching and learning. Virtual and augmented reality experiences, AI-assisted collaborative research, and adaptive learning ecosystems will likely become standard, fostering immersive, student-centered education. The successful adoption of AI depends not just on technology itself but on the human capacity to guide, interpret, and ethically implement it. Educators, administrators, and policymakers must embrace AI as a tool to complement human creativity and intuition rather than replace it.

The future of education in the digital age will be shaped by a synergistic relationship between AI and pedagogy where intelligent systems enhance human capabilities, empower learners, and transform classrooms into dynamic environments of innovation, collaboration, and growth. By thoughtfully integrating AI, education can move toward a more personalized, efficient, and equitable system that prepares learners not just for exams but for the complexities of an increasingly interconnected and technologically advanced world.

Suggestions

The integration of AI in education offers immense potential, but its effectiveness depends on thoughtful implementation and continuous evaluation. The following suggestions and recommendations can guide institutions, educators, and policymakers in leveraging AI to transform teaching, learning, and educational management:

1. Conduct regular professional development programs to enhance teachers' AI literacy.
2. Train educators to interpret AI-generated insights and effectively integrate adaptive learning tools into classroom instruction.
3. Implement AI-driven adaptive learning platforms to tailor content to individual student needs.
4. Use real-time feedback and performance analytics to identify learning gaps and provide targeted support.
5. Leverage AI to facilitate group projects, peer learning, and virtual collaboration.
6. Incorporate AI-powered simulations, virtual labs, and gamified learning to provide immersive, hands-on experiences.
7. Automate routine tasks such as attendance, grading, timetable scheduling, and admissions to save time and reduce errors.
8. Use AI to optimize resource allocation, classroom utilization, and staffing.

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN EDUCATIONAL ASSESSMENT AMONG POSTGRADUATE STUDENTS' AT NASARAWA STATE UNIVERSITY, KEFFI, NIGERIA

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Abstract

This study investigated application of artificial intelligence in educational assessment among post graduate students at Nasarawa State University, Keffi, Nigeria using descriptive survey research design. The study population consisted of 610 postgraduate students from the Faculty of Education, Nasarawa State University, Keffi. A sample of 300 students was selected through a simple random sampling technique. An unstructured questionnaire titled Applications of Artificial Intelligence in Educational Assessment (APAIEA) was used as the data-collection instrument. The instrument was subjected to experts in measurement and evaluation validity. Using Crombach alpha coefficient of reliability, a reliability coefficient of .78 was established. The study employed descriptive analysis, focusing on frequency and percentage distributions based on a Likert scale to assess awareness, usage, perceived benefits, and challenges associated with AI in educational assessment. The findings revealed that while a significant portion of respondents (68.7%) acknowledged awareness of AI tools that could aid in educational assessment; only 49.0% reported actually using them indicating a notable gap between awareness and practical application. Also, Respondents in this study reported significant perceived advantages of AI in enhancing educational assessment. Challenges such as limited training, difficulties in understanding AI tools, and concerns regarding data privacy were prevalent. This study concluded that addressing these challenges through targeted training programs and the establishment of ethical guidelines is crucial for effective AI integration in educational assessment. It was recommended that Nasarawa State University Keffi should incorporate AI training into the curricula to equip postgraduate students with essential skills for using AI tools in educational assessment. This can be achieved through workshops, seminars, and dedicated courses that enhance digital literacy thereby improving students' assessment capabilities as well as academic outcomes among other recommendations.

Keywords: Application, Artificial Intelligence, Educational Assessment, Postgraduate Students'

Introduction

In this 21st century, Artificial Intelligence (AI) is increasingly recognized as a transformative force in various fields, including education and research. The integration of AI technologies in educational contexts has opened new avenues for enhancing assessment, and fostering innovative approaches to learning and teaching. In recent years, AI applications such as machine learning, natural language processing, and predictive analytics have gained traction, enabling students to process vast amounts of data efficiently and derive meaningful insights (Russell & Norvig, 2021).

In Nigeria, the adoption of AI in educational assessment is still in its early stages, particularly among postgraduate students. While many students are aware of the potential benefits of AI tools in their assessment endeavors, there is a significant gap between awareness and actual usage. This discrepancy highlights the need for a deeper understanding of how AI applications can be effectively utilized to enhance the quality of educational assessment and address common challenges faced by postgraduate students.

AI refers to the creation of computer systems that can perform tasks typically requiring human intelligence, including problem-solving, learning, perception, language processing, and decision-

making (Russell & Norvig, 2021). AI systems leverage algorithms, machine learning models, and data analytics to analyze data, identify patterns, and make predictions or recommendations. These capabilities have made significant advancements across various sectors, including healthcare, business, and particularly in education.

The growing integration of AI into education is transforming traditional teaching and assessment methods. AI-powered assessments promise greater accuracy, adaptability, and scalability compared to conventional methods. These tools can tailor assessments to individual learners' needs, provide immediate feedback, and reduce the workload on educators, thus supporting a more personalized learning experience (Chattopadhyay et al., 2018). However, the application of AI in assessment raises critical concerns regarding data privacy, fairness, transparency, and the potential to replicate biases present in the training data.

AI technologies are being utilized in various forms within educational assessments, primarily focusing on three main areas: formative assessments, summative assessments, and adaptive testing. AI technologies are increasingly being utilized in diverse forms within educational assessments, spanning across a broad spectrum of applications. These technologies are primarily focused on three main areas, each serving a distinct purpose in the assessment process. Firstly, formative assessments employ AI to provide real-time feedback and personalized learning recommendations to students, enabling them to identify areas for improvement and refine their understanding of concepts. Secondly, summative assessments leverage AI's capabilities for automated grading and analysis, ensuring accuracy, consistency, and efficiency in evaluating students' performance. Thirdly, adaptive testing harnesses AI's potential to tailor assessment questions to individual students' abilities, dynamically adjusting the difficulty level based on their responses, thereby creating a more engaging and personalized assessment experience.

The theoretical framework for this study is based on several fundamental theories and models that help elucidate the applications of AI in educational assessment among postgraduate students at Nasarawa State University Keffi, Nasarawa State. These theories provide insights into the interplay between AI technology, educational practices, and student involvement in assessment. The Technology Acceptance Model (TAM) is a well-established Framework for examining user acceptance of technology. Introduced by Davis (1989), TAM suggests that two main factors influence individuals' decisions to adopt new technologies: perceived usefulness (PU) and perceived ease of use (PEOU).

i. Perceived Usefulness (PU): In this study, PU pertains to how much postgraduate students believe that AI tools can improve their assessment abilities and outcomes. This aligns with Venkatesh et al. (2016), who found that students are more inclined to use AI technologies when they perceive them as beneficial to their academic endeavors.

ii. Perceived Ease of Use (PEOU): PEOU refers to how easily students can understand and utilize AI tools. The more intuitive the technology is, the more likely students are to integrate it into their assessment activities. Addressing the obstacles related to comprehending AI tools is essential for enhancing student engagement with these applications.

Constructivist learning theory, articulated by theorists like Piaget and Vygotsky, highlights the importance of social interactions and experiences in the learning process. This framework posits that learners actively construct their knowledge through engagement with their surroundings. In this study, AI tools can promote assessment and enrich students' active learning experiences. By utilizing AI, students can delve deeper into their assessment activities, work alongside peers, and benefit from data analytics. This aligns with the findings of Ferguson (2019), who asserted that AI can foster interactive learning environments that support constructivist principles.

The Diffusion of Innovations Theory, proposed by Rogers (2003), examined how, why, and at what pace new ideas and technologies disseminate within a social system. This theory identifies several factors that affect the adoption of innovations, including perceived benefits, compatibility, complexity, trial ability, and observability. This framework is pertinent to the study as it emphasizes the importance of understanding how postgraduate students perceive and adopt AI tools

in their assessment practices. Factors such as the compatibility of AI technologies with existing assessment exercises and the perceived benefits of using AI in educational assessment are critical to the adoption process.

Shah (2022) observed a similar pattern among postgraduate students at universities in Pakistan. They noted that despite students' awareness of AI technologies, many lacked the skills or confidence necessary to apply these tools effectively in their research. Liu et al. (2021), who suggested that educational institutions frequently neglect to incorporate AI training into their curricula, leaving students unprepared to effectively utilize these tools in their studies. This absence of training creates a barrier to effective application, resulting in underutilization despite positive perceptions. Zhang and Zhang (2023) discovered that AI tools not only streamline assessment processes but also enhance data collection for assessment, leading to stronger outcomes. Khan and Zia (2020) highlighted that AI's capacity to efficiently provide large datasets allows students to concentrate on higher-order cognitive tasks. This underscores the potential of integrating AI into educational assessment to significantly improve productivity and the quality of assessment. Ogunleye (2023) for enhanced curricula that make AI literacy a core component of postgraduate education. Furthermore, as emphasized by Hwang et al. (2023), cultivating a culture of innovation and support can greatly influence students' willingness to adopt AI technologies.

At the Nasarawa State University Keffi, the Faculty of Education is home to a diverse group of postgraduate students who are engaged in various assessments. Understanding how these students perceive and utilize AI tools is critical for identifying both the opportunities and challenges associated with AI integration in their academic pursuits. Despite the potential of AI to improve assessment efficiency, accuracy, and overall outcomes, there are concerns regarding accessibility, training, and ethical considerations related to data privacy. On the other hand, the application of AI in educational assessment presents new challenges that postgraduate students must navigate. These include the technical complexities associated with learning how to use AI tools effectively, ethical considerations related to data privacy and algorithmic bias, and access to adequate computational resources (Zhou, 2021). Despite these challenges, AI has the potential to transform educational assessment, enabling postgraduate students to produce high-quality, data-driven insights that can contribute to academic progress. The rapid evolution of AI technologies has significantly impacted various sectors, including education. AI is no longer limited to fields like computer science or engineering; it has permeated educational assessment, revolutionizing the ways assessment is undertaking. In the context of postgraduate education, where rigorous assessments are essential, the application of AI tools has become particularly valuable (Hansen, 2024).

The rapid development of AI technologies has the potential to greatly enhance educational assessment by streamlining assessment processes, and delivering valuable insights. Several benefits of AI implementation in educational assessments have been identified. AI systems can personalize assessments based on individual student needs, learning styles, and progress. The potential to tailor questions and difficulty levels to suit the learner's current capability enhances engagement and learning outcomes (Miserandino, 2024). AI reduces the time and resources required for grading and evaluating student performance. It enables teachers to focus more on instructional tasks, as noted by Owan et al. (2023). AI systems can efficiently process large datasets, allowing for quick insights into overall class performance and individual progress. AI-powered assessment tools can scale easily, making them applicable to both small classroom settings and large-scale standardized tests. This is particularly valuable in contexts where educational resources are limited (Chattopadhyay et al., 2018).

However, despite these acknowledged advantages, postgraduate students at Nasarawa State University, Keffi, encounter several challenges that need to be addressed in order to fully harness the potential of AI in educational assessments. First, while many students are aware of various AI applications, there exists a significant gap between this awareness and their actual usage. This disconnects prompts questions about the factors influencing students' adoption of AI tools and the barriers they face.

Second, insufficient training and support concerning AI technologies can impede students' ability to incorporate these tools into their educational assessment. Many postgraduate students may lack the skills needed to navigate and effectively use AI applications, resulting in underutilization of resources that could improve the quality of their assessments.

Third, one of the most significant challenges is bias. AI algorithms can be biased against certain groups of students, such as students from minority backgrounds or students with disabilities (Gonzalez-Calatayud et al, 2021). It is important to ensure that AI-powered assessment tools are fair and unbiased, so that all students have an equal opportunity to succeed.

Fourth, the concerns about data privacy and ethical considerations present substantial challenges to the adoption of AI in educational assessment. Students may feel apprehensive about how their data is managed and the potential implications of using AI tools, which can further discourage them from engaging with these technologies. Furthermore, AI-powered assessment tools collect a large amount of data about students, including their responses to questions, their browsing history, and their online interactions. It is important to ensure that this data is protected from unauthorized access and use, and that students' privacy is respected.

Finally, there is the challenge of interpretability. AI algorithms can be complex and difficult to understand, which can make it difficult to interpret the results of AI-powered assessments. It is important to ensure that AI-powered assessment tools are transparent and interpretable, so that educators and students can understand how they work and make informed decisions about their use. Addressing these challenges through collaborative research and ethical guidelines is crucial to harness AI's full potential in education.

Given these challenges, it is crucial to explore how postgraduate students at Nasarawa State University perceive and utilize AI in their educational assessment. Gaining insights into their experiences, perceived benefits, and obstacles will help inform strategies for the effective integration of AI into academic practices and enhance training and support systems. This study intends to explore the implications of AI applications in educational assessment among postgraduate students at Nasarawa State University, Keffi. By examining students' awareness, usage patterns, perceived benefits, and challenges related to AI tools, the research seeks to provide insights into how these technologies can be better integrated into educational assessment practices. Ultimately, the findings will inform strategies to enhance the assessment capabilities of postgraduate students, ensuring they can leverage AI effectively in their academic work and contribute to the broader landscape of educational assessment in Nigeria.

Objectives

This study examined the application of AI in educational research among postgraduate students at Nasarawa State University, Keffi. The specific objectives of this study are:

- i. Investigate the level of awareness and understanding of AI tools available for educational assessment among postgraduate students of the Faculty of Education, Nasarawa State University, Keffi.
- ii. Analyze the perceived benefits of AI applications in educational assessment among postgraduate students of the Faculty of Education, Nasarawa State University, Keffi

Methods

This study employed descriptive survey research design. The study population consisted of 610 postgraduate students from the Faculty of Education of Nasarawa State University, Keffi. A sample of 300 students was selected through a simple random sampling technique.

An unstructured questionnaire, titled Applications of Artificial Intelligence in Educational Assessment (APAIEA), was used as the data collection instrument. Validity and reliability indices of .90 and .76 were achieved using construct validity and Cronbach's alpha coefficient of reliability.

The study employed descriptive analysis, focusing on frequency and percentage distributions based on a Likert scale to assess awareness, usage, perceived benefits, and challenges associated with AI in educational assessment.

Results

Research Question 1: What is the level of awareness and understanding of AI tools available for educational assessment among postgraduate students in the Faculty of Education at Nasarawa State University, Keffi?

Table 1

Awareness and Usage of AI Tools by Postgraduate Students

Statement	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
I am aware of AI tools that can help in educational assessment.	9 (3.0)	34 (11.3)	51 (17.0)	140 (46.7)	66 (22.0)
I have used AI tools for my assessment.	35 (11.7)	43 (14.3)	75 (25.0)	95 (31.7)	52 (17.3)

Table 1 shows that majority of respondents (68.7%) reported being aware of AI tools that can help in educational assessment, with 68.7% either agreeing or strongly agreeing. However, the usage of AI tools was relatively low, with only 49.0% of respondents indicating that they had used such tools in their research. This disparity between awareness and usage suggests a need for enhanced training and support to bridge the gap.

Research Question 2: What are the benefits of AI applications in educational assessment among postgraduate students in the Faculty of Education at Nasarawa State University, Keffi?

Table 2

Perceived Benefits of AI by Postgraduate Students

Statement	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
AI enhances the efficiency of my assessment process.	3 (1.0)	7 (2.3)	40 (13.3)	130 (43.3)	120 (40.0)
AI provides personalized feedback.	5 (1.7)	9 (3.0)	49 (16.3)	132 (44.0)	105 (35.0)
AI reduces time and resources for my assessment.	4 (1.3)	11 (3.7)	41 (13.7)	145 (48.3)	99 (33.0)

Table 2 shows that significant proportion of respondents (83.3%) agreed or strongly agreed that AI enhances the efficiency of their research processes, indicating a positive perception of AI's role in facilitating assessment tasks. Similarly, a substantial number (79.0%) acknowledged that AI provides personalized feedback, highlighting its potential to enhance assessment quality base on individual student needs, learning styles and progress. Also, 81.3% respondents agreed and strongly agreed that AI reduces time and resources. The results suggest that while students recognize the advantages of AI, there may still be gaps in their practical application, possibly due to a lack of training or familiarity with AI tools.

Discussion of Findings

The results of this study emphasize several key aspects related to the applications of AI in educational research among postgraduate students of the faculty of education at Nasarawa State University, Keffi (NSUK). The analysis indicates a notable awareness of AI tools, alongside considerable challenges that impede their effective utilization. This discussion situates the findings within the broader context of existing literature.

The study revealed that while a significant portion of respondents (68.7%) acknowledged awareness of AI tools that could aid in educational assessment, only 49.0% reported actually using them. This gap mirrors findings from Shah et al. (2022), who observed a similar pattern among postgraduate students at universities in Pakistan. They noted that despite students' awareness of AI technologies, many lacked the skills or confidence necessary to apply these tools effectively in their assessment. The divide between awareness and practical application may be attributed to a shortage of comprehensive training programs, as argued by Liu et al. (2021), who suggested that educational institutions frequently neglect to incorporate AI training into their curricula, leaving students unprepared to effectively utilize these tools in their studies. This absence of training creates a barrier to effective application, resulting in underutilization despite positive perceptions.

Respondents in this study reported significant perceived advantages of AI, including improvements in efficiency (83.3%), personalized feedback (79.0%), and reduces time and resources required for assessment (81.3%). These results support the findings of Zhang and Zhang (2023), who examined the influence of AI on assessment practices in higher education. They discovered that AI tools not only streamline assessment processes but also enhance data collection for assessment and provides personalized feedback, leading to stronger assessment outcomes. The favorable perception of AI's advantages aligns with the research of Khan and Zia (2020), which highlighted that AI's capacity to efficiently process large datasets allows students to concentrate on higher-order cognitive tasks. This underscores the potential of integrating AI into assessment to significantly improve productivity and the quality of assessment. The findings suggest a pressing need for educational institutions to bridge the gap between awareness and practical application of AI tools. Institutions should consider incorporating AI training into their academic programs to equip students with the skills and confidence needed to effectively use these tools. This recommendation aligns with the advocacy of Ogunleye et al. (2023) for enhanced curricula that make AI literacy a core component of postgraduate education. Furthermore, as emphasized by Hwang et al. (2023), cultivating a culture of innovation and support can greatly influence students' willingness to adopt AI technologies. By fostering an environment that encourages exploration and experimentation with AI tools, educational institutions can empower students to effectively leverage these technologies in their research.

Conclusion and Recommendations

This study examined the applications of AI in educational assessment among postgraduate students at Nasarawa State University, Keffi (NSUK). The findings indicated a significant awareness of AI tools among respondents, coupled with a strong acknowledgment of their potential benefits in enhancing assessment efficiency and accuracy. However, the study also identified notable challenges, including limited practical usage, insufficient training, and concerns about data privacy, which hindered students from fully integrating AI into their assessment practices. The results align with existing literature, underscoring the necessity for educational institutions to bridge the gap between awareness and practical application of AI technologies. By addressing these barriers, institutions can empower students to leverage AI effectively in their academic endeavors, thereby enriching their educational experiences and fostering innovative assessment.

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

1. Nasarawa State University Keffi should incorporate AI training into the curricula to equip postgraduate students with essential skills for using AI tools in educational assessment. This can be achieved through workshops, seminars, and dedicated courses that enhance digital literacy.
2. Nasarawa State University Keffi should create a supportive learning environment where faculty provide guidance and resources to encourage students to confidently experiment with AI applications in their educational assessment.

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ARTIFICIAL INTELLIGENCE AND ADMINISTRATIVE EFFECTIVENESS IN HIGHER EDUCATION: REPOSITIONING INSTITUTIONAL GOVERNANCE FOR THE DIGITAL AGE

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Abstract

This paper examined how artificial intelligence (AI) is reshaping administrative effectiveness in higher education, using Nigerian universities as its primary context. As a conceptual paper drawing on secondary data, it applies the Technology Acceptance Model (TAM) to argue that AI's contribution to university administration depends less on technical sophistication and more on whether administrators perceive such tools as useful and easy to use. The paper reviewed literature on AI-driven administration and identified a persistent gap where existing knowledge concentrates on students and teaching staff, leaving administrators understudied despite their central role in institutional governance. Drawing on recent empirical and conceptual studies, this paper examined global trends in AI-driven University Administration, AI as a Catalyst for Administrative effectiveness, challenges of AI adoption in Nigerian Universities, repositioning Institutional governance for the AI era, and implications for educational policy and practice. The paper concluded that repositioning Nigerian universities for the AI era requires simultaneous attention to administrators' competence and institutional policy, rather than treating technology procurement as sufficient in itself. It closed with recommendations for policymakers and university management.

Keywords: Artificial Intelligence, Administrative Effectiveness and Institutional Governance

Introduction

Higher education institutions worldwide are undergoing a period of administrative transformation driven by the rapid diffusion of Artificial Intelligence (AI) technologies. What began as isolated experiments with automation in student records and admissions has evolved into a broader restructuring of how universities plan, decide, and govern themselves, with AI-enabled systems now supporting functions ranging from predictive analytics for enrolment management to chatbots handling routine enquiries and machine learning models informing resource allocation and quality assurance. This shift shows the recognition that administrative effectiveness is increasingly tied to an institution's capacity to process data, anticipate outcomes, and respond swiftly to a changing environment.

For universities in Nigeria, this global movement presents both an opportunity and a challenge. Nigerian universities operate within a context marked by rising students' enrolment, chronic underfunding, and administrative structures still largely reliant on manual or semi-digitized processes, producing bureaucratic bottlenecks in admissions, records management, staff appraisal, and financial administration. These bottlenecks are often linked to inadequate infrastructure and limited institutional capacity rather than a lack of awareness of digital alternatives.

Khairullah et al. (2025) argued that the successful integration of AI into academic and administrative processes depends less on the technology itself than on the quality of leadership guiding its adoption. This is directly relevant to Nigerian universities, where administrators trained

within traditional bureaucratic systems are now expected to interpret dashboards, oversee algorithmic tools, and manage the ethical implications of automated processes affecting staff and students. Without deliberate leadership attention to this transition, institutions risk acquiring AI tools that remain underused or misapplied.

This paper approaches AI adoption in university administration as a management phenomenon rather than a purely technical one, using the Technology Acceptance Model to examine how perceived usefulness and perceived ease of use shape administrator engagement with AI. It builds a conceptual argument for how Nigerian universities might reposition their administrative structures for the digital age, drawing on secondary data and existing scholarship given the conceptual nature of the study.

Statement of the Problem

Despite growing global adoption of artificial intelligence in university administration, Nigerian higher education institutions continue to grapple with administrative inefficiencies that AI is well positioned to address. Admissions processing, records management, staff appraisal, and financial administration in many Nigerian universities remain slow, duplicative, and vulnerable to human error, often resulting in delayed decision-making and diminished institutional governance responsiveness. Where AI tools do exist, they are frequently underutilized. This gap is compounded by a scholarly imbalance. Existing literature on AI in higher education is centered on teaching and students' learning, with limited attention to administrative and managerial functions, particularly in Nigerian and broader African contexts. Where such studies exist, they tend to focus on infrastructural and financial constraints, giving less consideration to how administrators themselves perceive and respond to these technologies. This paper therefore addressed that gap by examining AI adoption in Nigerian university administration through the Technology Acceptance Model, treating perceived usefulness and ease of use as central to understanding why administrative effectiveness has not kept pace with technological availability.

Objectives of the Study

This paper sets out to achieve the following objectives, to:

examine the conceptual relationship between artificial intelligence adoption and administrative effectiveness in higher education institutions.

identify the key areas of university administration where AI can serve as a catalyst for improved effectiveness.

interrogate the challenges confronting AI adoption in Nigerian universities.

propose a framework for repositioning institutional governance to meet the demands of AI-driven administration.

These objectives guided the paper towards a conceptual synthesis of existing scholarship, aimed at informing both institutional practice and policy direction in the Nigerian higher education sector.

This paper contributes to a growing but still underdeveloped body of knowledge on AI in university administration within the Nigerian and broader African context. By focusing specifically on administrative effectiveness, this paper addressed a gap that has direct implications for how universities are governed and managed. For university governance, the discussion provides a framework for understanding why AI investments may fail to yield expected improvements, and what institutional conditions are needed to translate technological capacity into administrative effectiveness. The study clarifies the competencies required to function effectively within an increasingly AI-mediated administrative environment.

Conceptual Clarification

Artificial Intelligence

For this paper, AI is understood as computational systems capable of performing tasks that typically require human intelligence, including learning from data, recognizing patterns, making predictions, and supporting decision-making, while adapting their behaviour based on new information rather than relying solely on static, pre-programmed rules.

Artificial Intelligence are simulations of human intelligence processes by machines especially computer systems. AI is used to transform different areas of endeavours and educational administration is no exception. It has especially made its way into educational administration. This working definition, informed by Jiang et al. (2022) and Wang (2019) underpins the paper's treatment of AI not as a single technology but as a family of tools and techniques whose administrative relevance lies precisely in their capacity to process data and support decisions at a scale and speed beyond conventional manual methods.

Administrative Effectiveness

Administrative effectiveness can be described as the measure of the ability of school heads, administrators, and heads of departments to perform their administrative duties using methods, principles, and practices to establish and execute policies, plans, and procedures to achieve predetermined goals (Ogieva in Ogieva & Eimuihi, 2025).

Administrative effectiveness in higher education refers to the extent to which an institution's administrative processes and structures succeed in achieving their intended outcomes efficiently, accurately, and in a manner that supports the institution's broader mission. For this paper, administrative effectiveness is the degree to which university administrative systems, spanning admissions, records, human resources, finance, and quality assurance; achieve accurate, timely, and stakeholder-responsive outcomes, supported by both efficient processes and capable leadership. This definition, drawn from Alvarez-Sández et al. (2023), established administrative effectiveness as the outcome of central concern in this paper, the measure against which AI's contribution to university administration and governance in the Nigerian context was assessed.

Theoretical Framework

This paper is hinged on the Technology Acceptance Model (TAM) as its guiding theoretical framework for understanding how educational administrators engage with AI-based tools in Nigerian universities. It was developed by Davis (1989) and designed to explain and predict user acceptance of information technology through two core constructs: perceived usefulness, defined as the degree to which a person believes that using a particular system would enhance their job performance, and perceived ease of use, defined as the degree to which a person believes that using the system would be free of effort. According to the model, these two constructs shape an individual's attitude towards a technology, which in turn influences behavioural intention and, ultimately, actual system use.

TAM is particularly well suited to this paper's focus on administrative effectiveness because it shifts attention away from the technical specifications of AI systems and towards the perceptions of the people expected to use them. An AI-powered admissions system or predictive analytics dashboard may be technically sophisticated, but its contribution to administrative effectiveness depends on whether administrators perceive it as useful for their work and manageable to operate. The recent applications of TAM within Nigerian higher education reinforce its relevance to this discussion. Ezeonwumelu (2026) in a TAM-based study of AI adoption among engineering education stakeholders in Nigeria, found that perceived usefulness and ease of use were significant predictors of willingness to engage with AI tools, while also identifying infrastructural and attitudinal barriers that complicated adoption regardless of how useful the technology was perceived

to be. This finding is instructive for this study as it focused on administrators rather than students or lecturers, since it demonstrates that even where usefulness is recognized, adoption can stall when ease of use is undermined by poor infrastructure, limited training, or unsupportive institutional conditions, precisely the conditions that characterize many Nigerian university administrative environments.

An administrator who views an AI-based student records system as capable of reducing errors and saving time, and who finds the system straightforward to operate, is more likely to adopt it meaningfully into daily practice than one who views it as either irrelevant to their work or too complex to manage.

Global Trends in AI-Driven University Administration

Research on AI in higher education has grown rapidly over the past decade, with publication output rising sharply after 2020 as generative AI tools and predictive analytics systems became more accessible to institutions. Ocen et al. (2025) in a review of AI innovations, opportunities, and challenges in higher education institutions, noted that AI tools are increasingly used to streamline administrative tasks alongside teaching and research functions, with universities adopting intelligent systems for functions ranging from students' enrolment verification to automated academic advising. Their review cautions, however, that these opportunities are accompanied by real risks, including data governance concerns and the potential for AI tools to be poorly integrated into existing institutional workflows if adopted without adequate planning, a caution directly relevant to this paper's concern with administrative effectiveness rather than mere technological presence.

This expansion in practice is reflected in industry data as well as academic literature. A 2024 global survey of higher education administrators by Ellucian found that AI usage in the sector had more than doubled over the preceding year, with the large majority of institutional leaders citing efficiency and productivity gains as the primary driver of adoption and expecting further increases in AI use over the following two years (Ellucian, 2024). Taken together with the findings of Ocen et al. (2025) and Crompton and Burke (2023) suggested a global trajectory in which AI adoption in university administration is accelerating in both scholarly attention and institutional practice, driven substantially by expectations of improved efficiency.

What remains less examined in this global literature, however, is the human dimension of this adoption process, specifically, how administrators themselves perceive and respond to these tools once introduced. Much of the existing research documents what AI can technically do within university administration rather than whether and why administrators choose to use it, a gap that this paper addressed directly through its application of the Technology Acceptance Model. Khairullah et al. (2025) gestured towards this gap in noting that responsible strategic leadership, not the technology itself, determines whether AI adoption translates into genuine administrative improvement, but their focus remains on leadership rather than the broader population of administrators whose day-to-day perceptions of usefulness and ease of use ultimately shape whether AI tools are meaningfully embedded into institutional practice.

In Nigerian context, Ohamobi et al. (2026) noted that low digital literacy and resistance to change are presented not as infrastructural deficits but as barriers rooted in how administrators relate to the technology itself, a framing that aligns closely with this paper's use of perceived ease of use and usefulness as explanatory constructs, rather than treating adoption as a purely resource-driven outcome.

AI as a Catalyst for Administrative Effectiveness

Strategic planning and data-driven decision-making are increasingly treated as two sides of the same administrative function, since effective planning depends on the quality and timeliness of the data available to institutional leaders. Abulibdeh et al. (2025) in a scoping review of AI's strategic integration in higher education, found that AI enables institutions to move beyond reactive administration towards more anticipatory planning, using large-scale data analysis to inform resource allocation, enrolment forecasting, and the setting of institutional priorities.

Human Resource Management: AI's contribution to university administration is especially visible in two functions that directly involve managing people: staffing and student records. On the human resource side, Etomes (2024) examined AI's role in human resource management within Cameroonian higher education institutions, finding that AI can streamline recruitment and onboarding, support decision-making around staffing, and contribute to quality assurance by ensuring personnel possess the skills institutions need. This African case study is instructive for Nigerian universities because it identifies human resource functions- recruitment, staff development, and performance tracking- that mirror the administrative pressures Nigerian institutions face as they expand student populations without a corresponding expansion of administrative capacity.

Student Information Management: AI is reshaping what were once purely record-keeping systems into predictive tools. Wang (2025) developed a hybrid machine learning model integrating decision trees, random forests, support vector machines, and neural networks to monitor academic performance and flag at-risk students, achieving accuracy above 96% across three distinct educational datasets. For Nigerian universities managing large, growing student populations with limited administrative staff, this shift from reactive record-keeping to proactive monitoring represents a meaningful efficiency gain, provided administrators view such systems as both useful and manageable to operate within their existing workflows.

Quality Assurance: Quality assurance is an administrative domain where AI's contribution is increasingly tied to accountability rather than mere efficiency. Isaifan and Hasna (2025) examined Qatar's national quality assurance and accreditation framework, described how AI-driven tools can strengthen institutional accountability by automating the review of curriculum documents, assessment materials, and learning objective statements against accreditation standards, allowing quality assurance teams to examine every course offering rather than relying on sampling methods that risk missing compliance gaps. Their policy-to-practice model demonstrates that AI's value in quality assurance lies in extending institutional oversight to a scale and consistency that manual review cannot match, a capability directly relevant to Nigerian universities where quality assurance units are often understaffed relative to the number of programmes and courses they must monitor.

Financial Management: Financial management presents a parallel case, and one where the perception-based argument central to this paper finds direct empirical support. Berrachid and Berrachid (2025) in a qualitative study involving deans, financial administrators, and professors across Moroccan public universities found that AI adoption in financial management, covering budgeting, forecasting, and resource optimization, depended heavily on how financial administrators and academic staff perceived the technology, rather than on its technical capability alone. Their study, situated in a public university system facing funding constraints comparable to Nigeria's, found that administrators who perceived AI tools as genuinely useful for easing budgeting and forecasting burdens were considerably more willing to engage with them, while skepticism about reliability and unfamiliarity with the tools slowed adoption regardless of the tools' demonstrated efficiency gains elsewhere.

Stakeholder Communication and Engagement: AI-driven communication tools represent a narrower but still meaningful contribution to administrative effectiveness, primarily through chatbots and automated support systems that mediate routine interactions between universities and

their stakeholders. Okonkwo and Ade-Ibijola (2021) in a systematic review of educational chatbot applications found that such systems increasingly serve institutional employees as well as students, offering instant responses to routine enquiries and reducing the burden on administrative staff who would otherwise handle these interactions manually. Their review also identified user attitude as a persistent challenge to effective chatbot adoption. For Nigerian universities, where administrative staff often manages high volumes of routine stakeholder enquiries with limited support infrastructure, these tools offer a genuine efficiency gain, provided administrators view them as a manageable addition to existing workflows rather than an added technical burden.

Challenges of AI Adoption in Nigerian Universities

Funding constraints: This affects the adequate use of AI. Without adequate funding, institutions cannot build the infrastructure AI systems require, and without that infrastructure, whatever funding is available cannot translate into functional AI capability.

Inadequate Infrastructure: Mahuta and Abubakar (2025) identified inadequate digital infrastructure, including unreliable internet connectivity, outdated computing equipment, and inconsistent power supply, as the most critical impediment to AI adoption in Nigerian universities.

Skills gaps and ethical concerns: Skills gaps and ethical concerns in Nigerian universities are interconnected barriers. Nnaji et al. (2026) noted that administrators who have not been trained to use AI tools competently are simultaneously less equipped to safeguard the sensitive student and staff data these tools process. Most administrators who lack digital literacy are often the same administrators least equipped to recognize or manage the ethical risks that AI systems introduce.

Repositioning Institutional Governance for the AI Era

Leadership competence: This demands and begins with recognizing that leadership itself must adapt, since administrators are no longer expected only to oversee people and processes but to interpret AI-generated data, communicate through digital channels, and manage staff anxieties about automation.

Capacity building: Competence in AI tools cannot be assumed but must be deliberately developed. Hence there should be capacity building for management and institutional leaders.

AI-Driven Staff Training: Nnaji et al. (2026) proposed AI-Driven Staff Training Modules and a Performance Appraisal framework for Nigerian universities, designed specifically to strengthen staff digital skills while linking that training to transparent performance evaluation.

Change management: This brings about change management, which is the process through which leadership competencies and capacity building are translated into actual institutional practice. Nnaji et al. (2026) pointed to resistance and anxiety, whether framed as emotional discomfort with new communication modes or as broader unease about job security and institutional change, as a persistent obstacle that competent, emotionally intelligent leadership must actively manage rather than assume will resolve on its own.

Institutional AI structure: Administrators cannot be expected to sustain responsible AI adoption without the institutional structures to support them. Nwosu et al. (2024) in their study argued that AI holds significant potential to improve efficiency, transparency, and responsiveness in public governance, but only where supportive regulatory frameworks are put in place deliberately rather than assumed to emerge on their own.

Digital Governance: Leadership competencies, capacity building, and change management address the human side of repositioning Nigerian universities for the AI era. Repositioning Nigerian universities for the AI era therefore, requires institutional policy and governance structures to be built alongside, not after, the leadership development and change management processes discussed above.

Implications for Educational Management

Administrative effectiveness in the AI era depends on whether administrators perceive technology as useful and manageable within their actual working conditions, and whether institutions provide the resources, training, and governance structures that make such perceptions realistic, less dependent on the sophistication of available technology. This has implications for both policy and practice in Nigerian higher education.

The implication for universities is that AI adoption strategies built solely around procurement and infrastructure investment will underperform unless matched by comparable investment in the people expected to use these tools. These implications carry a broader lesson for educational management as a field. The Nigerian evidence reviewed throughout this paper suggests that administrative effectiveness in the AI era is not simply a matter of closing an infrastructure or funding gap, real as those gaps are, but of recognizing that technology adoption in public institutions is fundamentally a human and organizational process.

Conclusion and Suggestions

This paper examined how artificial intelligence is reshaping administrative effectiveness in higher education, with Nigerian universities as its primary lens. Hence, repositioning educational management for the digital age is not a question of whether Nigerian universities can access AI technology, but of whether the people responsible for administering these institutions are given genuine reason and genuine capacity to use it well. Repositioning Nigerian universities for the AI era requires simultaneous attention to administrator competence and institutional policy, rather than treating technology procurement as sufficient on its own.

Based on evidence and discussion, the following suggestions were made:

Government funding mechanisms, including the Tertiary Education Trust Fund, should establish dedicated funding streams for AI-related infrastructure and administrators' training.

Institutions should treat AI-related capacity building as an ongoing function tied to staff development and performance evaluation, rather than a one-off training exercise delivered at the point of system rollout.

The National Universities Commission, in collaboration with the National Information Technology Development Agency and the Nigeria Data Protection Commission, should develop sector-specific AI governance guidelines for universities.

Administrators should be given structured opportunities to engage directly with AI tools before full implementation, allowing perceived ease of use to develop through guided practice rather than forming under conditions of unfamiliarity and pressure.

Leadership development programmes for educational managers should explicitly incorporate the emotional and interpersonal competencies as necessary for managing staff resistance and anxiety during AI-driven organizational change.

Empirical studies applying the Technology Acceptance Model or related frameworks directly to Nigerian university administrators, rather than students or academic staff, are needed to test the conceptual arguments advanced in this paper.

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ARTIFICIAL INTELLIGENCE AWARENESS AND DIGITAL COMPETENCIES AMONG CARPENTRY AND JOINERY CRAFT TEACHERS' IN TECHNICAL COLLEGES IN EDO STATE

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Abstract

This research explored the level of artificial intelligence (AI) awareness and its association with digital competencies among carpentry and joinery (C&J) craft teachers' in technical colleges within Edo State, situated in the educational technology domain. The investigation focused on assessing the extent of AI awareness, evaluating the digital competence of these instructors, and analyzing the correlation between AI awareness and digital competence. Employing a correlational survey methodology, data were gathered from 21 C&J craft educators through structured questionnaire. Analytical procedures utilized descriptive statistics, Pearson Product Moment Correlation, and one-way ANOVA to interpret the findings. Results indicated that the participants demonstrated elevated levels of both AI awareness and digital competence. Moreover, a robust, positive, and statistically significant correlation between AI awareness and digital competence was identified ($r = .560$, $p < .001$). Notably, demographic variables such as age, gender, and teaching experience did not exert a significant impact on either AI awareness or digital competence ($p > .05$). The study concluded that advancing AI awareness plays a critical role in enhancing digital competencies among C&J educators, thereby facilitating technology-enhanced pedagogical strategies. Accordingly, it advocated for continuous professional development programs, institutional backing for AI integration and inclusive capacity-building efforts across all trade disciplines to foster effective digital transformation within technical education institutions.

Keywords: Artificial Intelligence, Digital Competences, TVET Teachers, Technical colleges.

Introduction

The rapid advancement of technology and artificial intelligence (AI) is fundamentally transforming educational systems globally, significantly altering approaches to teaching, learning, and skills development (Luckin et al., 2016). Within the domain of Technical and Vocational Education and Training (TVET), these innovations present opportunities to update curricula and pedagogical strategies, thus better preparing students to meet contemporary industrial demands (UNESCO, 2021). This is particularly pertinent for technical colleges tasked with equipping students with essential trade skills, such as those in carpentry and joinery craft.

Historically, carpentry and joinery craft have been grounded in traditional craftsmanship and manual dexterity. However, the integration of AI technologies such as intelligent tools, AI-assisted design software, digital fabrication, and virtual reality has begun to revolutionize both instructional methods and professional practice in these fields (Kong & Khan, 2020). For example, AI-powered computer-aided design (CAD) platforms enable enhanced precision in project planning and customization, while digital measurement and modelling technologies improve accuracy and efficiency in joinery tasks (Zhou et al., 2022).

To leverage these advancements effectively, teachers in carpentry and joinery must develop advanced digital competencies alongside a sound conceptual understanding of AI principles pertinent to their disciplines (European Commission, 2018). Digital competence in this context refers to the confident, critical utilization of digital technologies within professional practice,

communication, pedagogy, and evaluative processes. For carpentry and joinery teachers, this entails expertise in digital design software, familiarity with AI-enhanced tools, capabilities in online collaboration, critical assessment of digital resources, and facilitation of learners' engagement with technology.

Crucially, focusing on the Nigerian context, especially Edo State, technical colleges serve a vital role in preparing competent craftsmen who contribute substantively to the construction sector and allied industries. Despite this importance, there is a paucity of research examining the levels of AI awareness and digital competencies among carpentry and joinery craft teachers in technical colleges. Such inquiry is critical as these teachers not only impart technical expertise but also shape how emerging craftsmen incorporate technological innovations in their professional activities.

Furthermore, personal variables including gender and teaching experience may influence teachers' engagement with AI and digital tools, affecting their preparedness and ability to integrate these technologies into instructional practices. Investigating these factors will yield valuable insights into professional development requirements and aid in designing targeted interventions to enhance digital literacy and AI adoption within vocational education for carpentry and joinery craft. This study aims to assess the awareness of artificial intelligence (AI) and its correlation with the digital competencies of carpentry and joinery teachers in technical colleges located in Edo State.

Outcomes will help identify existing gaps in teachers' readiness and inform policy and educational practice to bolster AI-driven innovation in technical education programs. Ultimately, this will contribute to elevating the quality of skills training and improving graduate employability in alignment with evolving industrial demands.

Statement of the Problem

In the field of TVET, it is theoretically anticipated that educators possess a comprehensive understanding of Artificial Intelligence (AI) and exhibit advanced digital competencies. These educators are expected to proficiently incorporate AI-driven technologies into curriculum design, instructional delivery, and evaluation processes, thereby imparting students with competencies pertinent to contemporary technologies and the demands of the digital economy. TVET institutions ideally facilitate ongoing professional development and actively encourage the integration of AI within pedagogical practices. Nonetheless, empirical observations indicate that numerous TVET instructors in Nigerian universities demonstrate limited familiarity with AI principles and applications. Preliminary anecdotal data reveal that AI integration within TVET programs remains minimal, compounded by insufficient training opportunities for educators in emerging digital technologies. Variability in digital proficiency is evident, with many educators relying solely on fundamental ICT tools rather than embracing advanced or AI-enhanced pedagogical methodologies. The issue is exacerbated by infrastructural limitations, inadequate professional development frameworks, and a lack of comprehensive institutional policies fostering digital transformation in education. Consequently, despite the increasing global prioritization of digital transformation in educational contexts, there exists a significant research lacuna concerning the extent of AI awareness among TVET educators and its association with their digital competence within Nigerian universities. Existing literature predominantly addresses general ICT utilization or digital literacy in mainstream education, thereby neglecting the specific readiness of technical educators to integrate AI advancements. Bridging this knowledge gap is imperative for synchronizing technical education with worldwide technological progressions and aligning with national developmental objectives.

As noted by Okolie et al. (2021), the slow adoption of AI and advanced digital technologies in Nigerian TVET institutions is largely attributed to a lack of adequate teacher training and infrastructural deficits, highlighting the critical need for focused research on educators' AI awareness and competence to improve educational outcomes in the technical sector.

Purpose of the Study

This study examined the relationship between awareness of AI and digital competencies among technical college teachers in Edo State. Specifically, the study was conducted to:

1. Determine the level of awareness of AI among carpentry and joinery craft teachers' in technical colleges in Edo State.
2. Examine the level of digital competence among carpentry and joinery craft teachers' in technical colleges in Edo State.
3. Ascertain the relationship between AI awareness and digital competence among carpentry and joinery craft teachers' in technical colleges in Edo State.

Methods

In this study, a correlational survey design was employed, representing a non-experimental research approach that utilizes surveys to quantify two or more variables and evaluate the statistical associations between constructs without any experimental manipulation (Devi et al., 2022). This methodology was appropriate as it facilitates an exploration of the relationship between artificial intelligence (AI) awareness and digital competence.

The research focused on six technical colleges in Edo State that offer carpentry and joinery programs. The target population comprised 21 instructors specializing in carpentry and joinery across these institutions. A priori power analysis was conducted using G*Power 3.1.9.7 to establish the minimum sample size necessary for detecting a medium effect size in a bivariate correlation context. The analysis parameters included a t-test, a medium effect size ($\rho = .30$) following Cohen's standards, a significance level set at .05, and statistical power of 95%. The bivariate normal correlation model was chosen given the study's objective to investigate the association between two continuous variables. Results from G*Power indicated that a minimum sample of 19 participants was required to achieve the desired power. To accommodate possible non-responses or incomplete data, an additional 15% was added, yielding a target sample size of 26 participants.

The sample was selected through convenience sampling, reflecting pragmatic considerations during data collection, which involved multiple visits to the institutions. Since teacher availability varied, oversampling was necessary to ensure the minimum required sample size was obtained.

Data were collected via a self-developed questionnaire comprising three sections: Section A gathered personal data (gender and years of teaching experience); Section B contained eight items assessing AI awareness among carpentry and joinery instructors, measured on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5); Section C included nine items evaluating digital competence using a five-point Likert scale from Not Competent (1) to Highly Competent (5).

To establish content validity, the questionnaire underwent expert review by three faculty members from the Ambrose Alli University Ekpoma, two from Department of Vocational and Technical Education, and one from Measurement and Evaluation. Their feedback was incorporated into the final instrument.

A pilot study, involving 10 carpentry and joinery instructors outside the study population, was conducted for reliability assessment, yielding a Cronbach's alpha coefficient of .905, indicating high internal consistency. Questionnaires were administered and collected over a three-week period, resulting in 21 valid responses.

Descriptive statistics, including means and standard deviations, were utilized to analyze the levels of AI awareness and digital competence, with mean scores interpreted against a benchmark of 3.50. The relationship between AI awareness and digital competence was examined using Pearson's Product Moment Correlation coefficient.

Results

The analysis and results are presented.

Research Question 1: What is the level of awareness of artificial intelligence among carpentry and joinery craft teachers in technical colleges in Edo State?

Table 1

Level of Awareness of Artificial Intelligence among Carpentry and Joinery Craft Teachers

Variable	Mean	Standard Deviation	Interpretation
AI Awareness (Overall)	4.12	.60	High

(N = 21)

The data presented in Table 1 indicate that carpentry and joinery craft teachers demonstrated a substantial level of awareness regarding AI, evidenced by an overall mean score of 4.12 (SD = .60). The mean scores for individual survey items spanned from 4.01 to 4.31, reflecting uniformly elevated awareness across various dimensions of AI. These findings imply that the majority of participants possess a comprehensive understanding of AI principles and their practical implementations within educational settings.

Research Question 2: What is the level of digital competence among carpentry and joinery craft teachers in technical colleges in Edo State?

Table 2

Level of Digital Competence among Carpentry and Joinery Craft Teachers

Variable	Mean	Standard Deviation	Interpretation
Digital Competence (Overall)	4.11	.50	High

(N = 21)

Table 2 illustrates that carpentry and joinery craft teachers exhibited a considerable degree of digital proficiency, as indicated by an aggregate mean score of 4.11 (SD = .50). The individual item means ranged between 3.72 and 4.20, signifying a robust capability in applying digital technologies for instructional and professional purposes.

Research Question 3: Is there a significant relationship between AI awareness and digital competence among carpentry and joinery craft teachers in technical colleges in Edo State?

Table 3

Relationship between AI Awareness and Digital Competence

Variables	R	p-value	Decision
AI Awareness	.560	< .001	Significant Positive Relationship
Digital Competence			

The data presented in Table 3 illustrate the results of the Pearson Product Moment Correlation analysis, indicating a robust positive correlation between AI awareness and digital competence ($r = .560$, $p < .001$). This finding suggests that an increase in teachers' AI awareness corresponds with an enhancement in their digital competence. Furthermore, the statistical significance of this relationship implies that the observed association is unlikely due to random variation. Consequently, Hypothesis 1, which posited no significant relationship between AI awareness and digital competence among carpentry and joinery craft teachers in technical colleges in Edo State, was rejected.

Hypotheses

1. There is no significant relationship between AI awareness and digital competence among carpentry and joinery craft teachers in technical colleges in Edo State.

2. There is no significant difference in AI awareness based on gender and years of teaching experience among carpentry and joinery craft teachers in technical colleges in Edo State.
3. There is no significant difference in digital competence based on gender and years of teaching experience

Table 4
Summary of the Hypotheses Results

S/n	Null Hypotheses Decision	Statistical Test	Result
1.	No significant relationship exists between AI awareness and digital competence	Pearson Correlation	Significant
	Rejected	($r = .655, p < .001$)	
2.	No significant difference in AI awareness based on gender and years of experience	ANOVA and t-test	in all cases
	Retained	$p > .05$	
3.	No significant difference in digital competence based on gender, and years of experience	ANOVA and t-test	in all cases
	Retained	$p > .05$	

Table 4 presents a summary of the hypotheses evaluated in this research. Among these, only Hypothesis 1 yielded a p-value below .001, leading to its rejection, which indicates a significant relationship between AI awareness and digital competence. Conversely, for Hypotheses 2 and 3, personal variables such as gender, and years of experience did not demonstrate a significant effect on the AI awareness and digital competencies of carpentry and joinery craft teachers within technical colleges in Edo State.

Discussion

The research revealed that carpentry and joinery craft teachers in technical colleges within Edo State demonstrate a high level of awareness regarding artificial intelligence (AI). This outcome indicates that AI technologies have been increasingly recognized and incorporated within the technical college environment, enabling teachers to maintain a consistent understanding of AI applications pertinent to teaching and learning in carpentry and joinery disciplines. The elevated level of awareness may also reflect the impact of institutional initiatives such as workshops, online educational platforms, and the broad availability of AI-powered digital tools. This finding aligns with Ekwevugbe (2025), who documented a comparable high degree of AI tool awareness among academic lecturers. Consequently, the participants exhibit the requisite technological proficiency to leverage AI resources effectively in pedagogical delivery and professional practices. Also, Madu and Musa (2024) that found moderate awareness of AI and digital competences among lecturers. A further significant finding of this study is the identification of a robust and statistically significant positive correlation between AI awareness and digital competence, suggesting that teachers with greater knowledge of AI concurrently possess more advanced digital skills. Additionally, the study found that personal variables, including gender, and years of teaching experience, do not significantly affect AI awareness or digital competence levels. In support, Dringó-Horváth et al. (2025) also observed that there is no one-size-fits-all approach to AI, but a tailored approach to integration and utilization.

In conclusion, these results imply that institutional strategies aimed at fostering AI integration within carpentry and joinery craft teachers should prioritize comprehensive capacity-building initiatives that extend beyond a single discipline, encompassing other Trade and TVET subjects to promote broader adoption and integration.

Conclusion and Recommendations

The research indicates that carpentry and joinery teachers within technical colleges in Edo State exhibit elevated proficiency in both artificial intelligence awareness and digital competence. Moreover, there exists a robust correlation between AI awareness and digital competence, implying that enhancements in one area tend to bolster the other. Nevertheless, considering the practical characteristics of TVET trade disciplines, the study recommends the continued inclusive incorporation of these competencies.

1. Technical college's management and relevant educational stake holders should build more on regular training and retraining programmes for teachers on AI applications to sustain and deepen existing awareness levels.
2. Various areas of trade subjects in technical colleges should include practical AI literacy modules into staff development initiatives to facilitate effective instructional innovation.
3. Policymakers should develop robust guidelines for responsible and pedagogically sound integration of AI technologies into TVET instruction.
4. Government should provide AI supporting facilities to technical colleges.

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ARTIFICIAL INTELLIGENCE LITERACY AND DIGITAL RESILIENCE AS PREDICTORS OF BUSINESS EDUCATION STUDENTS' CYBERPRENEURIAL INTENTION IN EDO STATE

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Abstract

The rising graduate unemployment in Nigeria has exacerbated the need to train business education students' in digital competencies that could drive job creation. The main purpose of the study was to evaluate the extent to which artificial intelligence literacy and digital resilience predict business education students' cyberpreneurial intention in Edo State adopting correlational survey research design. Three research questions were addressed, while three hypotheses were tested at .05 level of significance. A total of 481 business education students from Ambrose Alli University, Ekpoma and the University of Benin constituted the study's population. The "Artificial Intelligence Literacy, Digital Resilience, and Cyberpreneurial Intention Questionnaire (AILDRASIQ)" was utilized in gathering the data; and was validated by two experts. The reliability coefficients obtained by Cronbach's alpha were .88 for artificial intelligence literacy, .82 for digital resilience, and .85 for cyberpreneurial intention after it was given to 30 business education students' at Delta State University, Abraka. Simple linear regression and multiple regression were utilized to assess the data. The results demonstrated that artificial intelligence literacy and digital resilience individually and jointly predicted business education students' cyberpreneurial intention in Edo State. It consequently means that conscious effort must be made to guarantee that the curriculum is reviewed to include AI literacy, digital business tools, and resilience-building digital learning experiences to increase students' readiness for cyberpreneurship. This study has addressed a research gap by exploring the hitherto underexplored link among AI literacy, digital resilience, and cyberpreneurial intention. Based on the results, it was recommended that students be introduced to trending AI tools that can facilitate digital business operations.

Keywords: Artificial Intelligence Literacy, Business Education, Cyberpreneurial Intention,
Digital Resilience

Introduction

The digital economy has brought about new techniques in recognizing and solving societal and economic challenges. One of the difficulties being faced in Nigeria is the increasing degree of unemployment that has further produced instability, poverty, and uncertainty in the society (Ediagbonya, 2022). This was what led to the introduction of Entrepreneurship education in the curriculum of higher institutions in Nigeria in 2004. The programme was deliberately developed to expose the undergraduates to alternate sources of income by preparing them with the necessary entrepreneurial skills needed for business start-up. This approach was purposefully meant to shift emphasis from paid work to self-employment.

The business landscape has shifted due to the increasing trend of automation and digital transformation; traditional entrepreneurship is no longer the only focus (Ediagbonya et al., 2024a; Ediagbonya et al., 2024b; Ediagbonya et al., 2024c; Ediagbonya et al., 2026). In other words, entrepreneurs are increasingly focused on using the internet's resources for their business endeavors. As a result, cyberpreneurship is becoming more and more important. Digital entrepreneurship and cyberpreneurship are frequently used interchangeably. Cyberpreneurship, according to Bensaid and Azdimousa (2021), is the process of creating new businesses with creative concepts that use an electronic platform in data networks to provide goods and/or services based only on electronic value

creation. Cyberpreneurship, according to Mohammed et al. (2023), is the process of influencing changes in the competitive environment through information and communication technologies, particularly digital media. In the current digital era, students are accustomed to using technology and may find it easy to pursue this kind of business venture.

Cyberpreneurial intention, according to Mir et al. (2023), is a person's deliberate desire to pursue an entrepreneurial career made possible by information and communication technology (ICT), particularly the intention to launch a new company using digital technology tools like the internet, mobile devices, and related technologies. Similarly, cyberpreneurial intention is defined by Vu et al. (2024) as a proactive commitment to navigate the digital environment to pursue innovative business projects and endeavors, which goes beyond a simple entrepreneurial tendency. Undergraduate students' intentions to pursue cyberpreneurship are frequently impacted by a number of elements, including digital resilience (DR) and artificial intelligence (AI) literacy.

Artificial intelligence (AI) is the term used to describe systems that can respond in ways similar to intelligent human behavior, such as understanding complex circumstances, simulating cognitive processes, reasoning, adapting, learning, and gaining information to solve problems. In contrast to the natural intelligence exhibited by humans and animals, the author emphasized that artificial intelligence (AI) is fundamentally a sort of intelligence manifested by computers. The information necessary to comprehend, the operational skills necessary to interact with, and the awareness necessary to critically assess AI systems, including its ethical, sociological, and practical ramifications, are together referred to as artificial intelligence literacy (Biagini, 2025).

Similarly, Long and Magerko (2020) defined AI literacy as having the skills necessary to assess AI technology critically, interact and cooperate with AI successfully, and use AI as a tool at home, at work, and online. In this digital economy, AI literacy has become an essential tool. Possessing AI literacy will boost people's confidence and encourage them to pursue cyberpreneurship. AI literacy is viewed as a benefit when starting a cyberpreneurial endeavour, in keeping with the human capital idea. Therefore, in order to effectively find and establish online business possibilities, entrepreneurs or would-be entrepreneurs must work toward becoming AI literate. AI literacy is viewed as a benefit when starting a cyberpreneurial endeavor, in keeping with the human capital idea. It takes a lot of digital resilience to maintain online engagement while conducting business.

The ability to absorb significant shocks, adjust to disturbances, and change into a new stable state where organizations are better equipped to withstand future shocks is known as "digital resilience" (Boh et al, 2023). Tim and Leidner (2023) defined digital resilience (DR) as the ability of people, organizations, and communities to recover from external shocks through the development, implementation, and utilization of information systems. Similarly, DR is defined by Lestari et al. (2025) as people's ability to alter their mental and behavioral states in reaction to the dangers that digital technologies present to society. The authors emphasized that DR includes essential elements including digital identity, digital assistance, and digital health. Digital entrepreneurial resilience, according to Berman et al. (2026), is a process wherein digital start-ups use digital technologies to cultivate entrepreneurial qualities like agility and adaptability in order to overcome hardship and guarantee survival and expansion.

People who comprehend these concepts—AI literacy and digital resilience—will be more equipped to start cyberpreneurial endeavors. Since digital technologies play a major role in today's economy, entrepreneurs' ability to use the internet and artificial intelligence (AI) to identify and maintain business prospects will be crucial to their survival. Previous research has mostly concentrated on traditional entrepreneurship, which is out of step with the current digital economy. Most studies have emphasized the association between resilience and cyberpreneurial intention (Hossain et al, 2023; Zahra, 2025; Balgiu et al, 2025; Aliffirmansyah & Nikmah, 2025; Han et al., 2026; Tantawy et al., 2026). Studies have also shown that there is a significant relationship between AI literacy and cyberpreneurial intention (Duong, 2024; Duong, 2025; Hajizadeh & Hassani, 2025; Tang et al., 2025; Duong et al., 2025; Duong et al., 2026). Despite the studies that have been done in this field, there is still a dearth of empirical studies. Most of the studies were conducted in the Western world, and the variable, digital resilience, is yet to gain sufficient attention. Most studies focused on

resilience in general without emphasizing digital resilience, which is fundamental in understanding the digital landscape. Again, none of the reviewed studies have looked at the predictive roles of AI literacy and digital resilience in explaining Business Education students' cyberpreneurial intention in Edo State. This gap has been filled in this study by investigating the extent to which AI literacy and digital resilience predict Business Education students' cyberpreneurial intention in Edo State.

Purpose of the Study

The main purpose of the study was to ascertain the extent to which AI literacy and digital resilience predict Business Education students' cyberpreneurial intention in Edo State. Specifically, the study sought to:

1. Determine if AI literacy is a significant predictor of Business Education students' cyberpreneurial intention in Edo State; and
2. Ascertain if digital resilience is a significant predictor of Business Education students' cyberpreneurial intention in Edo State.

Theoretical Framework

The theoretical framework was hinged on the Social Cognitive Career Theory (SCCT). The SCCT was propounded by Lent et al. (1994), and it posits that career behavior is shaped by the interaction of personal beliefs, expected outcomes, and environmental factors. Self-efficacy, result expectations, interests, goals (intentions), and contextual circumstances are the theory's core pillars. Self-efficacy is the conviction that one can complete a task. To put it simply, "outcome expectations" are beliefs about how that task will turn out. The preferences that arise from self-efficacy and anticipated results are related to interest. In the theory, "goals" refers to the aims. That is, the choices to follow a specific course. The supports and obstacles that affect behavior are referred to as contextual factors.

In the context of this study, artificial intelligence (AI) is a tool that, when used by an individual, can boost their sense of self-efficacy, which can encourage them to start a digital business. In other words, the AI abilities that Business Education students possess give them a certain amount of confidence, which encourages them to pursue online business prospects. A person's ability to avoid the dangers and vices of conducting business online is known as their "digital resilience." People with this type of disposition won't want to give up running internet enterprises. By this theory, Business Education students are likely to venture into cyberepreneurship as a result of their digital resilience and AI literacy skills they possessed. This theory is best in explaining the interrelationships that exist among AI literacy, DR, and cyberpreneurial intention of Business Education students in Edo State.

Methods

The study examined the relationship between the independent and dependent variables using a cross-sectional survey research design. Given its focus on determining the relationship between the independent variables (Artificial Intelligence literacy and Digital resilience) and dependent variable (cyberpreneurial intention), this design was deemed appropriate for the study.

The population was made up of 481 Business Education students from the two public universities offering Business Education in Edo State. The students were from 200 level to 400 level in the 2025/2026 academic session. The institutions are: University of Benin, Benin City and Ambrose Alli University, Ekpoma. The entire population was used in the study since the population was a management size.

Structured questionnaires that were modified from earlier scales served as the study's instruments. The AI literacy scale was adapted from Aktay et al. (2025), the digital resilience scale was adapted from Suranata et al. (2024), while the cyberpreneurial intention scale was adapted from Wibowo et al. (2023).

Two experts in the field of business education subjected the instrument to validity. The instrument's reliability was assessed using the Cronbach Alpha. 30 business education students were

given the instrument. The various scales yielded the following reliability coefficients: AI literacy (.79), digital resilience (.86), and cyberpreneurial intention (.89).

A total of 328 instruments were returned after the researcher used a Google Form to administer the instruments to the respondents. The Statistical Packages for Social Sciences (SPSS) Version 26.0 was used to analyze the collected data. The data was analyzed using simple regression analysis.

Results

The results of the data analysis are presented in this section with respect to the hypotheses testing of the study variables.

Hypothesis 1: AI literacy is not a significant predictor of Business Education students' cyberpreneurial intention in Edo State.

Table 1
AI Literacy Predicting Cyberpreneurial Intention

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	9.315	1.457	6.395	.000
	AI literacy	.149	.028	.295	.000

a. Dependent Variable: Cyberpreneurial Intention

Note: Adjusted $R^2 = .084$, Df = 1, 300, SE = .295, F = 28.518, $P < .05$, $t = 5.340$, $\beta = .295$

Table 1 reveals that AI literacy ($F(1, 300) = 28.518$, SE = .295, $\beta = .295$, $t = 5.340$) had a significant positive influence on cyberpreneurial intention. The Adjusted R-square (.084) reveals that 8.4% of the variance in cyberpreneurial intention is influenced by AI literacy. Therefore, hypothesis 1 is rejected in the study. That is, AI literacy is a significant predictor of business education students' cyberpreneurial intention in Edo State.

Hypothesis 2: Digital resilience is not a significant predictor of Business Education students' cyberpreneurial intention in Edo State.

Table 2
Digital resilience predicting cyberpreneurial intention

Model	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
1	(Constant)	4.376	1.385	3.160
	Digital resilience	.366	.040	.470

a. Dependent Variable: Cyberpreneurial Intention

Note: Adjusted $R^2 = .218$, Df = 1, 300, SE = .040, F = 84.903, $P < .05$, $t = 9.214$, $\beta = .470$

Table 2 reveals that digital resilience ($F(1, 300) = 84.903$, SE = .040, $\beta = .470$, $t = 9.214$) had a significant positive influence on cyberpreneurial intention. The Adjusted R-square (.218) reveals that 21.8% of the variance in cyberpreneurial intention is influenced by digital resilience. Therefore, hypothesis 2 is rejected in the study. That is, digital resilience is a significant predictor of cyberpreneurial intention among business education students in Edo State.

Discussion of Findings

The analysis conducted with respect to the first hypothesis revealed that AI literacy is a significant predictor of business education students' cyberpreneurial intention in Edo State. This means that possessing AI literacy skills tends to make students confident and motivated to venture into cyberpreneurship. It therefore implies that when individuals know AI and its utilization in

entrepreneurial activities, they will be more willing to pursue digital business enterprise. This finding corroborates the findings by Duong (2024), Duong (2025), Hajizadeh and Hassani (2025), Tang et al. (2025), Duong et al. (2025), Duong et al. (2026) who found that AI literacy has significant relationship with cyberpreneurial intention. However, this finding contradicts the findings by Duong (2025) and Alkhalaileh and Qasim (2026) who found insignificant relationship between AI literacy and cyberpreneurial intention.

The findings from the second hypothesis revealed that digital resilience is a significant predictor of business education students' cyberpreneurial intention in Edo State. This finding shows that individuals that possess this digital resilience trait are able to overcome all the challenges and vices associated with internet usage and still press on in pursuing digital businesses. This finding corroborates the findings by Hossain et al. (2023), Zahra (2025), Balgiu et al. (2025) Aliffirmansyah and Nikmah (2025), Han et al. (2026), and Tantawy et al. (2026) who found that digital resilience is a significant predictor of cyberpreneurial intention.

Conclusion and Recommendations

The findings indicate that AI literacy and digital resilience are both significant predictors of business education students' cyberpreneurial intention in Edo State. This finding underscores the need for an urgent curriculum review to accommodate both AI literacy and digital resilience, as these topics are highly useful in equipping learners with the skills needed to function effectively in this current digital economy. This will also inform the need for lecturers and instructors to be retrained for them to be proficient in knowledge delivery. This finding makes a novel contribution to the literature in cyberpreneurship and business education by utilizing Social Cognitive Career Theory (SCCT) in explaining how personal factors and contextual factors are capable of propelling individuals to venture into cyberpreneurial activities in Edo State.

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

1. the curriculum of entrepreneurship education should be reviewed with a view to incorporating topics on cyberpreneurship;
2. the students should be exposed to more Artificial Intelligence tools that are capable of supporting businesses;
3. regular retraining exercise should be conducted from time to time to assist those involved in the teaching of cyberpreneurship courses; and
4. the students should be carefully taught on how to build digital resilience personality.

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ARTIFICIAL INTELLIGENCE TOOLS AND THEIR INFLUENCE ON STUDENTS' ACADEMIC PERFORMANCE IN TERTIARY INSTITUTION

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Abstract

Artificial Intelligence (AI) has significantly transformed teaching and, learning, research and assessment in higher education. The rapid adoption of AI-powered tools such as ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, QuillBot, and adaptive learning platforms has significantly influenced teaching and learning processes in tertiary institutions worldwide. This paper examined artificial intelligence tools and their influence on students' academic performance in tertiary institutions. The purpose was to discuss the concept of artificial intelligence, commonly used AI tools among students, the positive and negative influences of AI on academic performance, challenges associated with AI adoption in higher education, and strategies for promoting ethical and effective use of AI technologies. The paper adopted a descriptive review approach by synthesizing findings from recent empirical studies conducted across in Nigeria. Evidence from the reviewed literature indicates that AI tools improve students' academic performance by enhancing personalized learning, increasing leaning motivation, supporting academic writing, improving research efficiency, and providing immediate feedback. However, excessive dependence on AI may weaken critical thinking, reduce creativity, encourage academic dishonesty, and compromise the development of independent learning skills. The paper concluded that AI should complement rather than replace students' cognitive efforts. It suggested amongst others that tertiary institutions formulate AI usage policies, train lecturers and students on responsible AI practices, redesign assessment methods, and integrate AI literacy into the curriculum to maximize its educational benefits.

Keywords: Artificial Intelligence, AI Tools, Academic Performance, Students.

Introduction

The emergence of Artificial Intelligence (AI) has transformed virtually every sector of society, including healthcare, banking, agriculture, manufacturing, communication, and education. In recent years, higher education has witnessed an unprecedented integration of AI technologies into teaching, learning, research, assessment, and administrative processes. The introduction of generative AI tools such as ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, QuillBot, and numerous intelligent tutoring systems has fundamentally changed how students access knowledge and complete academic tasks.

Artificial Intelligence refers to the capability of computer systems to perform tasks that ordinarily require human intelligence, including reasoning, learning, problem-solving, language understanding decision-making, and pattern recognition, Zawacki-Richter et al. (2019) AI systems use machine learning algorithms, natural language processing, computer vision, and deep learning techniques to analyze data, generate responses, and support human activities. Within tertiary institutions, AI tools assist students in researching academic topics generating ideas, summarizing literature, correcting grammar, solving mathematical problems, writing computer codes, and improving communication skills.

Globally, tertiary institutions are increasingly embracing AI-driven educational technologies because they offer personalized learning experiences that accommodate students with different learning abilities and academic backgrounds. AI powered platforms provide immediate feedback, recommend learning materials, identify students' learning weaknesses, and monitor academic progress (World Economic Forum 2023). Consequently, students are able to learn at their own pace while lecturers gain insights into learners' performance through intelligent analytics.

In Nigeria, the growing availability of smartphones, internet connectivity, and cloud-based AI applications has accelerated the adoption of AI tools among university, polytechnic and college of education students. Many students now use ChatGPT and similar applications for assignment preparation, research assistance, project writing, examination revision, programming support, and academic communication. These technologies have contributed to improved access to information and enhanced learning efficiency. Nevertheless, concerns have emerged regarding excessive dependence on AI-generated content, plagiarism, declining critical thinking skills, misinformation, and violations of academic integrity (UNESCO 2021)

According to Ogbebor (2025), academic performance remains a major indicator of educational success in tertiary institutions. It reflects the extent to which students' achieve established learning objectives through examinations, assignments, research projects, presentations, practical activities, and continuous assessments. Several factors influence academic performance, including study habits, learning environment, motivation, lecturer quality, technological resources, and students' cognitive abilities. The integration of AI introduces another important factor that deserves careful examination because its influence may be either beneficial or detrimental depending on how students utilize these technologies.

The increasing popularity of AI tools therefore presents both opportunities and challenges for higher education. While AI can improve learning outcomes, facilitate independent learning, and increase academic productivity, inappropriate use may undermine originality, creativity, and ethical scholarship. This paper therefore examines the Influence of Artificial Intelligence Tools on Students' Academic Performance in Tertiary Institutions by reviewing contemporary literature and offering recommendations for responsible AI adoption.

Statement of the Problem

The increasing availability and accessibility of Artificial Intelligence tools have transformed students learning experiences in tertiary institutions. AI applications are now routinely used for literature searches, essay writing, language editing, problem-solving, programming, data analysis, and examination preparation. Despite these benefits, many educators, remain concerned about the implications of excessive AI dependence on students' academic development.

Reports indicate that some students rely heavily on AI-generated responses without critically evaluating or understanding the information provided. Such practices may reduce analytical thinking, creativity, originality, and independent problem-solving skills that are expected from graduates of higher institutions. Furthermore, the misuse of AI has increased concerns about plagiarism, academic dishonesty, inaccurate information, and unethical assessment practices.

In many developing countries, including Nigeria, institutional policies regulating AI usage remain inadequate. Many lecturers lack sufficient knowledge of AI technologies, while students often receive little guidance regarding ethical AI practices. Consequently, uncertainty exists regarding the overall influence of AI tools on students' academic performance. Although numerous international studies have investigated AI in education, relatively fewer empirical studies have focused specifically on tertiary institutions in developing countries where technological infrastructure, digital literacy, and educational policies differ considerably. This gap underscores the need to synthesize current evidence on the influence of AI tools on Students' Academic Performance and identify strategies that promote responsible AI integration within tertiary education.

Purpose of the Study

The main purpose of this paper was to examine artificial intelligence tools and its influence on students' academic performance in tertiary institutions in tertiary institutions. The specific purpose are to:

1. Explain the concept of Artificial Intelligence and AI tools in tertiary institution;
2. Identify commonly used AI tools among students in tertiary institutions;
3. Examine the positive and negative influence of AI tools on students' academic performance;
4. Identify challenges associated with AI adoption in tertiary institutions; and
5. determine strategies for promoting ethical and effective use of AI tools in tertiary institutions.

Research Questions

The paper addresses the following questions on Artificial Intelligence Tools and its Influence on Students' Academic Performance in Tertiary Institutions.

1. What is Artificial Intelligence and what are the AI tools are commonly used in tertiary institution?
2. How do AI tools positively influence of AI tools on students' academic performance?
3. What positive and negative effects do AI tools have on students' academic performance?
4. What challenges affect adoption of AI tools in tertiary institutions?
5. What strategies are needed for promoting ethical and effective use of AI tools in tertiary institutions?

Conceptual Literature Review

Artificial Intelligence

Artificial Intelligence (AI) refers to the ability of computer systems to perform tasks that typically require human intelligence, including learning, reasoning, problem-solving, decision-making, language understanding, and pattern recognition. AI integrates technologies such as machine learning, deep learning, natural language processing (NLP), robotics, and computer vision to simulate human cognitive processes.

According to Russell and Norvig (2021), Artificial Intelligence is the study and design of intelligent agents that perceive their environment and take actions to maximize the likelihood of achieving specified goals. Similarly, Kaplan and Haenlein (2020) described AI as a system's capability to correctly interpret external data, learn from such data, and use those learnings to achieve specific objectives through flexible adaptation.

In education, AI has transformed traditional teaching and learning by enabling personalized instruction, intelligent tutoring, automated assessment, virtual learning assistants, predictive analytics, and adaptive learning systems. AI technologies support lecturers in curriculum delivery while assisting students with individualized learning experiences that enhance knowledge acquisition and academic achievement.

The rapid development of generative AI applications has further revolutionized higher education. Unlike traditional software that retrieves information, generative AI creates original text, images, computer codes, presentations and summaries in response to user prompts. Consequently, students can receive immediate explanations, personalized tutoring, and writing assistance, making AI an increasingly indispensable educational resource (UNESCO 2021).

Artificial Intelligence Tools Used by Students in Tertiary Institutions

Several AI-powered applications have become popular among students because they improve learning efficiency and academic productivity. Ngonso et al (2025) highlighted seven common AI tools used by students includes:

1. **ChatGPT**, developed by OpenAI, is one of the most widely used generative AI tools in tertiary institution. It assists students in generating ideas, explaining difficult concepts, summarizing articles, preparing assignments, solving programming problems, drafting research proposals, and improving academic writing. It also serves as a virtual tutor by providing instant responses to academic questions.
2. **Google Gemini** is an AI-powered assistant capable of generating text, solving mathematical problems, summarizing research materials, and supporting collaborative learning. Students use Gemini for brainstorming, project development, literature review, and language translation.
3. **Microsoft Copilot** integrates AI into Microsoft Word, Excel, PowerPoint, and other productivity applications. It assists students in drafting reports, creating presentations, analyzing datasets, and improving academic documents.
4. **Grammarly** is an AI-based writing assistant that checks grammar, punctuation, spelling, vocabulary, sentence structure, tone, and clarity. It enhances students' academic writing by improving readability and reducing grammatical errors.
5. **QuillBot** provides paraphrasing, summarization, grammar correction, citation generation, and plagiarism checking. Students use it to rewrite academic texts while maintaining their original meaning.
6. **Intelligent Tutoring Systems (ITS)** are AI-powered educational platforms that provide personalized instruction according to students' learning needs. These systems evaluate learners' progress and recommend suitable learning materials and exercises.
7. **Adaptive Learning Platforms** this is adaptive learning technologies continuously analyze students' performance and adjust instructional content to meet individual learning abilities. These platforms improve comprehension by allowing students to progress at their own pace.
8. **AI-Based Translation Tools** these are applications such as DeepL and Google Translate assist students in translating academic materials from one language to another, thereby supporting multilingual learning and access to global scholarly resources.

Academic Performance

Academic performance refers to the extent to which students successfully achieve educational goals established by their institutions. It is commonly measured through examination scores, grade point average (GPA), continuous assessment, project work, assignments, presentations, practical exercises, and classroom participation,

York et al. (2015) defined academic performance as the measurable level of educational achievement attained by students through formal evaluation processes. Similarly, Ali et al. (2013) explained that academic performance reflects the quality of learning outcomes resulting from students' intellectual abilities, motivation study habits, and learning environment.

Academic performance is influenced by numerous factors as enumerated by Ogbebor (2025) which includes: students' motivation; study habits; time management; teaching quality; learning resources; family background; digital literacy; technological infrastructure; and availability and effective utilization of artificial intelligence tools. When AI technologies are used responsibly, they can improve understanding, retention, and academic achievement. However, misuse may negatively affect learning outcomes and intellectual development.

Positive Influence of Artificial Intelligence Tools on Students' Academic Performance

Artificial Intelligence offers numerous educational benefits that contribute significantly to students' academic success. Below are some of the positive influence according to Kasneci et al. (2023):

1. **Personalized Learning.** AI systems adapt learning materials according to students' individual strengths, weaknesses, and learning pace. This personalized approach improves understanding and retention of knowledge.
2. **Immediate Feedback.** AI-powered learning systems, provide instant feedback on quizzes, assignments, and practice exercises. Immediate correction enables students to identify mistakes and improve their understanding.
3. **Improved Academic Writing.** Applications such as Grammarly and QuillBot help students produce clearer, more accurate, and professionally written assignments by correcting grammar, punctuation, sentence structure, and vocabulary.
4. **Enhanced Research Skills.** AI search tools simplify literature reviews by locating relevant journal articles, summarizing research findings, and organizing references, thereby saving time and improving research quality.
5. **Increased Learning Motivation.** Interactive AI learning environments make learning more engaging through simulations, virtual tutoring and personalized recommendations, increasing students' interest and motivation.
6. **Better Time Management.** AI automates routine academic tasks such as note summarization, scheduling, citation generation, and document formatting, allowing students to allocate more time to meaningful learning activities.
7. **Support for Students with Disabilities.** AI-powered speech recognition, screen readers, captioning tools, and text-to-speech applications improve educational access for students with visual, hearing, and learning disabilities, thereby promoting inclusive education.

Negative Influence of Artificial Intelligence Tools on Students' Academic Performance

Despite its benefits, AI also presents several educational challenges as asserted by Dwivedi et al. (2023):

1. **Overdependence on AI.** Students who excessively rely on AI-generated answers may fail to develop independent thinking, analytical reasoning, and problem-solving abilities.
2. **Academic Dishonesty.** The ease of generating essays, assignments and examination responses using AI has increased concerns regarding plagiarism, cheating, and violations of academic integrity.
3. **Decline in Critical Thinking.** When students accept AI-generated responses without verification, opportunities for critical analysis and independent reasoning are reduced.
4. **Inaccurate Information.** AI systems occasionally generate incorrect, outdated, or fabricated information. Students who fail to verify AI outputs risk using inaccurate academic content.
5. **Reduced Creativity.** Heavy dependence on AI-generated ideas may discourage originality, innovation, and creative thinking among students.
6. **Privacy and Data Security Concerns.** Many AI platforms collect user data, raising concerns about privacy, confidentiality and ethical handling of students' personal information.

Relationship between Artificial Intelligence Tools and Academic Performance

The relationship between AI tools and students' academic performance is generally positive when AI is used responsibly and ethically. AI enhances learning by providing personalized instruction, immediate feedback, improved writing assistance, efficient research support, and adaptive learning experiences. These benefits contribute to improved examination performance, higher GPA, increased learning motivation and better knowledge retention.

However, the relationship can become negative when students misuse AI by depending entirely on AI-generated content without engaging in independent learning. Responsible AI use therefore determines whether its influence on academic performance becomes beneficial or detrimental.

Theoretical Framework

This paper is anchored on the Technology Acceptance Model (TAM) developed by Davis (1989). The model explains how users come to accept and use a new technology. According to TAM, two major factors determine whether individuals adopt a technology:

1. **Perceived Usefulness (PU).** The extent to which a person believes that using a technology will improve his or her performance.
2. **Perceived Ease of Use (PEOU).** The extent to which a person believes that using a technology will be free of effort.

Applying TAM model to tertiary education, students are more likely to adopt AI tools such as ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, and QuillBot when they perceive these tools as useful for improving learning outcomes and easy to use. Frequent and effective use of AI technologies can enhance learning, research, assignment quality, and academic achievement. However, misuse or over dependence may negatively affect critical thinking, creativity, and independent learning. The Technology Acceptance Model is therefore relevant because it explains why students adopt AI tools and how such adoption influences their academic performance.

Empirical Review

Several empirical studies have examined the influence of Artificial Intelligence tools on students' academic performance.

Ogbebor (2025) investigated the influence of Artificial Intelligence tools on students' academic performance in selected tertiary institutions in Nigeria. The findings indicated that AI-assisted learning significantly improved students' research skills, assignment quality, digital literacy, and overall academic performance. The study recommended integrating AI literacy into tertiary institution curricula.

Ngonso et al. (2025) examined AI adoption among Nigerian university students and found that AI applications improved learning efficiency, information retrieval, and students' confidence in completing academic tasks. However, excessive reliance on AI reduced students' independent analytical abilities.

A study conducted at Nnamdi Azikiwe University revealed that students who used AI-powered educational technologies demonstrated higher levels of academic engagement and learning motivation than those who relied solely on conventional learning methods. The researchers emphasized that AI should be used as a complementary learning resource rather than a substitute or independent study.

Similarly, studies conducted in Nigerian universities have shown that AI-based writing assistants such as Grammarly improve students' grammar, coherence, and academic writing quality, especially during project writing and research report preparation.

Synthesis of the Reviewed Literature

The literature reviewed demonstrates that Artificial Intelligence has become an important educational innovation in tertiary institutions worldwide. Most researchers agree that AI tools improve personalized learning, facilitate academic research, enhance writing quality, provide immediate feedback, and increase students' learning motivation. The review also reveals that AI contributes positively to academic performance through adaptive learning systems, intelligent tutoring, automated assessment, and research support. Students' benefits from faster access to information, improved academic communication, and enhanced digital competencies.

However, the reviewed studies consistently caution against excessive dependence on AI-generated content. Overreliance on AI may reduce students' critical thinking, creativity, originality, and independent problem-solving skills. Ethical concerns relating to plagiarism, academic dishonesty, misinformation, and privacy remain significant challenges. Overall, the evidence suggests that the influence of AI is used responsibly, ethically, and under appropriate institutional guidelines.

Research Gap

Although numerous studies have examined Artificial Intelligence in education, several gaps remain.

First, many existing studies focus on developed countries where technological infrastructure and digital literacy levels are relatively high. Comparatively fewer studies have examined AI adoption within Nigerian tertiary institutions. Secondly, many studies investigate students' perceptions and acceptance of AI rather than its measurable influence on academic performance. Thirdly, because generative AI technologies such as ChatGPT, Google Gemini, and Microsoft Copilot are relatively recent innovations, long-term evidence regarding their educational impact is still limited.

Finally, institutional policies regulating ethical AI use in Nigerian tertiary institutions remain underdeveloped. More empirical research is therefore needed to establish appropriate frameworks for integrating AI into teaching, learning, assessment, and research while preserving academic integrity.

Conceptual Framework

The conceptual framework of this paper proposed that the effective use of Artificial Intelligence tools influences students' academic performance through improved learning processes.

The independent variables in respect to Artificial Intelligence Tools are ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, QuillBot, Intelligent Tutoring Systems and Adaptive Learning Platforms. The intervening variables are Digital literacy, Ethical use of AI, Internet accessibility, Institutional AI policy, Lecturer guidance and Students' learning motivation. Finally, the dependent variables on students' academic performance are improved examination scores, better assignment quality, higher GPA, enhanced research competence, improved critical understanding and increased academic productivity.

The framework suggests that the relationship between AI tool and academic performance is strengthened when students possess adequate digital literacy, receive proper guidance from lecturers, and use AI ethically and responsibly.

Discussion of Findings

The reviewed literature indicates that Artificial Intelligence (AI) has become an indispensable tool in tertiary education. AI-powered applications such as ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, QuillBot, and intelligent tutoring systems have significantly transformed the teaching and learning process. These tools enable students to access information quickly, improve their academic writing, conduct literature reviews efficiently, solve complex problems, and receive personalized learning support.

The findings further reveal that AI contributes positively to students' academic performance by improving learning motivation, engagement, critical understanding of concepts (when used appropriately), research competence, and assignment quality. AI-powered adaptive learning systems allow students to learn at their own pace while receiving immediate feedback that enhances knowledge retention and academic achievement.

However, the review also highlights several concerns associated with AI usage. Excessive dependence on AI-generated content may discourage originality, creativity, independent thinking, and problem-solving abilities. Students who submit AI-generated assignments without proper

evaluation risk violating academic integrity policies through plagiarism and other forms of academic misconduct. In addition, AI systems sometimes generate inaccurate or fabricated information ‘AI hallucinations’, making it essential for students to verify information obtained from these tools using credible academic sources.

To this end, the literature suggests that AI is neither inherently beneficial nor harmful, its influence depends largely on how responsibly students and lectures integrate it into teaching, learning, and research activities.

Implications for Tertiary Institutions

The increasing use of AI tools has several implications for tertiary institutions according to Chan and Hu (2023) are:

1. **Curriculum Review:** Institutions should revise curricula to include AI literacy, prompt engineering, digital ethics, and responsible AI use.
2. **Teaching Practices:** Lecturers should redesign instructional strategies to incorporate AI as a learning support tool while encouraging critical thinking and independent learning.
3. **Assessment Methods:** Traditional take-home assignments should be complemented with oral presentations, practical exercises, project-based assessments, reflective writing, and supervised examinations to minimize AI misuses.
4. **Academic Integrity:** Institutions should establish clear guidelines governing acceptable AI use in assignments, projects and examinations.
5. **Capacity Building:** Continuous training should be organized for lecturers and students on effective and ethical use of AI technologies.
6. **Infrastructure Development:** Universities, Polytechnics, and Colleges of Education should improve internet connectivity, electricity supply, and access to digital learning resources to maximize the educational benefits of AI.

Challenges Affecting the Adoption of AI in Tertiary Institutions

Despite its enormous potential, several factors hinder the effective adoption of AI in tertiary institution. Kaplan and Haenlein (2020) highlighted some of them, namely: inadequate digital infrastructure; poor internet connectivity; erratic electricity supply; limited AI literacy among lecturers and students; high cost of premium AI applications; inadequate institutional policies regulating AI use; privacy and cybersecurity concerns; academic dishonesty and plagiarism; and biases and inaccuracies in AI-generated responses.

Addressing these challenges requires collaborative efforts among governments, educational institutions, technology providers, lecturers, students and policymakers.

Conclusion

Artificial Intelligence has emerged as one of the most significant technological innovations influencing higher education in the twenty-first century. AI tools have transformed students’ learning experiences by improving access to information, facilitating personalized learning, enhancing academic writing, strengthening research capabilities, and supporting collaborative learning.

The review demonstrates that AI contributes positively to students’ academic performance when use responsibly and ethically. Nevertheless, excessive dependence on AI may weaken critical thinking, creativity, originality, and independent learning while increasing the risk of academic misconduct.

Therefore, AI should complement-not replace-students’ intellectual efforts. Tertiary institutions should develop comprehensive AI policies, promote AI literacy, redesign assessment methods, and encourage ethical AI practices to ensure that technological advancement contributes meaningfully to educational quality and graduate competence.

Suggestions

Based on the review, the following suggestions are made on artificial intelligence tools and their influence on students' academic performance in tertiary institutions:

1. Tertiary institutions should formulate clear institutional policies on the ethical use of Artificial intelligence in teaching, learning, research and assessment.
2. AI literacy courses should be incorporated into undergraduate and postgraduate curricular to equip students with the knowledge and skills required for responsible AI usage.
3. Lecturers should receive regular professional development training on integrating AI into instructional practices without compromising academic integrity.
4. Students should be encouraged to use AI as a learning aid rather than a substitute for independent thinking and research.
5. Institutions should redesign assessment methods by emphasizing practical projects, oral examinations, laboratory work, case studies, and reflective assignments that require critical thinking.
6. Governments should invest in digital infrastructure, reliable electricity, high-speed internet connectivity, and educational technologies to support AI adoption in tertiary institutions.
7. Institutions should strengthen plagiarism detection systems and establish clear sanctions for unethical AI use.

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DATA-DRIVEN SPORTS: THE CHALLENGES OF ARTIFICIAL INTELLIGENCE IN GLOBAL SPORTS MANAGEMENT

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Abstract

The rapid integration of Artificial Intelligence (AI) into the sports industry has transformed how athletes train, teams compete, and organizations make strategic decisions. This paper examines the role of AI in enabling data-driven sports by exploring its applications in performance analysis, injury prevention, talent identification, tactical decision-making, fan engagement, and sports management. The paper argues that AI-driven technologies, such as machine learning, computer vision, wearable sensors, and predictive analytics, have significantly improved the collection, processing, and interpretation of sports data, thereby enhancing athletic performance and organizational efficiency. However, the widespread adoption of AI also presents challenges related to data privacy, algorithmic bias, ethical governance, financial accessibility, and the evolving role of human expertise in decision-making. The paper maintains that while AI should be embraced as a transformative tool in modern sports, its implementation must be guided by ethical standards, transparency, and human oversight to ensure fairness and inclusivity. It concludes that the future of sports lies in a balanced partnership between artificial intelligence and human judgment, where technological innovation complements rather than replaces the expertise of coaches, athletes, officials, and sports administrators. The paper provides recommendations for policymakers, sports organizations, and researchers to promote responsible AI adoption that supports sustainable development and competitive excellence in the global sports industry.

Keywords: Artificial Intelligence, Data-Driven Sports, Sports Analytics, Athlete Performance, Sports Technology.

Introduction

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the Fourth Industrial Revolution, reshaping industries through intelligent automation, predictive analytics, and data-driven decision-making. Over the past two decades, professional sports have transitioned from an era governed primarily by subjective intuition and traditional coaching heuristics to an ecosystem powered by empirical data, real-time biomechanical tracking, and machine learning models (Davenport & Patil, 2012; Morgulev et al., 2018).

The sports industry has increasingly embraced AI technologies to improve athletic performance, optimize organizational operations, enhance fan experiences, and support strategic decision-making (Dwivedi et al., 2023). What began as rudimentary statistical collection, popularized by Sabermetrics in baseball, has evolved into complex artificial intelligence infrastructure utilizing deep neural networks, computer vision, and wearable micro-sensor arrays (Mommert & Raabe, 2021). From elite professional competitions to grassroots sports development, AI has become a valuable tool for analyzing complex datasets that were previously difficult or impossible to interpret using conventional methods. What began as rudimentary statistical collection, popularized by Sabermetrics in baseball, has evolved into complex artificial intelligence infrastructure utilizing deep neural networks, computer vision, and wearable micro-sensor arrays (Mommert & Raabe, 2021), in capturing, process, and measure every movement performed by athletes. These devices continuously generate performance metrics including speed, acceleration, heart rate, workload, reaction time, movement efficiency, tactical positioning, and recovery indicators, which are now forming the reference point for sports decision-making both at the managerial (involving coaches and technical staff) and administrative (the general governance of sports) level (Claudino et al., 2019).

The increasing availability of wearable technologies, Internet of Things (IoT) devices, high-performance cameras, and cloud computing has significantly expanded the volume of sports-related data generated daily. AI systems are capable of processing these vast datasets rapidly and accurately, providing coaches, athletes, medical personnel, and sports administrators with evidence-based insights for improving performance and reducing uncertainty (Rai et al., 2022). Consequently, sports organizations across the world have adopted machine learning, computer vision, deep learning, predictive analytics, and natural language processing to gain competitive advantages. Artificial intelligence enables organizations to convert these large volumes of raw data into actionable knowledge. Machine learning algorithms identify patterns that are difficult for humans to detect, while predictive analytics forecast future outcomes based on historical performance data (Bunker & Thabtah, 2019). As a result, sports organizations have shifted from intuition-based decision-making towards evidence-based management. This transformation has improved competitive performance across multiple sporting disciplines while enabling more efficient allocation of financial, medical, and human resources.

AI adoption in sports has become a well-structured and institutionalized process with clear definition and categorization of the aspects of sports where these technologies are applied (Claudino et al., 2019). However, providing a clear definition for the aspects of sports that necessitate the use of AI and selecting appropriate technologies to adopt has done very little to eliminate the challenges that are associated with the adoption of this technology. This has left its application subject to significant debate, with many decrying the challenges that trail the use of AI in sports (Rai et al., 2022). Critics argue that excessive reliance on algorithmic systems may compromise fairness, increase inequality among organizations with different financial capacities, threaten athlete privacy, and reduce the importance of human expertise in coaching and officiating (Jobin et al., 2019; Brumann et al., 2021; Skovalchik, 2023; Vec et al., 2024).

This study, in view of the above, is aimed at examining the role of artificial intelligence in performance analysis, injury prevention, talent identification, decision-making, fan engagement, and sports management. It also seeks to identify the challenges bedeviling the adoption of this technology in sports, and effective mitigation strategies that can be adopted by athletes, coaches, and sports organizations.

Methods

This paper adopted a qualitative, desk-based research approach based on a review and critical synthesis of secondary literature. Relevant information was obtained from peer-reviewed journal articles, academic books, conference papers, institutional reports and policy documents, gotten from such reputable platforms as Science Direct, PubMed, SportsDiscuss, Scopus, Web of Science, ResearchGate, and SpringerLink, with emphasis on recent literature published between 2020 and 2026. Searches focused on terms such as artificial intelligence in sport, AI in sport management, sports analytics, AI ethics, data privacy, algorithmic bias, AI governance, and technology-driven sport.

Relevant sources were selected based on their academic credibility, relevance to the topic and contribution to understanding AI adoption in sports, as well as the accompanying challenges. The selected literature was analyzed using thematic analysis, with findings organized around key themes including data privacy and cyber security, algorithmic bias, ethical concerns, technological dependence, employment implications, regulatory challenges, financial barriers and the reliability of AI-driven decision-making (see thematic analysis table below). Evidence from different sources was compared to identify common arguments, contrasting perspectives and emerging issues.

The paper follows APA 7th edition referencing and prioritizes credible and recent sources to enhance the validity and academic relevance of the discussion. However, reliance on secondary literature means that the study does not provide direct empirical evidence from sports managers, athletes or other stakeholders. Despite this limitation, the methodology provides an appropriate basis

for critically examining the opportunities and challenges presented by AI in contemporary global sports management.

Table 1 Thematic Analysis of the Key Dimensions of AI Adoption in Sports

Theme	Key Benefits Identified in the Literature	Implications for Global Sports Management
Performance Enhancement and Analysis	AI enables real-time performance monitoring, predictive analysis, tactical assessment and personalized training. Machine-learning and computer-vision models can identify complex performance patterns and support more precise athlete evaluation.	Sports managers can use AI-generated insights to improve training strategies, tactical planning and performance outcomes while strengthening evidence-based decision-making.
Injury Prevention and Athlete Health	AI can identify injury-risk patterns, monitor workload and movement, support early detection of health problems and facilitate personalized rehabilitation programmes.	Organizations can improve athlete welfare, reduce avoidable injury-related losses and develop more proactive approaches to sports medicine and athlete management.
Talent Identification and Recruitment	AI can analyze large volumes of performance data to identify promising athletes, compare player characteristics and support more objective recruitment decisions.	Global sports organizations can expand their talent-scouting capacity and potentially identify talent beyond traditional geographical and observational networks.
Decision-Making and Strategic Management	Predictive analytics and AI-based decision-support systems provide managers with rapid analysis of complex datasets, helping them forecast outcomes and evaluate strategic alternatives.	AI can strengthen evidence-based management, resource allocation, tactical planning and organizational decision-making, although human judgment remains essential.
5. Fan Engagement and Commercial Development	AI facilitates personalized content, real-time interaction, audience segmentation, predictive marketing and data-driven commercial strategies.	Sports organizations can strengthen fan relationships, improve marketing effectiveness and develop new revenue opportunities through more personalized experiences.
6. Administrative and Operational Efficiency	AI can automate repetitive processes, process large amounts of information and support scheduling, monitoring, reporting and other organizational functions.	Sports organizations can reduce administrative workload, improve operational efficiency and allow managers to devote greater attention to strategic and stakeholder-related responsibilities.

Theme	Key Issues Identified in the Literature	Implications for Global Sports Management
Data Privacy and Security	AI requires extensive collection of athletes' personal, biometric and performance data, creating risks of unauthorized access, misuse and data breaches.	Sports organizations need robust data-protection, consent and cyber security mechanisms to safeguard athlete information.
Algorithmic Bias and Fairness	AI systems may reproduce biases embedded in training datasets, potentially producing unfair outcomes in athlete selection, talent identification and performance evaluation.	Managers need diverse datasets, regular algorithmic audits and human oversight to minimize discriminatory outcomes.
Transparency, Accountability and Ethics	AI-generated decisions can be difficult to explain, raising concerns about transparency, accountability and responsibility when automated decisions produce harmful or inaccurate outcomes.	Sports organizations should establish clear accountability structures and ensure that important decisions are subject to human review.
Technological Dependence and Human Judgment	Excessive reliance on AI may reduce the role of professional expertise and human judgment in coaching, management and decision-making.	Managers should integrate AI as a decision-support tool rather than allow it to completely replace human expertise.
Employment and Organizational Change	AI-driven automation can transform existing roles while increasing demand for technological and analytical competencies among sports professionals.	Sports organizations need employee training, reskilling and effective change-management strategies to facilitate technological adaptation.

Financial and Technological Inequality	<i>The high cost of AI technologies, infrastructure, data systems and specialist expertise can limit adoption among smaller or less-resourced sports organizations.</i>	<i>Unequal access to AI may widen competitive and technological disparities between wealthy and less-resourced organizations and sporting nations.</i>
Governance and Regulatory Challenges	<i>The rapid development of AI creates regulatory gaps concerning data protection, accountability, fairness and appropriate use of AI within sport.</i>	<i>International sports organizations require adaptable governance frameworks and common standards for responsible AI adoption.</i>

Table 2. Thematic Analysis of the Challenges Associated with AI Adoption in Sports

AI Application in Performance Analysis

AI in sports performance analysis can broadly be understood as the application of computational techniques that enable systems to identify patterns, make predictions, classify actions, recognize movements and support decision-making from sports data (Rein & Memmert, 2026). Contemporary applications include computer-vision-based player tracking, automated video analysis, biomechanical assessment, workload monitoring, tactical analysis, performance prediction, talent identification, fatigue monitoring and injury-risk assessment (Rossi et al., 2018). A recent systematic review found AI applications across 13 different sports and reported the use of techniques including convolutional neural networks (CNNs), long short-term memory (LSTM) networks, reinforcement learning and predictive modelling (Rai et al., 2022).

In elite basketball and association football, AI-driven shot-quality and expected goals (age) frameworks have redefined offensive playbooks, demonstrating how algorithmic intelligence rewires foundational sports tactics (Lucey et al., 2014). Major teams in these elite sports employ AI-powered performance platforms in evaluating player efficiency, optimizing tactical formations, and monitoring individual progress throughout training seasons (Dwivedi et al., 2023). These systems allow coaches to make informed decisions regarding player selection, substitutions, and tactical adjustments (Fujii, 2021). Positional algorithms, for example, evaluate passing lanes, pitch control models, and defensive spacing in real-time, allowing technical staff to execute high-probability substitutions and strategic adjustments (Rein & Memmert, 2026).

AI Technologies Used in Sports Performance Analysis

Machine learning represents one of the most important branches of AI used in sports. ML algorithms learn patterns from existing data and use those patterns to classify, predict or estimate future outcomes. Machine learning is particularly useful where relationships between performance variables are nonlinear or difficult to identify through conventional statistical methods (Brumann et al., 2021). For example, an ML model may analyze training load, previous performance, physiological variables and contextual factors simultaneously to identify patterns associated with changes in performance. Rico-González et al. (2023), in a systematic review of ML applications in soccer, identified applications in performance forecasting, physical and physiological forecasting, technical and tactical analysis, injury-related applications and talent forecasting.

Another AI technology that is becoming popular in sports is deep learning. Deep learning is a subset of machine learning involving multilayer neural networks capable of learning complex representations from data (Ghosh et al 2023). Its importance in sports has increased considerably because sports generate large volumes of visual, temporal, spatial and sensor-based information. CNNs are particularly effective for processing images and video, whereas LSTM and related recurrent architectures can model sequential information. Recent evidence indicates that deep learning is increasingly being applied to athlete and ball detection, action recognition, pose estimation, trajectory analysis, tactical analysis, workload monitoring and injury-risk prediction (Ghosh et al., 2023).

There is a close relationship between potential and training load in performance analysis (Mundt, 2023; Pollard et al., 2021). Because athletes must be subjected to appropriate loads that not only maintains current performance but better the chance of future performances, the performance tracking abilities of artificial intelligence become the reference point for determining an athlete's present workload what is too small, too much, or appropriate (Zhu, 2021). AI predicts future performance based on historical and current data, leveraging predictive models that are

capable of incorporating previous competition results, training workload, physiological variables, technical statistics and contextual factors (Skovalchik, 2023). Horvat and Job (2020) noted that sports prediction has increasingly employed ML because sports generate large volumes of structured and unstructured data. Their review found that classification and neural-network approaches were frequently used for sports prediction. However, prediction should not be interpreted as certainty. Sports outcomes are influenced by unpredictable environmental, psychological, tactical and opponent-related factors (Rico-González et al., 2023).

The application of AI differs according to the characteristics of each sport. In individual sports, the focus may be on movement mechanics, physiological responses, and technique and opponent behaviour. In team sports, AI must additionally analyze interactions among multiple players and tactical structures. In soccer, for example, AI can combine player tracking, event data and video to analyze physical, technical and tactical performance. A systematic review of 32 studies found that performance was the dominant ML application area in soccer, followed by injury and talent-related applications (Rico-González et al., 2023). In racket sports such as tennis and squash, computer vision can track player movements and ball trajectories, while deep learning can classify strokes and movement patterns. In squash, research has demonstrated the feasibility of deep CNN approaches for player detection and motion analysis (Brumann et al., 2021; Mundt, 2023).

The Role of AI in Injury Prevention and Rehabilitation

Athlete injuries remain one of the greatest challenges in competitive sports. Traditionally, injury prevention has depended on clinical assessments, coach observations, athlete-reported symptoms, training-load monitoring and retrospective analysis of previous injuries (Nassis et al., 2023). However, Artificial intelligence (AI) is increasingly transforming sports medicine, injury prevention and athletic rehabilitation by enabling the collection, integration and analysis of large volumes of athlete data. These approaches remain important. AI provides additional capabilities through machine learning (ML), deep learning, computer vision, wearable sensors and predictive analytics. These technologies can identify complex patterns in training load, biomechanics, physiological responses and athlete behaviour that may be difficult to recognize through conventional approaches (Tedesco et al., 2022). The application of AI to injury prevention is particularly relevant because sports injuries are multifactorial. AI has significantly improved injury prevention through continuous monitoring of physiological and biomechanical indicators (Claudino et al., 2019).

In addition to performance analysis, the use of AI-powered wearable devices also provides important data for injury assessment and early identification of fatigue signs (Mundt, 2023). AI can combine physiological, workload, movement and subjective wellness data to identify patterns associated with fatigue. Wearable sensors are particularly relevant because they allow repeated monitoring of physiological and movement characteristics. These devices are equipped with AI algorithms capable of monitoring heart rate variability, muscle fatigue, sleep quality, workload intensity, hydration status, and recovery patterns. Predictive models analyze these variables to identify athletes who may be at elevated risk of injury before symptoms become apparent (Brumann et al., 2021). Molavi et al. (2026), examined the effectiveness of artificial intelligence in predicting the likelihood of anterior cruciate ligament (ACL) injuries between the years 2019-2024, reported that AI-powered predictive models achieved accuracies of 79.5-96% within the observed period. In a different study, Dhahbi et al. (2026) reported that the use of AI-informed

prevention strategies was associated with injury reductions ranging from 23% to 42%, derived from synthesis-level and single-Centre intervention evidence, respectively.

Table 3. Common technologies applied in Injury prevention and Rehabilitation

<i>Technology</i>	<i>Examples of data collected</i>	<i>Potential AI application</i>
GPS	Distance, speed, acceleration	Workload and fatigue monitoring
Accelerometers	Movement intensity	Fatigue and movement analysis
Gyroscopes	Angular movement	Biomechanical assessment
Heart-rate monitors	Heart rate and variability indicators	Physiological monitoring
Smart insoles	Pressure and loading patterns	Gait and load analysis
Motion sensors	Joint and limb movement	Rehabilitation monitoring
Force sensors	Force production	Strength and functional recovery

Role of AI in Talent Identification and Recruitment

Talent identification and recruitment are fundamental components of high-performance sport because the ability of sporting organizations to identify athletes with exceptional potential can influence long-term competitive success. Talent identification refers to the systematic process of recognizing individuals who demonstrate characteristics associated with the potential to achieve high levels of sporting performance (Vec et al., 2024).

At the grassroots Artificial intelligence is becoming very handy for scouts in the identification and selection of athletes with potential for world-class performance as early as possible. Talent identification has traditionally depended on scouts' experience and subjective evaluation (Dwivedi et al., 2023). The tide has turned quickly, however, and these recruitment teams now rely heavily on AI in enhancing the talent selection process through comprehensive analysis of player statistics, physical characteristics, technical abilities, and long-term performance trends collative with the use of machine learning and analytic software. Machine learning models are designed with the capacity to evaluate thousands of performance variables simultaneously to predict future athlete development (Bunker & Thabtah, 2019). Consequently, professional clubs are increasingly combining AI-generated recommendations with traditional scouting methods to identify undervalued talent. This approach reduces recruitment risks while improving investment decisions in player acquisition and youth development programs.

Role of AI in Decision-Making

Decision-making is central to virtually every aspect of modern sport. It helps coaches to decide training strategies, tactical formations and substitutions; athletes to make rapid decisions during competition; sports scientists to determine workload and recovery strategies; medical teams to evaluate injury and rehabilitation information; and managers to make decisions concerning recruitment, contracts and resource allocation (Vec et al., 2024; Tedesco et al., 2022). Traditionally, these decisions have depended largely on professional experience, observation, intuition and relatively limited performance statistics (Skovalchik, 2023). However, the emergence of artificial intelligence (AI) is bringing a new era to sports decision-making (Ghosh et al., 2023).

Artificial Intelligence has transformed tactical preparation by enabling coaches to analyze opponents' playing styles, identify strategic weaknesses, and simulate different match scenarios. Predictive analytics models estimate likely tactical outcomes based on historical competition data, enabling coaching staff to prepare evidence-based game plans (Dwivedi et al., 2023). During competitions, AI systems provide real-time statistical feedback that assists coaches in making substitution decisions and tactical adjustments. Although AI improves tactical preparation,

successful implementation still depends on coaches' contextual understanding, leadership skills, and psychological insight (Deep Learning for Sensor-Based Sport Performance and Health Monitoring, 2026; Tedesco et al., 2022).

One of the foremost reasons for the adoption of artificial intelligence is the facilitation of fairness and accuracy in sports officiating (Farajpour et al., 2025). The industry, in diverse instances (sometimes in high-stakes scenarios), has been repeatedly marred by certain decisions that constituted an obstruction to fairness, sometimes due to human error, limited coverage, and self-interest. Athletes are surely the front-line victims, but sometimes even officials have fallen victim to their own decisions, made in real-time. To curb these situations, the use of automated systems, most of which are powered by artificial intelligence, became the obvious best option. The use of computer vision systems and AI-powered ball-tracking, such as Semi-Automated Offside Technology (SAOT) in football and Hawk-Eye in tennis and cricket (all introduced in response to the clamor for automated systems), has, true to predictions, dramatically elevated officiating precision (Morgulev et al., 2018). These technologies process high-speed camera feeds and sensor inputs to render objective, millimeter-accurate spatial judgments within seconds, drastically reducing human error in high-stakes moments (Kolbinger & Lames, 2017).

AI in Fan Engagement and Commercial Development

The commercial success of modern sports largely depends on fan engagement (Davenport et al., 2020). Artificial intelligence (AI) is increasingly transforming fan engagement and commercial development in global sports. Through machine learning, predictive analytics and generative AI, sports organizations can analyze large volumes of fan data to understand preferences, predict behaviour and deliver personalized content. AI-powered systems can recommend match highlights, statistics and other digital content based on individual interests, enabling organizations to maintain stronger relationships with fans before, during and after sporting events (Westerbeek, 2025).

A major contribution of AI is personalized fan engagement. By analyzing viewing patterns, social-media interactions and purchasing behaviour, AI enables sports organizations to move beyond standardized communication towards more targeted experiences. Generative AI can also facilitate real-time content creation, including personalized messages, match summaries and social-media content. This can improve the overall fan experience and encourage greater interaction with teams and sporting events (Westerbeek, 2025; Allami & Nashid, 2025). AI also provides significant opportunities for commercial development. Sports organizations can use AI-driven analytics to segment audiences, identify consumer preferences and develop targeted marketing campaigns. These capabilities can improve merchandise sales, digital subscriptions, advertising and sponsorship activation by enabling organizations and sponsors to target specific fan groups more effectively. AI can therefore transform fan data into commercially valuable insights and support more evidence-based marketing and revenue-generation strategies (Allami & Nashid, 2025; Westerbeek, 2025).

Role of AI in Sports Administration, Organizational, and Management

Artificial intelligence (AI) is increasingly influencing sports administration, organizational processes and managerial decision-making. Sports organizations are using AI-powered systems to analyze large datasets, automate routine administrative activities, improve resource allocation and support strategic planning (Dwivedi et al., 2023). By processing information more rapidly than

conventional methods, AI can assist managers in identifying patterns, forecasting outcomes and making evidence-based decisions. Consequently, AI has the potential to improve organizational efficiency, responsiveness and the quality of management decisions (Westerbeek, 2025).

One important application of AI is administrative automation. AI can support tasks such as scheduling, financial analysis, membership management, communication and information processing, allowing sports administrators to devote greater attention to strategic and stakeholder-related activities (Youn et al., 2025). AI-based analytics can also support workforce planning and organizational performance monitoring by providing managers with real-time insights into operational activities. This suggests that AI can shift sports administration from largely reactive management towards more proactive and data-driven organizational practices (Allami & Nashid, 2025).

AI is also increasingly relevant to strategic decision-making and organizational planning. Predictive analytics can help sports organizations forecast attendance, fan behaviour, financial performance and operational demands. Managers can consequently use AI-generated insights to evaluate alternative strategies and allocate resources more effectively. However, AI should primarily function as a decision-support mechanism rather than replace managerial judgment. The quality of AI-generated recommendations depends on the accuracy of the data, the design of the algorithms and the context in which the information is interpreted (Westerbeek, 2025).

Challenges Associated with AI Adoption in Sports

1. Data Privacy and Security: AI systems require extensive personal data, including athletes' medical records, physiological information, movement patterns, and behavioral characteristics. The continuous monitoring of athletes through wearable devices creates severe data privacy vulnerabilities (Solove, 2021). Biometric data collected during training and daily life can potentially be exploited during contract negotiations, insurance underwriting, or player transfer evaluations, shifting power disproportionately toward club management (West, 2019). Without explicit legal guardrails regarding data ownership, athletes risk losing sovereignty over their intimate physiological metrics (Jobin et al., 2019).

2. Algorithmic Bias: The universal flaw of digital systems is “garbage-in, garbage-out” (Kilkenny & Robinson, 2018), and strange as it may sound, AI is by no means immune to this flaw. The inbuilt learning capabilities contained in AI systems predispose the system to certain mistakes that can, in real-time, prove very costly (Hanson et al., 2023). AI algorithms learn from historical datasets that may contain hidden biases. Consequently, automated decision-making systems may unintentionally discriminate against athletes based on gender, race, nationality, disability, or socioeconomic background (Floridi & Cowls, 2019). In addition to unintentional discrimination, there is also the possibility of AI systems misleading officials into announcing and standing by decisions that are erroneous. Errors from poorly trained vision systems and a lack of variety in camera angles can entice officials into making calls with limited, and more dangerously, suggestive data, when in fact their decision should be based solely on objectivity (Dhahbi et al., 2026). These identified biases undermine fairness and reduce diversity within competitive sport.

3. Cost of Implementation and Financial Inequality: Developing and implementing sophisticated AI systems requires substantial financial investment. Advanced AI platforms, computer vision infrastructure, and specialized data science units

require multi-million-dollar capital investments (Rai et al., 2022). Wealthier sporting organizations can leverage state-of-the-art analytical tools to gain compounding competitive advantages over under-resourced clubs and emerging leagues (Gerrard, 2017). This digital divide threatens competitive balance, which is vital to the economic health and public appeal of professional leagues.

4. Growing Dependence on Technology for Decision-Making: Although AI improves analytical accuracy, excessive reliance on technology may reduce creativity, intuition, and interpersonal relationships that remain fundamental to successful coaching. Human judgment incorporates emotional intelligence, motivation, leadership, ethical reasoning, and contextual understanding; qualities that AI cannot fully replicate (Dwivedi et al., 2023). Coaches should therefore regard AI as a decision-support system rather than an autonomous decision-maker.

5. Ethical Governance: AI raises important ethical questions regarding transparency, accountability, fairness, and responsibility. Decisions affecting athlete careers should not be based solely on opaque algorithmic recommendations (Floridi & Cows, 2019). Sports organizations must establish ethical guidelines that ensure AI systems remain transparent, explainable, and accountable to athletes and other stakeholders.

Conclusion

Despite its remarkable advancements, AI adoption in sports has generated significant debate. Critics argue that excessive reliance on algorithmic systems may compromise fairness, increase inequality among organizations with different financial capacities, threaten athlete privacy, and reduce the importance of human expertise in coaching and officiating (Jobin et al., 2019). Others contend that AI should be viewed as a complementary tool rather than a replacement for human judgment. This paper maintained that artificial intelligence represents one of the most significant innovations in modern sports and should be embraced as an indispensable component of future sports development. AI has demonstrated substantial benefits in performance optimization, injury prevention, tactical planning, talent identification, fan engagement, and organizational efficiency. However, technological advancement should not supersede the fundamental values of sport, including fairness, integrity, inclusiveness, respect, and human development. AI should complement rather than replace coaches, athletes, referees, sports scientists, and administrators. The future of data-driven sports therefore depends on achieving an appropriate balance between technological innovation and human expertise. Responsible AI implementation requires ethical governance, transparency, regulatory oversight, continuous monitoring, and investment in digital literacy across the sports sector. By implementing responsible governance frameworks and maintaining transparency, accountability, and inclusiveness, the sports industry can harness AI's transformative potential while safeguarding the core values that define competitive sport.

Suggestions

To promote responsible AI adoption in modern sports, the following recommendations are proposed:

1. There is a need to develop comprehensive AI governance frameworks that regulate data collection, storage, privacy protection, transparency, and accountability within sports organizations.

2. Maintain human oversight in all critical decision-making processes involving athlete selection, performance evaluation, officiating, and disciplinary actions.
3. Promote equitable access to AI technologies by supporting smaller sports organizations and developing countries through public funding, partnerships, and knowledge-sharing initiatives.
4. Strengthen cyber security and athlete data protection by implementing international standards for secure data management and informed consent.
5. Invest in AI education and digital literacy for coaches, sports administrators, athletes, and sports scientists to ensure responsible and effective technology utilization.
6. Encourage interdisciplinary research involving sports science, artificial intelligence, ethics, medicine, and law to address emerging technological challenges.
7. Establish independent ethical review committees to evaluate AI applications before large-scale implementation within professional sports organizations.

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EXPLORING ACADEMIC STAFF PERCEPTIONS AND ACCEPTABILITY OF AI IN INSTRUCTIONAL DELIVERY IN TVET PROGRAMMES IN FEDERAL UNIVERSITIES IN SOUTH-SOUTH NIGERIA

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Abstract

This study looked at the perception and acceptability of TVET academic staff in instructional delivery using AI in Federal Universities in South-South Nigeria adopting a descriptive survey research design. A structured questionnaire validated by three lecturers was administered to a sample of 158 TVET academic staff randomly selected across Federal Universities in South-South Nigeria. The reliability coefficient utilizing the Cronbach alpha was $\alpha=.79$. A quantitative approach was used in the study using standard deviation to assess the degree to which participants' responses were clustered around the mean. The results indicated that using AI enhances teaching, enhances research, enhances learning practice, and helps to manage classrooms among others. Furthermore, the results showed that TVET academic staff accept using AI in instructional delivery in TVET programmes due to adequate content knowledge, effective tools in teaching practical lessons, enables learners to learn effectively among others. Based on the finding, the following recommendation was made, it will be beneficial for all major stakeholders of TVET programmes to collaborate to inculcate using AI in their instructional delivery in TVET programmes among others.

Keywords: Academic Staff Perceptions, AI, Instructional Delivery, TVET

Introduction

Instructional delivery encompasses the multifaceted methods and strategies educators employ to impart knowledge and foster student learning (Audu et al., 2023). It is the art of teaching that shapes a student's intellectual, economic, and social trajectory (Ogbebor & Osagiede, 2024). This encompasses a spectrum of modalities, from conventional in-person instruction to online platforms and hybrid models. Agina-Obu and Onwugbuta-Enyi (2017) framed instructional delivery as a dynamic and inventive process, where educators leverage past experiences to integrate content, methodologies, concepts, and media in both novel and established ways, thus solidifying student comprehension.

Teacher's instructional delivery stands out as a critical factor influencing students' long-term learning and employment prospects (Chika & Ebeke, 2007). Effective instructional delivery may be the key to imparting skills, reducing unemployment, stimulating economic growth, alleviating poverty, and reshaping individuals' career perspectives. The advent of technology, particularly artificial intelligence (AI), has further enhanced the capabilities of educators, facilitating task execution with heightened efficiency and effectiveness. These technological advancements extend their influence across diverse academic disciplines, promising elevated levels of productivity.

Pokrivcakova (2019) defined artificial intelligence in education as the culmination of extensive interdisciplinary efforts aimed at creating intelligent systems. These systems are designed to augment both educators and learners by fostering knowledge acquisition and adaptable skill sets crucial for navigating an evolving global landscape. The incorporation of AI into Technical Vocational Education and Training (TVET) aligns with the worldwide trend of leveraging AI to optimize learning outcomes and cultivate essential skills. AI's potential within TVET lies in its capacity to individualize learning pathways, thereby equipping students with targeted competencies demanded by the modern job market and ultimately transforming the educational paradigm. This personalized

approach enhances skill development, leading to improved employability and workforce preparedness.

Furthermore, the incorporation of virtual reality and simulation technologies enhanced by AI could improve TVET programmes' educational experience, provide hands-on, intensive training experiences to students. Additionally, by using AI to automate administrative work, teachers may have more time to focus on mentoring and coaching students, raising the overall quality of technical vocational education and training (TVET).

Technical vocational education and training (TVET) is a programmes that is delivered at various institutions with the goal of acquiring practical skills and scientific knowledge for a nation's economic and technical development. TVET, according to Audu et al. (2013), is a work-related education that is tailored to the demands of the workforce and industries. TVET is defined as education, training, and skill development related to a variety of occupations, production processes, services, and means of subsistence (UNESCO/ILO, 2002). Accordingly, TVET is regarded as a crucial tool for giving the workforce the skills needed for the "jobs of tomorrow" (Tether et al., 2005). At the secondary, post-secondary, and tertiary levels, technical vocational education and training are provided. They could have the most potential to create jobs, keep jobs, and lower poverty in a community. Depending on each institution's capacity, TVET programmes in tertiary institutions offer a variety of courses, such as business, home economics, agricultural, and industrial technical education. Academic staff perceptions of AI-powered instructional delivery may influence TVET programmes' efforts to help students acquire global skills and find work upon graduation.

The way faculty members perceive their jobs, duties, and workplace could be referred as academic staff perception. Perceived Paedagogical Affordances (PPA), which measures whether instructors think AI offers advantages like individualized learning, increased student engagement, or more efficient assessment techniques, indicates how lecturers in educational institutions view how AI-powered tools may improve teaching practices. It may also involves evaluating the lecturers' enthusiasm, nervousness, self-efficacy, and emotional reactions to issues or problems related to AI, such as data privacy or job security. Teachers' views and behaviors about AI could be shaped by a variety of social and cultural elements, including professional networks, school leadership, coworkers, and educational regulations. The desire and preparedness of lecturers and instructors to embrace and incorporate AI technologies into their teaching practices could be referred to as academic staff acceptance.

Academic staff acceptability may be influenced by several factors, including technological pedagogy, content knowledge, understanding of artificial intelligence, subject matter, administrative support, workshops and technical assistance, incentive, and organizational climate, age, experience, attitude toward technology outcome, student engagement, and job security. The topic of technology adoption and use by academic staff in TVET programmes continues to be of great interest to researchers and practitioners, regardless of the technology available and the benefits that are promised. This study specifically focuses on how to optimize the advantages of emerging technologies, such as artificial intelligence (AI), for students by comprehending and maybe promoting its acceptance within the framework of TVET programmes.

It is on this premises that the researchers sought to investigate academic staff perceptions and acceptability of AI in instructional delivery in TVET programmes in Federal Universities in South-South Nigeria. The specific objectives of the study were to:

1. Investigate academic staff perceptions of AI in instructional delivery in TVET programmes in Federal universities in South-South Nigeria.
2. determine the factors that influence academic staff acceptance of AI in instructional delivery in TVET programmes in Federal universities in South-South Nigeria.

Literature Review

Across all educational levels, there are several AI prospects to improve research, teaching, and learning methods. AI has the potential to completely change education by improving classroom management, encouraging faculty cooperation, and delivering instruction using cutting-edge AI-

powered teaching strategies (Ghnemat et al., 2022). Numerous studies have shown that AI technology can improve students' cognitive and learning capacities and increase the effectiveness of teaching and learning procedures through individualized learning experiences (Huang et al., 2021). In the context of higher education institutions (HEIs), artificial intelligence (AI) can be particularly helpful in promoting the growth of soft skills (Kohnke et al., 2023) and improving students' overall educational experiences in several ways. For instance, giving students instant access to information, accommodating their unique learning preferences and needs, helping them with their research, and even helping students with disabilities by offering text-to-speech capabilities. In their meta-review of 14 research papers on the implementation of AI curricula in the Asia-Pacific region, Su et al. (2022) discovered that learning outcomes, models, activities, platforms, tools, and content knowledge are all crucial for AI acceptance.

Additionally, from 2016 to 2022, Ng et al. (2021) carried out an extensive review that covered AI education at all levels, from kindergarten to university. They looked at teaching resources, learning materials, assessment techniques, and pedagogical approaches. Additionally, they suggested using P21's framework for 21st century learning to identify the fundamental knowledge and abilities in AI literacy that students need to succeed in their academic and personal endeavors. This demonstrates unequivocally that user acceptance of AI is essential to its advancement in higher education. Adoption and acceptance are essential if AI is to fulfill its promised advantages for a broad spectrum of users. To the detriment of instructors and students, low adoption rates can result in a decrease in the use of AI, wasting money, creating an excess of AI gadgets, and possibly slowing down technological advancement (Choi et al., 2023).

Despite numerous studies underscoring the importance of AI in education and investigating the interaction between humans and AI, there remains a gap in our understanding regarding academic staff's perception of integrating AI in instructional delivery in TVET programmes in South-South Nigerian Universities for the benefit of students and also the factors that influence their acceptance of AI in instructional delivery in TVET programmes in Federal Universities in South-South Nigeria.

Methods

A descriptive survey research design was adopted for this study. The respondents were 158 academic staff in TVET programmes from Federal Universities in South-South Nigeria.

A self-constructed questionnaire titled Questionnaire for Academic Staff Perceptions and Acceptability of AI (QASPA) developed from the literature, was reviewed as an instrument for the collection of data. The instrument was a four-point scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The instrument consisted of 18 items, where nine items measure the perceptions of academic staff regarding the integration of AI in instructional delivery in TVET programmes. The remaining nine items measure the factors that influence academic staff acceptability of AI in instructional delivery in TVET programmes.

Three lecturers verified the content of the instrument. One of them was from measurement and evaluation, and the two others were from TVET disciplines. The authors analyzed the responses of 20 lecturers, from University in South East Nigeria which was not part of the study sample, to determine the instrument reliability. The results of analyzed responses showed that the instrument for data collection was reliable, with a Cronbach alpha coefficient value of $\alpha=.79$.

Data was analyzed using the mean, and standard deviation. Mean values were used to answer the research questions, and standard deviation was used to determine the degree to which TVET academic staff responses were clustered around or deviated from the mean. A mean score equivalent to, or greater than 2.50 implied that TVET academic staff agreed with the questionnaire items, and mean scores under 2.50 implied that TVET academic staff disagreed with the corresponding questionnaire items. Also, the standard deviation values between .00 and .96 suggested that TVET academic staff reactions were exceptionally close, which implies that their answers were clustered around the mean.

Results

Research Question 1: What are the perceptions of academic staff of AI in instructional delivery in TVET programmes in Federal universities in South-South Nigeria?

Table 1

Mean and Standard Deviation of TVET Academic Staff Perceptions of AI in Instructional Delivery in TVET Programmes

S/N	Item Statement	M	SD	Remark
1.	Using AI to enhance teaching in TVET programmes	3.70	.72	Agreed
2.	Using AI Enhance research in TVET programmes	3.80	.69	Agreed
3.	Using AI to enhance learning practice in TVET programmes	3.34	.84	Agreed
4.	Using AI helps to manage classrooms in TVET programmes	3.29	.65	Agreed
5.	Using AI to foster Faculty Collaboration in TVET programmes	3.51	.76	Agreed
6.	AI-powered teaching methods in TVET programmes	3.47	.82	Agreed
7.	Using AI enhances students' cognitive capabilities in TVET programmes	3.39	.69	Agreed
8.	Using AI to enhance learning processes in TVET programmes	3.57	.78	Agreed
9.	Using AI fosters the development of soft skills in TVET programmes.	3.62	.82	Agreed

N = 158, M = Mean, SD = Standard Deviations

The outcomes of the information presented in Table 1 demonstrates that nine items, with sequential numbers 1, 2, 3, 4, 5, 6, 7, 8, and 9 had mean values that ran from 3.29 to 3.80, and the comparing standard deviation values ran from .65 to .84. The mean values infer that the item statement agreed with the perceptions of academic staff regarding the integration of AI in instructional delivery in TVET programmes. The corresponding standard deviation values indicated that the generality of academic staff perceptions of AI in instructional delivery in TVET programmes were clustered.

Research Question 2: What are the factors influencing academic staff acceptability of AI in instructional delivery in TVET programmes in Federal universities in South-South Nigeria?

Table 2

Mean Responses on Factors Influencing Academic Staff Acceptability of AI in Instructional Delivery in TVET Programs

S/N	Item Statement	M	SD	Remark
10	AI has adequate content knowledge on the topic of the lesson.	3.61	.79	Agreed
11	There are effective tools for teaching practical lessons using AI in TVET programmes.	3.32	.84	Agreed
12.	AI-enhanced platforms enable learners to learn effectively in TVET programs	3.51	.68	Agreed
13.	Practical activities can be demonstrated using AI in TVET programmes.	3.38	.83	Agreed
14.	AI usage will promote the effective assessment of learners in TVET programmes	3.37	.86	Agreed
15.	Learning outcomes can be achieved effectively using AI tools in TVET programmes.	3.36	.91	Agreed
16.	AI tools can be used as models during teaching and learning in TVET programmes	3.98	.90	Agreed
17.	I am interested in using AI in teaching TVET programmes	3.48	.87	Agreed
18.	If trained, I am open to using AI in promoting TVET programmes.	3.36	.47	Agreed

N = 158, M = Mean, SD = Standard Deviations

The outcomes of the information presented in Table 2 indicates that nine items, with sequential numbers 10, 11, 12, 13, 14, 15, 16, 17, and 18 had mean values that ran from 3.32 to 3.98, and the comparing standard deviation values ran from .47 to .91. The mean values infer that the item statement agreed with the factors influencing academic staff acceptability of AI in instructional delivery in TVET programmes. The corresponding standard deviation values indicated that the generality of the factors influencing academic staff acceptability of AI in instructional delivery in TVET programmes were clustered.

Discussion of Findings

The present study specifically aims to provide empirical evidence on the perceptions and acceptability of academic staff regarding the integration of AI in instructional delivery in TVET programmes. Analysis of research question 1 indicated that academic staff agreed on their perception of AI as it enhances teaching, enhances research programmes, enhances learning practices, helps to manage classrooms, fosters faculty collaboration, empowers teaching methods, enhances cognitive capabilities, enhances the learning process and foster the development of soft skills. This finding is in collaboration with the finding of Ghnemat et al. (2022) who opined that AI is poised to revolutionize education by transforming how we manage classrooms, foster faculty collaboration, and deliver learning through innovative AI-powered teaching methods. Furthermore, the finding is in agreement with that of Kohnke et al. (2023) that AI technology holds the potential to enhance students' learning and cognitive capabilities, as well as elevate the efficiency of teaching and learning processes with personalized learning experiences.

The analysis of research question 2 indicated that academic staff agreed with the factors influencing academic staff acceptability of AI in instructional delivery in TVET programmes such factors include adequate content knowledge on the topic, effective teaching tools for practical lessons, enhanced platform to learn effectively, demonstration of practical activities, and effective assessment of learners, model, interest and open to training. This finding is in collaboration with the findings of Su et al. (2022) their study found that content knowledge, tools, platforms, activities, models, assessment methods, and learning outcomes are essential components of AI acceptance. In addition, the finding of the study by Ng et al. (2021) is that pedagogical methods, teaching tools, learning content, and assessment strategies are among the factors influencing academic staff acceptability of AI in education.

Conclusion and Recommendations

The study aims to provide empirical evidence on exploring academic staff perceptions and acceptability of AI in instructional delivery in TVET programmes. The research questions revealed academic staff perceptions and acceptability of AI in instructional delivery in TVET programmes. Therefore, the authors concluded that all the agreed perceptions and acceptability are needed for the integration of AI in instructional delivery in TVET programmes.

Based on the conclusion, the following recommendations were made:

1. All major stakeholders of TVET programmes should collaborate to inculcate using AI in their instructional delivery in TVET programmes.
2. AI should be incorporated into TVET programmes towards providing adequate content knowledge on the topics, effective teaching tools for practical lessons, enhanced platform to learn effectively, demonstration of practical activities, and effective assessment of learners.
3. All relevant stakeholders of TVET programmes should cooperate towards using AI to develop student's knowledge and skills needed to achieve the goals of TVET programmes.

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FROM CHALKBOARD TO ALGORITHM: HISTORICAL SHIFTS IN TEACHER AUTHORITY IN THE DIGITAL AGE

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Abstract

The accelerated development of digital technologies and artificial intelligence has drastically changed the historical roots of teachers' authority in modern educational systems. This paper looked into historical changes in teacher's authority from traditionally chalkboard-based pedagogy towards algorithmically driven learning in the digital era. The theoretical basis for this analysis were drawn from theories of authority by Weber, theories of power and discipline by Foucault, and critical pedagogy by Freire. The paper explored how the process of technological innovation, algorithmic governance, and AI-driven instruction systems has been re-shaping educational power dynamics, class dynamics, and pedagogy itself. The paper contends that while traditionally teachers relied on their monopoly in disseminating knowledge, their institutional authority and ability to control and punish students, the modern technological developments have been gradually changing educational power dynamic. This paper examined the important issues of debate around the themes of algorithmic surveillance, automated evaluation, dependence on platforms, and the increasing conflict between human teacher-student relationships and the machine-based processes of learning. Even when technology is seen to be democratizing education, making education more efficient and enabling personalized learning, this paper holds that technology cannot be used to substitute for the human elements of teaching such as moral reasoning, emotional intelligence, mentoring, and interpersonal communication. Therefore, the paper concluded that teacher authority is not fading away but undergoing a historical reformation in digital educational realities in which teachers become facilitators, moral guides, and human navigators in algorithmic learning. The paper advocates for the balanced use of technology, maintenance of human pedagogy, and ethical regulation of artificial intelligence in education.

Key Words: Algorithmic Education, Artificial Intelligence, Digital Pedagogy, and Teacher Authority

Introduction

In the past, teacher authority has been at the center of formal educational systems, whereby the teacher was historically seen as the undisputed keeper of knowledge, discipline, and morality in the classroom environment. In the past school setting and the early modern schooling system, authority was mainly hierarchical in that learners were supposed to learn knowledge from the teacher passively through teacher-centered approaches that were characterized by chalk-and-talk instructions, memorization, and discipline. Modern schooling brought about by the industrial era and colonialism served to cement the position of the teacher's epistemic and institutional authority in that schools became the formal places where standardized knowledge and social values would be transmitted through formal schooling processes. The rapid technological development in the 21st

century has radically altered the nature of classroom interaction, communication, and information access in ways that have brought into question the historical monopoly of teachers in the production and distribution of knowledge. Internet technology, virtual learning systems, digital platforms, and smartphones have served to change the place of learning from the confines of the classroom environment to digital space, which has become more fluid and interactive (Selwyn, 2021; Williamson & Eynon, 2020).

The emergence of artificial intelligence (AI) and learning algorithms contributes to a heated discussion about the future of teacher authority and evolving relationships in a digitally transforming environment. Such technologies as adaptive learning platforms, automated assessment systems, intelligent tutoring apps, and predictive analytics are performing functions that used to be performed only by teachers; in doing so, algorithms become mediators of learning process and decision making in the classroom. The modern discourse about education becomes characterized by the clash of the traditional idea of "teacher as an authority" and the novel phenomenon of "algorithm as an instructional mediator," which uses technology for personalization of learning pathways, monitoring of students' progress, and shaping learning experiences through data-driven recommendations (Holmes et al., 2022; Zawacki-Richter et al., 2021). Supporters of technology state that algorithms help improve efficiency, access, and learners' autonomy. However, the critics maintain that relying too much on AI can undermine teachers' authority, eliminate human interaction, and contribute to digital surveillance and algorithmic control of school life. This transformation poses some serious philosophical and historical questions about whether technological systems are helping or transforming the essence of pedagogical authority. Therefore, it is crucial to learn about historical transitions from chalkboard-based instruction.

Statement of the Problem

Traditionally, teachers played an important role as providers of knowledge and authority within the classroom; however, due to the development of the digital age and the application of AI in the field of education, this position is becoming increasingly threatened. In the context of the easy access to information through the Internet and use of digital learning tools, the power teachers traditionally had when it comes to transferring knowledge is being challenged, while learner-based and technology-based instruction replaces traditional forms of teacher-based instruction. Moreover, the implementation of personalized learning and AI-based instructional systems affects the learning process in ways that put into question the necessity of traditional teacher authority and management. At the same time, despite all the technological advances, there are still some important aspects of teaching that cannot be provided by the algorithm – ethical, emotional, and interpersonal aspects of teaching.

Objectives of the Study

1. To trace the historical evolution of teacher authority across educational eras.
2. To examine how technological advancement transformed teacher-student power relations.
3. To analyze the implications of algorithmic learning for teacher identity and authority.
4. To interrogate the future of pedagogical authority in digital education systems.

Research Questions

1. How has teacher authority evolved historically?
2. What factors contributed to the transformation of teacher authority?
3. How has digital technology altered classroom power dynamics?
4. What are the implications of algorithmic education for the future of teaching?

Review of Literature

Modern literature shows that teacher authority continues to be an important part of education system even with fast-changing teaching and learning processes in the era of digital technology. Modern researchers describe teacher authority as a multidimensional concept covering traditional authority, epistemic authority, moral authority, institutional authority, and pedagogical authority in teaching practices and education governance. Traditional authority is about the historically established recognition of teachers' roles as disciplinarians and providers of knowledge, while epistemic authority is derived from professional expertise and intellectual competence of teachers in subject delivery (Harjunen, 2022). Moral authority is related to the teacher's ethics, mentoring function, and ability to form learners' characters and values, while institutional authority is derived from educational policies, rules and procedures that enable teachers to control classroom activities and instruction processes (Biesta, 2021). Recent pedagogical discussion, however, puts more focus on pedagogical authority. According to current interpretations of the works of Paulo Freire, democratic pedagogy in the modern world calls for teachers to serve as facilitators of critical inquiry and co-constructors of knowledge rather than just disseminators of information (Schutz & Gereon, 2021). However, the expansion of digital technologies, e-learning platforms, and open access systems of information delivery is seen by researchers as having undermined the monopoly teachers used to hold on information dissemination (OECD, 2023; Selwyn, 2021).

The recent scholarly work reveals the transformation of educational processes in the context of algorithmic education based on the use of AI technologies in teaching. Algorithmic education can be defined as the implementation of AI-based systems of education, which include intelligent tutoring systems, automated assessment systems, predictive analysis, and other machine learning technologies aimed at personalization and optimization of learning (Holmes et al., 2022).

With adaptive learning technology, educational technologies have started collecting data and analyzing students' performances, engagements, and behavior patterns to tailor educational delivery according to their learning needs (Zawacki-Richter et al., 2021). Educational theorists such as Williamson (2023) and Selwyn (2021) argued that educational authority has started moving from human-centric education to technological-mediated systems characterized by algorithms, analytics, and digital infrastructures. Such development has led to the increase in the use of data-driven pedagogy, where the planning, evaluation, and management of learners are done via automated systems and digital performance monitoring. Recent critical research has raised concerns about the governance and surveillance associated with algorithms in education, asserting that the monitoring of learners through educational technologies leads to new kinds of governance and control of platforms (Knox, 2023; Williamson & Eynon, 2020). Utilizing the interpretation of Foucault's concept of disciplinary power in the contemporary era, researchers suggest that such digital surveillance systems have a detrimental impact on teachers' autonomy and pedagogical relationships and commercialize educational processes. Therefore, according to recent literature, while algorithmic education fosters innovation and flexible learning opportunities for students, it raises numerous ethical and philosophical concerns related to issues of authority, identity of teachers, privacy, and future of humanistic teaching methods.

Theoretical Framework

The current research underpinned by the theories of authority, power, and critical pedagogy put forward by Weber (1947), Foucault (1977), and Freire (1970; 1998), respectively. These theories give an overarching theoretical framework which allows understanding the process of historical evolution of teacher's authority from the traditional classroom learning system to the algorithm-based learning system. The Theory of Authority proposed by Weber revealed the ways in which the authority has been functioning in the school systems traditionally, charisma, and legally. In the traditional form, the teachers have functioned as socially respected guardians of both the knowledge and discipline whose legitimacy was based on well-established cultural and institutional norms especially those in the colonial and conventional schooling systems. The charisma authority has been functioning due to the teacher's individual characteristics, academic influence, and inspirational ability to affect the learners not only institutionally but also beyond that. Nevertheless,

current technological shifts have resulted in changes in the above-mentioned foundations of power as the digital learning environment and algorithms are becoming more and more involved in mediating the process of communication and instruction. It is worth noting that Foucault's Theory of Power and Discipline offers additional analytical perspectives for the examination of educational organizations as instruments of surveillance and control. Specifically, Foucault's concept of disciplinary power can be used as an explanation of the following aspects related to the classroom practice: the process of classroom surveillance, institutional monitoring, performance appraisal, and the development of such digital surveillance technologies as learning analytics, AI-based assessment systems, biometrics attendance, and online tracking tools which constantly monitor students' learning behavior (Knox, 2023; Williamson & Eynon, 2020).

However, despite these theories explaining the issues of authority and control within institutions, the Critical Pedagogy perspective by Freire (1998) is more transformative since it questions the authoritarian nature of educational institutions by promoting dialogic education, democratization of classroom authority and agency of students. According to Freire, the process of learning should foster an engaging and interactive process of education which involves developing critical consciousness, not just memorizing, and not teacher domination (Schutz & Gereon, 2021). In today's digital education, Freire's perspective is especially vital since it helps to question if the process of learning through algorithms does not turn into a form of dependence on new technological means. Therefore, combining the theories of Weber, Foucault, and Freire creates an adequate interdisciplinary theoretical base for analyzing the process of transformation of teacher authority in modern times.

Reconstructing Teacher Authority in the Digital Age

The fast-growing dynamics of digital technology, artificial intelligence, and algorithmic education have considerably affected the traditional role of teacher authority in modern educational settings. In the past, teachers had an absolute role as carriers of knowledge, authority in discipline, and morality; however, with the advent of new learning technologies and algorithms for instruction, this dominance in the sphere of knowledge transfer is constantly undermined (Williamson, 2023; Selwyn, 2021). Modern educational settings are based on technologically mediated practices in which not only teachers but also algorithms, data analytics, and automation in the learning process play an active role in instructive practices and learner engagement. These changes have become the source of numerous academic discussions concerning whether teacher authority is shrinking, changing its nature, or just being redistributed within digital learning environments. Some academics state that technological innovation contributes to the democratization of the educational process because learners gain an opportunity to obtain information freely, while others assert that the algorithms may undermine teacher autonomy, increase surveillance, and dehumanize the teaching-learning process. Consequently, understanding the reconstruction of teacher authority in the digital age requires critical examination of how technology is reshaping educational power, pedagogy, and human interaction within contemporary schooling systems.

From Knowledge Custodian to Learning Facilitator

Traditionally, teachers used to derive their authority from the exclusivity that came from being the only source of the creation and distribution of information in academic contexts where the learners relied solely on classroom teachings and the book-based method of teaching to grow intellectually. However, the advent of digital technologies, online libraries, social media, and artificial intelligence-based education system has led to a significant erosion of the power monopoly of teachers over information sources (OECD, 2023). Learners are becoming more and more capable of accessing information independently through various virtual learning platforms, search engines, and educational applications, thus making the classroom a space where the monopoly of the teacher is giving way to decentralization. Hence, modern-day teachers are increasingly expected to act not just as information providers but rather as facilitators, interpreters,

mentors, and guides helping students to navigate through the ocean of digital information at their disposal (Biesta, 2021).

Algorithmic Power and Educational Control

The development of algorithmic education has led to new forms of power, governance, and institutionality being present in modern education systems via increased deployment of AI learning technologies, prediction algorithms, automated assessment methods, and digital surveillance technologies. Modern educational institutions depend on the process of datafication in which they collect, analyze, and interpret information about students' performance, behavior, attendance, and level of engagement in an effort to govern the learning process and increase efficiency of the institution (Williamson & Eynon, 2020). Even though these technologies are usually used with the purpose of creating better personalized learning experience and making administration more effective, they also lead to increased surveillance and control of educational institutions over their students. With the increasing usage of educational platforms and automation, there are issues of privacy, autonomy of teachers, and increased commercialization of learning spaces in which algorithmic tools affect the decisions about teaching that were made by teachers. Moreover, the overuse of assessment through algorithms and AI-based instruction may have the effect of dehumanizing the educational process by treating human processes of learning as measurable quantities. Therefore, the power of algorithms in education is both a breakthrough development and a mechanism of technological control that can change the dynamics of power in schools.

Human Authority versus Machine Mediation

The growing application of artificial intelligence in education has sparked a number of philosophical discussions about the extent to which an algorithmic system may take over the role of the human element in educational authority. Even though the use of AI tools makes it possible to personalize instruction, evaluate performance, and give instant feedback, there are many concerns surrounding the capability of such technology to make moral judgments, exercise emotional intelligence, empathize, and interpret the context of an educational relationship (Holmes et al., 2022). The act of teaching encompasses more than just imparting knowledge; it includes mentoring, providing ethical leadership, motivation, and encouragement of human values. Though algorithms can be quite effective in organizing study material and predicting patterns of performance, they do not have the human consciousness, experience, and relational skills to deal with the complex issues that arise in the context of education. In addition, an over-reliance on technology can make the learner become a mere passive recipient of technologically managed learning, undermining the human interaction that needs to happen between the teacher and the learner. In this light, even with the rise of AI in education, there is no replacement for human pedagogical authority.

The Future of Teacher Authority

The future of the authority of teachers in digitally enabled educational settings seems to rest not on the ownership of information but rather on their capacity to offer ethical advice, mentoring, critical thinking, emotional intelligence, and contextual interpretation of information. As Selwyn argues, in an era where information can easily be accessed via digital platforms, AI systems, and other tools, teachers are slowly shifting from being authoritarian custodians of knowledge to becoming intellectual mentors who can assist learners in navigating the world of information responsibly and critically (Selwyn, 2021). Modern education requires teachers to nurture the analytical skills, ethics, and social-emotional skills of students. Accordingly, the legitimacy of future educators could be based on their distinctly human traits of empathy, morality, communication, and the comprehension of knowledge through different social and cultural settings. Teachers, rather than being completely replaced by technological systems, will continue serving as "human navigators within algorithmic learning spaces," bridging the gap between the learner and increasingly intelligent digital systems. This means that the reconstruction of teachers' authority in the future will require striking a balance between technology and humanity within education.

Counter Arguments and Critical Debates

Contemporary debates surrounding digital education and artificial intelligence reveal significant optimism regarding the transformative potential of technology within modern educational systems. Proponents of educational technology argue that digital platforms and AI-driven instructional systems democratize education by expanding access to knowledge beyond the physical classroom and reducing barriers associated with geography, cost, and institutional exclusivity (OECD, 2023). Through online learning environments, open educational resources, virtual classrooms, and AI-supported instructional tools, learners can increasingly access educational opportunities irrespective of social or spatial limitations. Similarly, advocates of algorithmic education maintain that artificial intelligence improves instructional efficiency by automating repetitive academic tasks such as grading, attendance monitoring, performance analysis, and administrative management, thereby allowing teachers to focus more on facilitation and learner support (Holmes et al., 2022). Moreover, proponents of adaptive learning technologies argue that algorithms enable personalization through the analysis of the learner's behavior patterns, academic achievements, and cognitive preferences in order to provide educational materials personalized for each learner (Zawacki-Richter et al., 2021). From such a perspective, algorithmic systems are considered to be novel instruments that have the potential to foster flexibility, inclusiveness, learner autonomy, and better educational results in the emerging technological learning environments.

In spite of all the mentioned benefits of algorithms, some scholars criticize the overreliance on technology and algorithmic systems as being potentially harmful to the human aspects of education and diminishing the practice into mere mechanical instruction. Although modern digital technologies allow gaining easy access to the information and improving administrative functions of learning environments, they cannot substitute human relations and ethical mentoring. Education is not only a cognitive activity that implies sharing information but also a very social and emotional activity that depends on empathy, communication, morality, and human connections. In their view, critics consider the danger that the increased level of automation may turn education into a dehumanized process in which performance indicators, predictions, and standard digital results take precedence over the holistic development of students as social beings (Knox, 2023). Also, the growing power of algorithms in making decisions in the educational sphere can lead to teachers' loss of freedom and prevent the engagement in critical thinking, creative discussion, and human interactions. Thus, while technology and artificial intelligence provide many opportunities in education, modern discussions reveal that sustainable development in the field involves the right balance between innovations in technology and pedagogy based on humans.

Implications for Education

The evolution of teacher authority in the face of algorithmic technologies in education has various implications in many areas of modern-day education such as teacher education, curriculum development, educational policies, digital literacy, educational leadership, classroom management, and the ethics of AI application in schools. Teachers should be trained to deliver lessons as well as teach through technology; teachers should be knowledgeable in technology-based teaching skills and be capable of making decisions ethically and managing the learning process in an algorithm-enabled environment. Just like that, curriculum development is required in order to adjust to the current trends in digital education in terms of teaching and learning which incorporate critical thinking, digital citizenship, media literacy, data analysis, and proper AI use. In turn, educational policies should react to the increasing impact of algorithmic technologies by setting certain standards concerning data privacy, accountability, digital inclusion, and equal access to technological means in schools (OECD, 2023). In addition, the fast growth of AI technology in education creates some important ethical issues about surveillance, bias in algorithms, privacy of learners, and the commercialization of data related to the educational process, which calls for more strict institutional regulation that will be able to secure teachers and learners from exploitation of such technologies (Williamson, 2023). Furthermore, digital literacy has now become an important

element of the modern educational system because teachers and learners need to possess the skills to assess digital content, operate on digital platforms properly, and understand the social dimensions of algorithms. The concept of educational leadership and classroom management must also shift from traditional management models to technology-oriented ones.

Suggestions

Considering the rising impact of technologies and algorithms in education, this study calls for the harmonious implementation of technology in teaching and learning processes that do not substitute the role of humans as educators but supplement it. The use of technologies should be aimed at preserving the human element of pedagogy through encouraging critical discussion, emotional communication, ethical mentoring and collaborative learning rather than being used as a tool for automation and dehumanization of the educational process. In addition, teacher education programs should focus on offering professional development courses in digital pedagogy, artificial intelligence knowledge and ethical use of technologies.

In addition to this, there should be ethical guidelines formulated by the government or educational policy makers for the use of artificial intelligence in the school system, especially in relation to issues of data protection, algorithm transparency, surveillance techniques, and responsibility of automation of decisions in education. Schools must ensure that digital literacy is fostered among both students and teachers for engaging critically with the technology rather than just being dependent upon the algorithms. In essence, sustainable education in the digital era demands a delicate balance between technology and human interaction within education.

Conclusion

The historical development of education, from blackboard teaching through to algorithms-based learning systems, has shown clearly that rather than eroding teacher power, it is being dramatically transformed through the changes brought about by technological advances, social developments, and pedagogy. Although the advent of technology, artificial intelligence, and data-based education systems has greatly changed the power relations within the classroom environment and challenged the teacher's historical monopoly of knowledge, they have certainly not undermined the uniquely human qualities of teaching which are crucial for any form of education. Today's reality is placing increased demands on teachers to be not only providers of knowledge but moral guides and interpreters of complex digital knowledge environments. While algorithms might increase efficiency, personalization, and access to information, algorithms cannot replace the human capacity to reason, to use emotional intelligence, empathy, moral judgement, and relation. Thus, the move from the blackboard to the algorithm does not spell the end of teacher power, but rather the redefinition of such power in the context of technologically-mediated education where human input is still essential for the proper development of students.

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IMPACT OF AI-DRIVEN SIMULATIONS ON TEACHING CHEMISTRY AND SCIENTIFIC CONCEPTS IN PUBLIC SECONDARY SCHOOLS IN EKPOMA, EDO STATE, NIGERIA

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Abstract

This study examined the perceived impact of AI-driven simulations on the teaching of Chemistry and students' understanding of scientific concepts in public secondary schools in Ekpoma, Edo State, Nigeria. The study adopted a descriptive survey design involving 210 respondents, comprising 180 Senior Secondary II Chemistry students and 30 Chemistry teachers selected through simple random sampling. Data were collected using a researcher-developed instrument titled AI-Driven Simulations and Chemistry Teaching Questionnaire (AIDSCTQ), which recorded a Cronbach's alpha reliability coefficient of .86. Mean and standard deviation were used to analyze the data, with a criterion mean of 2.50. The findings showed that respondents perceived AI-driven simulations as positively influencing Chemistry teaching and students' understanding of scientific concepts (grand mean = 2.95). The strongest perceived benefit was the simplification of difficult Chemistry concepts (mean = 3.26), followed by improved understanding of scientific concepts (mean = 3.14). However, perceived effects on knowledge retention and teachers' classroom effectiveness were comparatively moderate. Major implementation barriers included inadequate ICT facilities (mean = 3.31), poor electricity supply (mean = 3.20), inadequate internet connectivity (mean = 3.09), insufficient government support, limited teacher training and the cost of digital facilities (grand mean = 3.01). The study concludes that AI-supported simulation can strengthen Chemistry instruction when implemented as a complement to teacher-led and laboratory-based learning. It recommends sustained investment in digital infrastructure, teacher professional development, curriculum alignment and responsible, human-centred use of AI-enabled learning technologies.

Keywords: Artificial Intelligence in Education, AI-Driven Simulation, Chemistry Instruction, Conceptual Understanding, Digital Pedagogy, Secondary Science Education, Virtual Laboratory

Introduction

Chemistry occupies a central position in Nigerian secondary education because it provides foundational knowledge for medicine, pharmacy, engineering, agriculture, environmental management and several technology-oriented occupations. It also contributes to the development of scientific literacy and the human capital required for national science, technology and innovation. Yet, learning Chemistry remains challenging for many secondary school students, particularly when instruction requires learners to connect observable phenomena with invisible molecular and sub-microscopic processes. Evidence from the West African Examinations Council (WAEC) continues to point to weaknesses in conceptual reasoning and the application of Chemistry principles, while broader research identifies inadequate practical resources, teacher-centred pedagogy and unequal access to educational technologies as persistent concerns (West African Examinations Council [WAEC], 2023; Almasri, 2024).

Many Chemistry concepts are inherently abstract. Atomic structure, chemical bonding, electrolysis, reaction kinetics, molecular geometry and chemical equilibrium require learners to reason about processes that cannot always be directly observed. Where classroom instruction relies

mainly on verbal explanation and static representations, students may memorize rules without developing robust mental models. Mayer's (2021) Cognitive Theory of Multimedia Learning (CTML) explains why appropriately designed combinations of words, images, animation and interaction can support meaningful learning: learners must actively select relevant information, organize it into coherent representations and integrate those representations with prior knowledge.

Artificial intelligence (AI) has expanded the range of digital learning environments available to teachers and learners. In education, AI can support adaptive feedback, personalized learning, automated assessment and intelligent tutoring, while simulation technologies can provide interactive representations of phenomena that are difficult, expensive or unsafe to reproduce physically (UNESCO, 2021; Almasri, 2024). In Chemistry, AI-enabled or intelligent simulation environments may allow learners to manipulate variables, visualize molecular processes, test hypotheses, receive feedback and repeat activities without consuming physical laboratory materials. Importantly, not every digital simulation is itself an AI system. Accordingly, this study uses the term AI-driven simulations to refer to simulation-based instructional environments that incorporate intelligent, adaptive or AI-supported functions; evidence from conventional computer and PhET simulations is treated as closely related simulation evidence rather than automatically classified as AI.

Research evidence supports the educational value of simulation-based learning. Oladejo et al. (2021) found that senior secondary students taught Chemistry with computer simulation performed better than those taught through a traditional lecture approach, including on higher-order cognitive outcomes. Ibitomi et al. (2022) similarly reported improved performance in chemical equations among students exposed to computer simulation. Ibrahim et al. (2025) found that PhET simulation improved students' performance in selected Chemistry content and reported stronger outcomes for the simulation group. These findings are consistent with the broader literature showing that AI and simulation technologies can strengthen engagement, conceptual learning and access to interactive representations in science education (Almasri, 2024; Iyamuremye et al., 2024).

Within Nigeria, however, the promise of AI-enabled science instruction is constrained by unequal technological readiness. Bali et al. (2024) observed that many Nigerian educational institutions have yet to take full advantage of AI because of infrastructural and technological limitations. In Chemistry education specifically, Bugaje and Madaki (2025) identified computer simulations, virtual laboratories, personalized learning and automated assessment among emerging AI-related applications, while also highlighting challenges relating to resources, teacher competence, data quality, model validation, ethics and security. Ikokwu (2026) found moderate integration of AI in Chemistry teaching and learning in colleges of education in South-East Nigeria and identified high costs, insufficient resources and inadequate training as important barriers. Ugosor et al. (2026) likewise identified infrastructure, teacher capacity, equity, ethics and regulatory gaps as major considerations for AI integration in Nigerian Chemistry education.

The situation warrants particular attention in public secondary schools in Ekpoma, Esan West Local Government Area of Edo State. The setting combines a strong educational presence with the practical constraints experienced by many public schools, including limited access to functional laboratories, digital devices, reliable electricity and high-quality internet connectivity. Under such conditions, simulation-based technologies may provide a useful supplementary route for representing abstract Chemistry processes and extending learning opportunities beyond what can be achieved through physical laboratory resources alone. However, technology should not be treated as a substitute for teachers or authentic laboratory experiences. UNESCO (2023) emphasized that educational technologies should be used where they are relevant, equitable, sustainable and demonstrably supportive of learning, while preserving the central role of human interaction.

Although existing studies provide encouraging evidence, important contextual and methodological gaps remain. Much of the Nigerian evidence has been generated in locations such as Ogun, Kwara and South-East Nigeria, and several studies have focused on academic achievement following experimental exposure to conventional computer simulations. Less attention has been given to public secondary schools in Ekpoma, where infrastructural conditions may shape

whether AI-supported simulation can be meaningfully implemented. There is also limited local evidence that considers both perceived instructional benefits and implementation barriers in the same study. This study therefore investigates the perceived impact of AI-driven simulations on Chemistry teaching and students' understanding of scientific concepts in public secondary schools in Ekpoma, Edo State, while also identifying the major challenges that may limit effective implementation.

Statement of the Problem

Chemistry education requires learners to understand relationships among observable laboratory phenomena, symbolic representations and microscopic explanations. In many public secondary schools, these learning demands are complicated by inadequate laboratory resources, large classes, limited instructional time and uneven access to digital technologies. The result can be a gap between what students are expected to understand and what classroom resources allow teachers to demonstrate. At the same time, AI-supported educational technologies and interactive simulations are increasingly promoted as tools for visualization, adaptive support and learner engagement.

The problem, therefore, is not simply whether AI exists as an educational innovation, but whether AI-driven simulation can provide meaningful instructional value within the resource realities of public secondary schools in Ekpoma. Without local evidence, claims about its usefulness may remain largely aspirational. A study focused on Ekpoma is justified because it can generate context-specific evidence on two connected issues: the instructional value perceived by the principal users of Chemistry education and the practical barriers that may prevent that value from being realized. The inclusion of both teachers and students strengthens the study by bringing together pedagogical and learner perspectives.

The study is further justified by the need to distinguish technology enthusiasm from evidence-informed implementation. A descriptive survey cannot establish a causal treatment effect; it can, however, document how teachers and students perceive the instructional contribution and feasibility of AI-driven simulations within their actual school environment. This distinction is important for responsible educational decision-making and prevents the findings from being interpreted as proof that AI alone causes improved achievement. The study consequently contributes contextual evidence for school administrators, curriculum planners and policymakers considering phased, human-centred adoption of AI-enabled simulation in Chemistry education.

Theoretical and Empirical Literature Review

Cognitive Theory of Multimedia Learning

This study is anchored on Mayer's Cognitive Theory of Multimedia Learning (CTML). The theoretical foundation should not be attributed to 2021 as the year in which the theory was first developed. Rather, Mayer's 2021 third edition of *Multimedia Learning* provides the current authoritative formulation and synthesis of the theory used in this study. CTML explains how learners process information from words and pictures through separate but interacting representational channels, subject to limited cognitive capacity and requiring active cognitive processing. Meaningful learning occurs when learners select relevant information, organize it into coherent verbal and pictorial models and integrate those models with prior knowledge (Mayer, 2021).

CTML is directly relevant to Chemistry because many Chemistry concepts require learners to move between macroscopic observations, symbolic equations and sub-microscopic representations. AI-enabled simulations can provide dynamic visualizations, interactive manipulation, multiple representations and immediate feedback that may help learners construct more coherent mental models. From a CTML perspective, however, multimedia is not automatically beneficial. Poorly designed animation, excessive information or unnecessary interaction can increase cognitive load. Thus, the value of AI-driven simulation depends on purposeful instructional design and teacher guidance rather than technological novelty alone.

The theoretical linkage guiding this study is therefore straightforward: AI-driven simulation provides multimedia and interactive representations; these representations can support the selection and organization of relevant information; improved integration of representations with prior knowledge can strengthen conceptual understanding; and teacher guidance can help learners interpret simulation outputs correctly. The framework also explains why simulations should complement rather than replace teacher explanation and physical laboratory activities. This theoretical position is consistent with UNESCO's (2023) emphasized on evidence-based, learner-centred technology use and with recent reviews of AI in science and Chemistry education (Almasri, 2024; Iyamuremye et al., 2024).

Empirical Review

Oladejo et al. (2021) investigated the use of computer simulation in senior secondary Chemistry in Ogun State using a quasi-experimental design. Students exposed to computer simulation outperformed those taught through the traditional lecture method, including on higher-order cognitive outcomes. The study provides relevant Nigerian evidence that simulation can support Chemistry learning, although it involved conventional computer simulation rather than an explicitly AI-driven platform.

Ibitomi et al. (2022) examined computer simulation in learning chemical equations among senior secondary students in Offa, Nigeria. Their quasi-experimental study reported differences in performance favouring students exposed to computer simulation. The relevance to the present study lies in the capacity of simulation to make otherwise invisible chemical processes more representationally accessible, while the methodological difference reinforces the need to distinguish simulation technology from AI technology.

Ibrahim et al. (2025) examined PhET simulation as a platform for improving students' performance in Chemistry content among senior secondary students in Kwara State. Their findings indicated improved performance and retention among students exposed to the simulation. PhET is appropriately treated here as evidence for simulation-based Chemistry instruction; it should not be represented as an AI system merely because it is digital or interactive.

Adeyele (2024) reported that simulation games, blended learning and interactive multimedia can produce differential learning outcomes in Basic Science, demonstrating the broader instructional value of interactive representations. Although the participants were younger Basic Science learners rather than senior secondary Chemistry students, the study reinforces the principle that multimedia effectiveness depends on instructional design and learner context.

At the broader AI level, Almasri (2024) synthesized empirical research on AI in science education and reported evidence of benefits across learning environments, assessment, student support and other instructional functions, while also identifying contextual and implementation challenges. Iyamuremye et al. (2024) similarly reviewed AI and machine learning in Chemistry education and identified opportunities for personalized learning, active learning, virtual laboratories and real-time support, alongside concerns relating to infrastructure, ethics, validation and teacher readiness.

Nigerian studies published more recently strengthen the contextual argument. Bugaje and Madaki (2025) identified computer simulation, virtual laboratory, personalized learning and automated assessment as important AI-related applications in Chemistry education and highlighted the need for teacher professional development. Ikokuwu (2026) found moderate AI integration in Chemistry education in South-East Nigerian colleges of education, with inadequate resources, high costs and poor training among the major challenges. Ugosor et al. (2026) similarly argued that AI has potential to strengthen Chemistry education in Nigeria but that infrastructure, teacher capacity, equity, ethics and regulatory preparedness must be addressed.

Taken together, the empirical literature supports the plausibility of simulation and AI-supported tools for Chemistry learning, but it also reveals a clear evidence gap. Much of the available evidence either examines conventional simulations under experimental conditions or addresses AI

at a broad conceptual level. There is comparatively little evidence from public secondary schools in Ekpoma that simultaneously considers perceived instructional benefits and implementation barriers. The present study addresses this gap by combining teachers' and students' perceptions within a specific local context.

Research Questions

1. To what extent do AI-driven simulations improve the teaching of Chemistry and students' understanding of scientific concepts in public secondary schools in Ekpoma, Edo State?
2. What challenges influence the effective use of AI-driven simulations in teaching Chemistry in public secondary schools in Ekpoma, Edo State?

Methods

This study adopted a descriptive survey research design. The design was appropriate because the study sought to document respondents' perceptions of the instructional contribution and implementation challenges of AI-driven simulations without manipulating an intervention or assigning participants to treatment groups. This methodological choice is important because the study's findings concern perceived impact rather than a causal treatment effect.

The study was conducted in public secondary schools in Ekpoma, within Esan West Local Government Area of Edo State, Nigeria. The population comprised Senior Secondary School Two (SS II) students offering Chemistry and Chemistry teachers in public secondary schools in the study area. SS II students were selected because they had encountered several fundamental and abstract Chemistry concepts and could therefore provide informed responses regarding simulation-supported learning.

A sample of 210 respondents, comprising 180 SS II Chemistry students and 30 Chemistry teachers, was selected through simple random sampling. The inclusion of both teachers and students provided complementary perspectives on instructional usefulness and implementation constraints. The sampling procedure was intended to reduce selection bias and provide a reasonable representation of the study population.

Data were collected using a researcher-developed instrument titled AI-Driven Simulations and Chemistry Teaching Questionnaire (AIDSCTQ). The instrument was structured into three sections: Section A collected demographic information; Section B measured perceived instructional benefits of AI-driven simulations for Chemistry teaching and scientific-concept understanding; and Section C measured challenges affecting implementation. Items were rated on a four-point scale of Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1).

Face and content validity were established by three experts: two specialists in Science Education and one specialist in Educational Technology from Ambrose Alli University, Ekpoma. Their observations were incorporated into the final instrument. Reliability was established through a pilot study involving 20 respondents from a public secondary school outside the study area but with similar characteristics. Cronbach's alpha produced a reliability coefficient of .86, indicating high internal consistency.

The questionnaires were administered personally by the researcher with the assistance of two trained research assistants, and all administered copies were retrieved. Data were analyzed using mean and standard deviation. A criterion mean of 2.50 was used for decision-making: mean scores of 2.50 and above were interpreted as agreement, whereas mean scores below 2.50 were interpreted as disagreement. Because the study is descriptive, the results are interpreted as respondents' perceived impact and perceived barriers rather than evidence of causal effects.

Results

Research Question 1: To what extent do AI-driven simulations improve the teaching of Chemistry and students' understanding of scientific concepts in public secondary schools in Ekpoma, Edo State?

Table 1

Mean Ratings on the Impact of AI-Driven Simulations on the Teaching of Chemistry and Students' Understanding of Scientific Concepts (N = 210)

S/N	Item	Mean ($\bar{x}$)	SD	Rank	Decision
1	AI-driven simulations make difficult Chemistry concepts easier to understand.	3.26	.74	1 st	Agree
2	AI-driven simulations improve students' understanding of scientific concepts.	3.14	.81	2 nd	Agree
3	Virtual simulations improve students' participation during Chemistry lessons.	3.02	.85	3 rd	Agree
4	AI simulations increase students' interest in learning Chemistry.	2.91	.89	4 th	Agree
5	Students remember Chemistry concepts better after using AI simulations.	2.76	.93	5 th	Agree
6	AI-driven simulations improve teachers' classroom effectiveness.	2.58	.97	6 th	Agree
Grand Mean		2.95	.87		Agree

The results in Table 1 show an overall favourable perception of AI-driven simulations, with a grand mean of 2.95, above the criterion mean of 2.50. The highest-rated item was the view that AI-driven simulations make difficult Chemistry concepts easier to understand (mean = 3.26), followed by improved understanding of scientific concepts (mean = 3.14). Participation during Chemistry lessons also received a relatively high rating (mean = 3.02). However, the lower ratings for retention (mean = 2.76) and teachers' classroom effectiveness (mean = 2.58) suggest that respondents did not perceive the benefits as uniformly strong across all outcomes. The pattern is therefore best interpreted as positive but moderate perceived influence rather than proof of a causal effect.

Research Question 2: What challenges influence the effective use of AI-driven simulations in teaching Chemistry in public secondary schools in Ekpoma, Edo State?

Table 2

Mean Ratings on Challenges Affecting the Use of AI-Driven Simulations in Teaching Chemistry (N = 210)

S/N	Item	Mean($\bar{x}$)	SD	Rank	Decision
1	Most public secondary schools lack adequate ICT facilities.	3.31	.71	1 st	Agree
2	Poor electricity supply affects the use of AI technologies.	3.20	.76	2 nd	Agree
3	Internet connectivity is inadequate in many schools.	3.09	.82	3 rd	Agree
4	Government support for AI integration remains inadequate.	2.96	.88	4 th	Agree
5	Many teachers require additional training on AI applications.	2.82	.91	5 th	Agree
6	The cost of digital facilities limits AI implementation.	2.67	.95	6 th	Agree
Grand Mean		3.01	.84		Agree

The findings in Table 2 indicate that implementation barriers were consistently perceived as important, with a grand mean of 3.01. Inadequate ICT facilities ranked first (mean = 3.31), followed by poor electricity supply (mean = 3.20) and inadequate internet connectivity (mean = 3.09). Government support, teacher training and the cost of digital facilities were also rated above the criterion mean. The results suggest that the feasibility of AI-driven simulation in the study area

depends first on basic technological readiness and teacher capacity rather than on the availability of AI software alone.

Discussion of Findings

The first finding indicates that respondents perceived AI-driven simulations as beneficial to Chemistry teaching and students' understanding of scientific concepts. The strongest perceived benefit was the simplification of difficult Chemistry concepts, followed by improved conceptual understanding and classroom participation. This pattern is consistent with CTML because dynamic visual and interactive representations can help learners organize information and connect it with prior knowledge (Mayer, 2021). It is also consistent with evidence from Nigerian simulation studies, including Oladejo et al. (2021), Ibitomi et al. (2022) and Ibrahim et al. (2025), which reported improved learning outcomes following exposure to computer or PhET simulations.

The finding also aligns with broader reviews of AI and science education. Almasri (2024) found evidence that AI-supported technologies can contribute to learning outcomes, engagement and instructional support across science education contexts, while Iyamuremye et al. (2024) identified virtual laboratories, personalized learning and intelligent support as promising applications in Chemistry. The present result therefore has theoretical and empirical support. Nevertheless, the descriptive design means that the finding should be stated as a perceived positive influence rather than a demonstrated causal impact.

The relatively moderate ratings for retention and teacher effectiveness are important. They suggest that simulation does not automatically produce deep or durable learning. Learners still require purposeful tasks, teacher explanation, opportunities for retrieval and practice, and appropriate assessment. Similarly, a digital tool can enhance a teacher's repertoire without necessarily making classroom instruction effective in the absence of pedagogical competence. This interpretation is consistent with UNESCO's (2023) position that educational technology should complement, rather than displace, human interaction and sound pedagogy.

The second finding shows that inadequate ICT facilities, electricity and internet connectivity constitute the most prominent barriers. This result closely reflects the Nigerian context described by Bali et al. (2024), who identified infrastructural and technological constraints as important limitations on AI adoption. It also agrees with Bugaje and Madaki (2025), who highlighted resource limitations and teacher competence, and with Ikokwu (2026), who reported high costs, insufficient resources and inadequate training as major barriers to AI integration in Chemistry education. Ugosor et al. (2026) similarly emphasized infrastructure, teacher capacity, equity, ethics and policy readiness.

The implication is that schools should not pursue AI adoption as a stand-alone procurement exercise. Devices, connectivity and electricity must be accompanied by teacher development, curriculum alignment, technical support, clear guidance on responsible use and opportunities for learners to engage critically with AI-generated outputs. In resource-constrained schools, phased implementation using low-bandwidth or offline-capable simulations may be more realistic than immediate dependence on sophisticated cloud-based systems. At the same time, simulation should complement physical Chemistry practicals because virtual environments cannot fully reproduce the psychomotor, safety and collaborative competencies developed through real laboratory work.

Conclusion and Recommendations

This study examined the perceived impact of AI-driven simulations on Chemistry teaching and students' understanding of scientific concepts in public secondary schools in Ekpoma, Edo State. The respondents reported a generally positive perceived influence, particularly in simplifying difficult Chemistry concepts, supporting conceptual understanding and increasing classroom participation. However, the perceived benefits were moderate for knowledge retention and teachers' classroom effectiveness. The study also identified inadequate ICT facilities, poor electricity supply, weak internet connectivity, limited government support, insufficient teacher

training and the cost of digital facilities as important barriers. The central conclusion is that AI-driven simulations have meaningful potential as a complementary instructional resource, but their educational value depends on infrastructure, teacher competence, curriculum alignment and responsible pedagogical use. Given the descriptive design, the findings should not be interpreted as evidence of a causal treatment effect.

1. Government and relevant education authorities should improve the basic digital infrastructure of public secondary schools, including functional ICT facilities, reliable electricity and appropriate internet connectivity.

2. Chemistry teachers should receive sustained professional development on AI literacy, simulation-based pedagogy, verification of AI-generated content, digital ethics and the integration of simulation with existing Chemistry curriculum requirements.

3. School administrators should adopt AI-driven simulations as complementary resources alongside teacher-led instruction and physical laboratory practicals rather than as substitutes for teachers or authentic laboratory experiences.

4. Curriculum planners and teacher-education institutions should provide practical guidance on the pedagogically appropriate use of AI-enabled simulation, including activities that connect macroscopic observations, symbolic representations and sub-microscopic Chemistry concepts.

5. Schools should consider phased implementation strategies, including low-bandwidth and offline-capable simulation resources, where full digital infrastructure is not yet available.

6. Future researchers should employ quasi-experimental, experimental or mixed-methods designs to determine the causal effects of specific AI-enabled simulation platforms on Chemistry achievement, retention, scientific reasoning and practical skills over longer periods.

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INFLUENCE OF ARTIFICIAL INTELLIGENCE COMPUTERIZED MULTIPLE CHOICE ADAPTIVE ACHIEVEMENT TEST (AI-CAT) ON ACADEMIC PERFORMANCE OF UNDERGRADUATES IN LAGOS STATE UNIVERSITY OF EDUCATION, LAGOS STATE, NIGERIA

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Abstract

This study examined how use of Artificial Intelligence Computerized Multiple Choice Adaptive Achievement Test (AI-CMCAAT) influenced undergraduates' performance in Lagos State University of Education, Lagos State, Nigeria. Two hypotheses were formed in the study. Quasi-experimental research design using a pretest-posttest control group experimental design was adopted. The population comprised of 2,345 third year undergraduate students in Lagos State University of Education. One tenth of the population was used and a sample of 285 undergraduates was obtained using multi-stage sampling procedure. Data was collected using AI-CMCAAT from seven selected topics on Educational Measurement and Evaluation. The instrument contained 35 items using four-options response format. The validity of the test was determined by three experts in the field of Measurement and Evaluation. Cronbach's alpha reliability was used to determine internal consistency of items which yielded a coefficient $r=.779$. Independent sample t-test was used to analyze the data as hypotheses were tested at .05 level of significance. The findings revealed that the performance of students generally was not as significant as expected to compliment previous studies. It also discovered that although AI generated scale provides personalized assessment, immediate feedback, and improved test precision, the conventional test (Teacher Made Test) is perceived to be more learner friendly, relate learners learning condition and time, factor ability level of students in the course of test development among others. The authors concluded that while AI adaptive tests remains an effective assessment innovation capable of improving students' academic performance in school, teachers need be trained on the globally accepted structured format needed to formulate test items especially in this era of digital space. It recommended that educational stakeholders should complement adapting AI adaptive tests in classrooms in other to enhance better learning outcome.

Keywords: Academic Performance, Artificial Intelligence, Computerized Adaptive Technique, Multiple Choice Test, Undergraduates

Introduction

The emergence of Artificial Intelligence (AI) has sparked innovations and enhanced efficiency as one of the most innovative technologies in contemporary higher education, thereby reshaping instructional delivery, learning support and educational assessment. Due to the numerous positives, AI is highly embraced across all fields of human endeavours and education is not an exemption. The integration of AI into assessment practices has moved beyond conventional computer-based testing to intelligent systems capable of adapting to the ability level of individual learners (Fasinro et al., 2024). One of the most innovative applications of AI in educational measurement is the Artificial Intelligence Computerized Multiple Choice Adaptive Achievement Test (AI-CAT), which dynamically selects test items based on a student's responses, thereby providing a more precise estimate of academic ability. Unlike the traditional paper-and-pencil examination where all students answer identical questions irrespective of their competence, AI-CAT presents items that

match each learner's ability level, minimizes item exposure, shortens testing time, and improves measurement accuracy. These capabilities align with global trends toward personalized learning and competency-based assessment, making AI-CAT increasingly relevant for improving learning outcomes in higher education (Abubakar et al., 2024).

The increasing adoption of AI technologies within Nigerian higher education has created new opportunities for improving teaching, learning, and assessment. Nigerian universities and other tertiary institutions are gradually integrating AI-supported instructional platforms, intelligent tutoring systems, learning analytics, and digital assessment technologies to enhance educational quality. Studies conducted by Fasinro et al, (2024), Peters and Olojede (2025) in Nigerian universities indicated that undergraduate students generally perceive AI-supported learning environments as beneficial because they provide immediate feedback, personalized learning pathways, and greater academic engagement. Similarly, Tijani and Adeduyigbe (2026) argued that AI has the potential to improve assessment validity by reducing human errors, increasing objectivity, and providing real-time performance analytics for educators. These developments suggest that AI-driven adaptive assessment systems could significantly improve the quality of measurement of students' academic achievement or performance in tertiary institutions across Lagos State.

Academic performance remains one of the most important indicators of educational quality in higher education because it reflects the extent to which students have achieved expected learning outcomes. In Nigerian tertiary institutions, assessment largely determines students' progression, graduation, scholarship opportunities, and employability (Federal Republic of Nigeria (FRN), 2013). However, conventional multiple-choice achievement tests frequently suffer from several limitations, including the administration of identical test items to students with varying ability levels, prolonged testing duration, item redundancy, examination fatigue, and reduced measurement precision. These challenges may produce inaccurate estimates of students' actual abilities, particularly among highly talented or academically weak learners. AI-CAT addresses these shortcomings by employing adaptive algorithms that continuously estimate student ability and administer questions appropriate to each individual's competence level, thereby improving both efficiency and precision of assessment. Such innovations are particularly important in large university systems where student populations continue to expand while maintaining the demand for reliable and valid assessment practices.

Within Lagos State, which hosts some of Nigeria's largest federal, state, and private tertiary institutions, the need for innovative assessment approaches has become increasingly evident. The state serves as Nigeria's educational and technological hub, with public and private institutions experiences rapid digital transformation. The increasing availability of digital infrastructure, internet connectivity, and AI-enabled educational technologies provides favourable conditions for implementing AI-CAT. Nevertheless, despite growing investments in educational technology, assessment practices in many institutions remain predominantly dependent on conventional multiple-choice examinations that offer limited personalization and delayed feedback. There is a growing need to examine whether AI-assisted adaptive achievement testing can significantly improve undergraduate students' academic performance within the confines of Lagos State institutions.

The theoretical justification for AI-CAT is rooted in modern educational measurement, particularly Item Response Theory (IRT), which emphasizes estimating examinees' latent abilities through mathematically calibrated test items. AI enhances the adaptive testing process by employing intelligent algorithms that continuously update ability estimates after each response, select optimally informative items, and terminate testing once sufficient measurement precision is achieved. Moreso, Peters and Olojede (2025) noted that AI-CAT provides individualized assessment experiences while maintaining high reliability and validity. Furthermore, adaptive testing reduces test anxiety associated with excessively difficult or excessively easy examinations because students receive questions aligned with their demonstrated competence. The immediate scoring and diagnostic feedback generated by AI-CAT also enable lecturers to identify learning

gaps promptly and design targeted instructional interventions that enhance students' academic performance. These characteristics position AI-CAT as an important innovation for evidence-based assessment and continuous quality improvement in higher education.

With the growing interest in AI applications in Nigerian education, past studies have focused predominantly on AI-assisted learning, generative AI, students' perceptions of AI technologies, and ethical considerations surrounding AI adoption, while relatively little attention has been devoted to AI-enabled computerized adaptive achievement testing and its direct influence on undergraduate students' academic performance. Existing Nigerian studies have rarely investigated AI-CAT as an assessment innovation within tertiary institutions, particularly in Lagos State where digital readiness is comparatively high. The gap in the study limits policymakers, university administrators, lecturers, and educational technologists in making informed decisions regarding the adoption of adaptive assessment technologies. Therefore, this study seeks to investigate the influence of AI-CAT on the academic performance of undergraduates in Lagos State institutions, with the expectation that the findings will contribute to educational assessment, technology integration, and policy formulation aimed at improving learning outcomes in Nigerian higher education.

Statement of the Problem

Just like every other mathematics related courses in universities, the academic performance of undergraduates in educational measurement and evaluation has also experienced some degree of setback as it derived performance has not really met the required baseline expected by those who teach the course. Possible factors that may be associated with the decline in undergraduates' performance could be attributed to low latent ability, poor knowledge of mathematics, phobia for failure, inadequate and irrelevant instructional materials, poor timing, poor reading ability, lack of motivation among others. As part of effort to improve the quality of assessment in higher education, the academic performance of many undergraduates remains inconsistent, with concerns about the effectiveness, fairness and diagnostic value of teacher made based multiple-choice achievement tests. Traditional assessment (use of Teacher Made Multiple Choice Measurement and Evaluation Achievement Test) often present identical test items to all students regardless of their ability levels, thereby increasing the likelihood of item mismatch, test anxiety, guessing, and measurement errors that may not accurately reflect students' true academic abilities. The emergence of AI-CAT offers an innovative assessment approach that dynamically adjusts the difficulty of test items based on students' responses, thereby providing more precise measurement, immediate feedback, and enhanced testing efficiency. Although AI-driven adaptive testing have gained increasing global acceptance, research on its effectiveness in improving the academic performance of undergraduates within higher institutions, particularly in Lagos State, remains limited. It is unclear whether AI-CAT significantly enhances students' academic performance as compared with the traditional assessment methods. This lacuna in researched knowledge creates uncertainty for lecturers, educational administrators, and policymakers regarding the adoption of AI-based assessment technologies in tertiary institutions. It is against this background that this study investigated the influence of AI-CAT on the academic performance of undergraduates in Lagos State University of Education.

Purpose of the Study

The study of the study was to investigate the influence of AI-CAT on academic performance of undergraduates in Lagos State University of Education. Specifically the aim of the study was to examine:

1. the difference in students' posttest score in AI-CAT by experimental and control group; and
2. the difference in students' posttest academic performance in TMMCMEAT by experimental and control group.

Research Questions

Two research questions were raised from the study and they include:

1. **What is the** difference in students' posttest score in AI-CAT by experimental and control group?
2. .What is the difference in students' posttest academic performance in TMMCMEAT by experimental and control group?

Methods

The true-experimental research design using Pretest-Posttest control group experimental design was adopted. The design allows for randomization of participants into experimental and control groups. The experimental groups were exposed to treatment condition that is AI-CAT and TMMCMEAT strategies and the control group was exposed to advise that is Advisory Service. The experimental groups were exposed to structured teaching on M &E for four weeks of an hour each for four weeks. Each of those one hour was used to cover a minimum of one topic from the course outline accounting for the teaching of seven topics in four weeks.

Fig. 1: Solomon IV Pretest Posttest control group experimental research design is expressed below:

Fig. 1: Solomon IV research design is expressed below:

R₁: 0₁₁ X₁ 0₁₂ Experimental group (AI-CAT)
 R₂: 0₂₁ //// 0₂₂ Control group
 R₃: X₂ 0₃₂ Experimental group (TMMCMEAT)
 R₄: 0₄₂ Control group

Source: Kerlinger and Lee (2002)

- Where R is randomization;
- X₁ and X₂ are interventions;
- //// is Dummy item
- 0₁₁ & 0₂₁ is Pre-test scores
- 0₁₂, 22, 32 & 0₄₂ as post-test scores.

The population consisted of 2345 third year (300 level) undergraduate students in Lagos State University of Education. One tenth of the population was used and a sample of 285 undergraduates was obtained using multi-stage sampling procedure. Data was collected using AI-assisted Computerized Multiple Choice Adaptive Achievement Test (AI-CMCAAT), from seven selected topics on Educational Measurement and Evaluation. The instrument contained 35 items using four-points response format. The validity of the test was determined by three experts in the field of measurement and evaluation. Cronbach's alpha reliability was performed which yielded a coefficient $r=.779$. Independent sample t-test was used to analyze the data as hypotheses was tested at .05 level of significant.

Results

Hypothesis 1: There is a significant Posttest difference in students' academic performance in AI-CAT by experimental and control group.

Table 1

Independent t-test Analysis' showing Significant Posttest difference in Students' Academic Performance in AI-CAT by Experimental and Control Group.

Groups	N	Mean	SD	Df	t	Sig.	Decision
Experimental	35	2.59	.59	133	2.40	.019	Reject H0 ₁
Control	100	2.76	.71				
Total	135						

N= 135, SD= .59, .71; df= 133; Sig= .019

Table 1 shows that participants in the control group are more than the experimental group however the mean and standard deviation values in the control group is higher than that of experimental group. The output also shows that t-calculated value is 2.40 as Sig. level at .019 respectively. Since $p < .05$, the null hypothesis is rejected and the alternative which states there is a significant posttest difference in students' academic performance in AI-CAT by experimental and control group is retained.

Hypothesis 2: There is a significant posttest difference in students' academic performance in TMMCMEAT by experimental and control group.

Table 2

Independent Sample t-test Analysis showing Significant Posttest difference in Students' Academic Performance in TMMCMEAT by Experimental and Control Group

Groups	N	Mean	SD	Df	t	Sig.	Decision
Experimental	35	4.36	.87	148	3.47	.000	Reject H0 ₂
Control	115	2.94	.58				
Total	150						

N= 150; SD= .87, .58; df= 148; Sig= .000

Table 2 showed that participants in the control group are more than the ones in experimental group however the mean and standard deviation in the experimental group exceed those in control group. The output also shows that t-calculated value is 3.47 as Sig. level at .000 respectively. Since $p < .05$, the null hypothesis is rejected and the alternative which states that there is a significant posttest difference in students' academic performance in experimental and control group is retained.

Discussion of Findings

The result from hypothesis one shows that students in the control group outperform those in the experimental group as seen in their post-test scores. This implies that the introduction of AI-based adaptive testing in educational measurement and evaluation did not automatically translate into improved academic achievement for the experimental participants. Such an outcome may be attributed to factors including students' unfamiliarity with adaptive testing procedures, inadequate digital literacy, test anxiety associated with AI-driven assessment, unstable technological infrastructure, or insufficient orientation before exposure to the adaptive testing environment. Students in the control group, who may have completed the assessment under more familiar or conventional testing conditions, were less likely to experience the cognitive overload associated with navigating a new assessment technology, thereby demonstrating superior performance. This finding aligns with that of Abubakar et al. (2024), Alabi et al. (2025) who claimed that the effectiveness of AI use in education depends not merely on the availability of intelligent technologies but also on learners' readiness, teachers' competence, institutional support, and adequate digital infrastructure. Meanwhile Ukozor (2025) argued that while artificial intelligence has considerable potential to improve assessment and learning outcomes, its benefits may not be fully realized where implementation challenges, limited technological skills, inadequate training, and infrastructural deficiencies persist. The superior performance of the control group underscores the importance of systematic preparation, digital literacy training, and gradual integration of AI-

based assessment systems before expecting measurable improvements in students' academic performance.

Data from hypothesis two shows that there is a significant post-test difference in students' academic performance in Teacher Made Multiple Choice Measurement and Evaluation Achievement Test by experimental and control group. It reveals that students in experimental group performed better than their counterparts in the control group especially when exposed to Teacher-Made Multiple Choice Measurement and Evaluation Achievement Test. This indicates that the instructional intervention or teachings produced superior learning outcomes beyond those achievable through conventional classroom instruction. This implies that students exposure to quality instruction enhanced students' understanding of measurement and evaluation concepts, improved test-taking competence and promoted deeper cognitive engagement with the course content. The superior performance of the experimental group is consistent with constructivist learning principles, which posit that learners achieve higher academic outcomes when actively engaged in meaningful and learner-centred instructional activities. The outcome corroborates with that of Abanobi (2022) who established that learners exposed to timely content and information are bound to outperform those not exposed to same content at intervals. Meanwhile Uka et al. (2026) reported that students who received AI-supported instructional interventions achieved significantly higher scores on a teacher-made achievement test than students in the control group, highlighting the effectiveness of technology-enhanced instructional approaches in improving learning outcomes. The findings revealed that the performance of students generally was not as significant as expected to compliment previous studies. It also discovered that although AI generated scale provides personalized assessment, immediate feedback, and improved test precision, the conventional test (Teacher Made Test, TMT) is perceived to be more learner friendly, relate learners learning condition and time, factor ability level of students in the course of test development among others. It concluded that while AI adaptive tests remains an effective assessment innovation capable of improving students' academic performance in school, teachers need be trained on the globally accepted structured format needed to formulate test items especially in this era of digital space.

Conclusion and Recommendations

From the findings made in the study, the researchers concluded that effectiveness of AI use in education depends not merely on the availability of intelligent technologies but on learners' readiness, teachers' competence, institutional support, and adequate digital infrastructure. It also concluded that students in experimental group performed better than their counterparts in the control group especially when exposed to Teacher-Made Multiple Choice Measurement and Evaluation Achievement Test. This suffices that instructional intervention or teachings produced superior learning outcomes beyond those achievable through conventional classroom instruction.

The following recommendations were made:

1. Educational stakeholders should endeavor to complement adapting AI adaptive tests in classrooms in other to enhance better learning outcome.
2. AI generated test items should be validated by experts in the field of study in other to remove items that discriminate among learners geographically
3. Students should be multi-tasked occasionally in classroom activities in other to improve quality reasoning and logical presentation of content rather than depending solely on AI use.

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INFLUENCE OF TEACHERS' PROFESSIONAL DEVELOPMENT ON INSTRUCTIONAL DELIVERY AND PERCEIVED ACADEMIC PERFORMANCE OF PUPILS IN PRIMARY SCHOOLS IN ESAN CENTRAL LOCAL GOVERNMENT AREA, EDO STATE

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Abstract

Teachers' professional development (TPD) refers to the continuous process through which teachers upgrade their knowledge, skills, and teaching practices in response to changing curricula, technologies, and pedagogical trends. This study examined the influence of TPD on instructional delivery and teachers' perceived academic performance of pupils in public primary schools in Esan Central Local Government Area, Edo State, Nigeria. A descriptive survey design was adopted. The population comprised 272 public primary school teachers, from which a sample of 40 teachers (approximately 15%) was drawn using simple random sampling. Data were collected using a structured questionnaire titled the Teachers' Professional Development, Instructional Delivery and Academic Performance Questionnaire (TPDIDAPQ), validated by subject experts and found reliable (Cronbach's alpha = .84), and analyzed using frequency counts, percentages, mean, and standard deviation. Findings showed that teachers who participated regularly in workshops, seminars, and in-service training reported improved lesson planning, classroom management, and instructional delivery, which they perceived to be associated with better pupil engagement and academic outcomes. The study concludes that TPD is associated with improvements in teachers' self-reported instructional practice, though the descriptive, self-report design used here does not permit causal claims about pupils' actual academic performance. It is recommended that government, school administrators, and other stakeholders provide regular, sustained training opportunities for teachers, and that future studies incorporate objective measures of pupils' academic performance, such as school-based test or examination scores.

Keywords: Teachers' Professional Development, Instructional Delivery, Perceived Academic Performance, Primary Schools

Introduction

Teachers occupy a central position in the education system, as the quality of instruction pupils receive largely determines the extent to which educational goals are achieved. Beyond the transmission of knowledge, teachers shape learners' character, social skills, and readiness to contribute meaningfully to society. The manner in which teachers discharge these responsibilities is therefore a matter of concern to government, school administrators, and other education stakeholders.

Many teachers currently in service were trained before the widespread availability of digital tools such as tablets, smartphones, e-books, and online learning platforms, which now shape how pupils access information. Teachers who qualified before these innovations became common may need continuous retraining to remain effective in a changing instructional environment. This need underlies the concept of teachers' professional development (TPD): the deliberate and ongoing processes and activities designed to enhance educators' professional knowledge, skills, and attitudes, with the ultimate goal of improving pupils' learning (Guskey, 2000).

TPD is expected to be a continuous process centred on instructional delivery in the classroom. Instructional delivery refers to the process of ensuring that pupils receive instruction effectively, in a manner that supports mastery of content through appropriate teaching strategies (Azar, 2017). When teachers apply the knowledge and skills gained from professional development to their instructional

delivery, this is generally expected to be associated with improved academic outcomes for pupils (Etuk & Umoh, 2013).

Statement of the Problem

Despite ongoing investment by government and school authorities in workshops, seminars, and in-service training for primary school teachers, concerns persist about the quality of classroom instruction and the academic outcomes of pupils in public primary schools in Esan Central LGA. It is not always clear whether the professional development activities teachers participate in translate into observable improvements in how lessons are delivered, or whether teachers themselves perceive such a link. Existing studies within the LGA have tended to focus on broader curriculum reform (Asika, et al., 2025) rather than on teachers' direct experience of professional development and its relationship with classroom practice. There is therefore limited empirical evidence, from the perspective of teachers in this specific LGA, on how professional development relates to instructional delivery and to teachers' perception of pupils' academic performance. This study was designed to address that gap.

Objectives of the Study

The general objective of this study was to examine the influence of teachers' professional development on instructional delivery and perceived academic performance of pupils in public primary schools in Esan Central LGA, Edo State. Specifically, the study sought to:

1. determine the extent to which teachers in public primary schools in Esan Central LGA participate in professional development programmes;
2. examine teachers' perception of the relevance of professional development to their instructional delivery in the classroom; and
3. assess teachers' perception of the relationship between professional development and pupils' academic performance.

Methods

The study adopted a descriptive survey research design, appropriate for describing the characteristics, opinions, and perceptions of a population using a questionnaire, without manipulating any variable.

The population of the study comprised all 272 public primary school teachers in the 40 public primary schools in Esan Central LGA, Edo State (Department of Planning, Research and Statistics, Esan Central Educational Authority, Irrua, Edo State, 2026).

A sample of 40 teachers, representing approximately 15% of the population, was selected using simple random sampling, which gives every member of the population an equal chance of being included. Six schools (three urban and three rural) were first randomly selected from the 40 schools in the LGA, and teachers were then randomly sampled from these schools.

A sample of this size is smaller than would typically be recommended for a population of this size by common sampling guidelines (Nwana, 1990). This is acknowledged as a limitation of the study (see Section 6). A full census of the 272 teachers, or a larger probability sample, would strengthen the generalizability of future studies on this topic.

Data were collected using a structured questionnaire titled Teachers' Professional Development, Instructional Delivery and Academic Performance Questionnaire (TPDIDAPQ), developed by the researchers. The instrument comprised 14 items rated on a 4-point scale, organized into three sections:

- Section A (1 item): frequency of teachers' participation in professional development programmes (Table 1).
- Section B (8 items): teachers' perception of the relevance and applicability of professional development to instructional delivery (Tables 2–9).

- Section C (5 items): teachers' perception of the relationship between professional development and pupils' academic performance (Tables 10–14).

Items were scored as follows: Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points, Strongly Disagree (SD) = 1 point.

Content and face validity of the instrument were established through expert review. The draft instrument was reviewed by two lecturers in Measurement and Evaluation, who assessed the items for clarity, relevance to the study objectives, and appropriateness of language. Their observations were used to revise and refine the final version of the instrument.

To establish the internal consistency of the instrument, a pilot test was conducted with a small group of teachers in a public primary school outside the sampled schools. Data from the pilot test were analyzed using Cronbach's alpha, which yielded a reliability coefficient of .84. Since this value exceeds the generally accepted threshold of .70, the instrument was considered reliable for the study.

Copies of the questionnaire were administered directly to the sampled teachers, with instructions provided on completion. Completed questionnaires were retrieved immediately, giving a 100% retrieval rate.

Data were analyzed using frequency counts, simple percentages, mean, and standard deviation. For each item, a criterion mean of 2.50 (the midpoint of the 4-point scale) was used as a benchmark: item means at or above 2.50 were interpreted as indicating agreement, while means below 2.50 would indicate disagreement. As this study used descriptive rather than inferential statistics, no inferential significance level applies to the item-level results reported in Section 3.

Results and Discussion

Results are presented in three parts, corresponding to the three research questions: teachers' participation in professional development (Table 1); teachers' perception of the relevance of professional development to instructional delivery (Tables 2–9); and teachers' perception of the relationship between professional development and pupils' academic performance (Tables 10–14). For each item, frequency, percentage, mean, and standard deviation are reported, followed by a brief discussion.

Research Question 1: To what extent do teachers in public primary schools in Esan Central LGA participate in professional development programmes?

Table 1

Regularly Participate in Professional Development Programmes

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	3	7.5	7.5	7.5
Disagree	5	12.5	12.5	20
Agree	14	35	35	55
Strongly Agree	18	45	45	100
Total	40	100	100	

Mean = 3.17, SD = .93 (criterion mean = 2.50)

The results show that 18 teachers (45.0%) strongly agreed and 14 (35.0%) agreed that they regularly participate in professional development programmes, against 5 (12.5%) who disagreed and 3 (7.5%) who strongly disagreed. With a mean score of 3.17 (SD = .93) against a criterion mean of 2.50, participation in professional development is fairly common among the sampled teachers, though the standard deviation indicates some spread in experience across respondents.

This is broadly consistent with the view that continuous professional learning helps teachers keep pace with pedagogical and curriculum changes (Guskey, 2000). It suggests that most, though not all, teachers in the sampled schools have access to or make use of professional development opportunities, which has implications for how uniformly training-related benefits may be distributed across schools.

Research Question 2: What is teachers' perception of the relevance of professional development to their instructional delivery?

Table 2

Workshops and Seminars Improve my Teaching Skills

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	0	0	0	0
Disagree	0	0	0	0
Agree	13	32.5	32.5	32.5
Strongly Agree	27	67.5	67.5	100
Total	40	100	100	

Mean = 3.67, SD = .47 (criterion mean = 2.50)

All 40 respondents agreed or strongly agreed (Mean = 3.67, SD = .47) that workshops and seminars improve their teaching skills, with no disagreement recorded. The low standard deviation indicates a strong consensus on this item. This finding aligns with Human Capital Theory (Schultz, 1961), which holds that investment in training improves workers' productivity. Teachers appear to regard workshops and seminars as a reliable source of new pedagogical knowledge.

Table 3

Professional development exposes me to modern teaching methods.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	0	0	0	0
Disagree	1	2.5	2.5	2.5
Agree	15	37.5	37.5	40
Strongly Agree	24	60	60	100
Total	40	100	100	

Mean = 3.58, SD = .55 (criterion mean = 2.50)

A large majority (97.5%) agreed or strongly agreed that professional development exposes them to modern teaching methods (Mean = 3.58, SD = 0.55). This suggests that training programmes are, for most respondents, functioning as an important channel for exposure to learner-centred and technology-supported instructional approaches.

Table 4

In-service Training Enhances my Classroom Management Skills

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	1	2.5	2.5	2.5
Disagree	0	0	0	2.5
Agree	11	27.5	27.5	30
Strongly Agree	28	70	70	100
Total	40	100	100	

Mean = 3.65, SD = .62 (criterion mean = 2.50)

The majority of respondents (97.5%) agreed or strongly agreed that in-service training enhances their classroom management skills (Mean = 3.65, SD = .62). Classroom management is widely regarded as a foundation for effective instructional delivery, so this finding points to a perceived benefit of training in an area central to teaching practice.

Table 5

Professional Development has Improved my Lesson Planning.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	0	0	0	0
Disagree	1	2.5	2.5	2.5
Agree	14	35	35	37.5
Strongly Agree	25	62.5	62.5	100
Total	40	100	100	

Mean = 3.60, SD = .55 (criterion mean = 2.50)

97.5% of respondents agreed or strongly agreed that professional development has improved their lesson planning (Mean = 3.60, SD = .55). Since lesson planning provides direction for instruction, this finding is consistent with the broader pattern of perceived improvements across instructional-delivery items.

Table 6

Professional Development Enables me to Use Diverse Teaching Strategies.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	1	2.5	2.5	7.5
Agree	14	35	35	42.5
Strongly Agree	23	57.5	57.5	100
Total	40	100	100	

Mean = 3.45, SD = .78 (criterion mean = 2.50)

92.5% of respondents agreed or strongly agreed that professional development enables them to use diverse teaching strategies (Mean = 3.45, SD = .78), while 7.5% disagreed. This finding is broadly consistent with the case for differentiated instruction, though the comparatively higher standard deviation here suggests more varied experience among teachers on this item than on Items 2–5.

Table 7

I make better use of instructional materials after attending training programmes.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	3	7.5	7.5	7.5
Disagree	0	0	0	7.5
Agree	14	35	35	42.5
Strongly Agree	23	57.5	57.5	100
Total	40	100	100	

Mean = 3.42, SD = .84 (criterion mean = 2.50)

92.5% of respondents agreed or strongly agreed that training improves their use of instructional materials (Mean = 3.42, SD = .84). The 7.5% who strongly disagreed may reflect teachers whose training has not translated into practical changes in how they select or use materials, which could be a useful focus for future training design.

Table 8

Professional development has improved my classroom communication skills.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	0	0	0	0
Disagree	1	2.5	2.5	2.5
Agree	19	47.5	47.5	50
Strongly Agree	20	50	50	100

Total	40	100	100
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Mean = 3.48, SD = .55 (criterion mean = 2.50)

97.5% of respondents agreed or strongly agreed that professional development has improved their classroom communication skills (Mean = 3.48, SD = 0.55), a finding consistent with the broader pattern of positive perceptions across Section B.

Table 9

Training programmes help me assess students more effectively.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	0	0	0	0
Disagree	2	5	5	5
Agree	14	35	35	40
Strongly Agree	24	60	60	100
Total	40	100	100	

Mean = 3.55, SD = .60 (criterion mean = 2.50)

95.0% of respondents agreed or strongly agreed that training programmes help them assess pupils more effectively (Mean = 3.55, SD = 0.60). Taken together, Items 2–9 (Mean range 3.42–3.67) suggest that respondents consistently perceive professional development as beneficial to the practical dimensions of instructional delivery covered in this study.

Research Question: What is teachers' perception of the relationship between professional development and pupils' academic performance?

Table 10

Students perform better academically when teachers participate in professional development programmes.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	2	5	5	10
Agree	19	47.5	47.5	57.5
Strongly Agree	17	42.5	42.5	100
Total	40	100	100	

Mean = 3.27, SD = .78 (criterion mean = 2.50)

90.0% of respondents agreed or strongly agreed that pupils perform better academically when teachers participate in professional development (Mean = 3.27, SD = .78). It is important to note that this and the remaining Section C items measure teachers' perception of a relationship, not an independently verified outcome; no pupil test or examination data were collected in this study.

Table 11

Professional development improves students' understanding of lessons.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	2	5	5	10
Agree	23	57.5	57.5	67.5
Strongly Agree	13	32.5	32.5	100
Total	40	100	100	

Mean = 3.17, SD = .75 (criterion mean = 2.50)

90.0% of respondents agreed or strongly agreed that professional development improves pupils' understanding of lessons (Mean = 3.17, SD = .75). As with Item 10, this reflects teachers' perception rather than a directly measured learning outcome.

Table 12

Students are more engaged in learning when teachers apply skills acquired from training.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	0	0	0	5
Agree	15	37.5	37.5	42.5
Strongly Agree	23	57.5	57.5	100
Total	40	100	100	

Mean = 3.48, SD = .75 (criterion mean = 2.50)

95.0% of respondents agreed or strongly agreed that pupils are more engaged when teachers apply skills gained from training (Mean = 3.48, SD = .75). This is broadly consistent with constructivist accounts of learning, which hold that meaningful learning occurs when learners are actively engaged rather than passive recipients of instruction (Piaget, 1992). Teachers who apply active-learning strategies gained through training may be more likely to create classroom conditions associated with this kind of engagement, though this study did not independently observe classroom engagement.

Table 13

Effective instructional delivery contributes to improved students' achievements.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	2	5	5	10
Agree	20	50	50	60
Strongly Agree	16	40	40	100
Total	40	100	100	

Mean = 3.25, SD = .78 (criterion mean = 2.50)

90.0% of respondents agreed or strongly agreed that effective instructional delivery contributes to improved pupil achievement (Mean = 3.25, SD = .78), reinforcing the view among respondents that instructional quality matters for pupil outcomes.

Table 14

Teacher professional development positively influences student's examination results.

Response	Frequency	Percent	Valid Percent	Cumulative %
Strongly Disagree	2	5	5	5
Disagree	0	0	0	5
Agree	21	52.5	52.5	57.5
Strongly Agree	17	42.5	42.5	100
Total	40	100	100	

Mean = 3.33, SD = .73 (criterion mean = 2.50)

95.0% of respondents agreed or strongly agreed that professional development positively influences pupils' examination results (Mean = 3.33, SD = .73). This is the item most directly linking TPD to a measurable outcome (examination results), and the strength of agreement here underscores why future research using actual examination records, rather than teacher perception alone, would be a valuable next step.

Summary of Findings

Across all 14 items, mean scores ranged from 3.17 to 3.67, all above the criterion mean of 2.50, indicating consistent agreement among the sampled teachers that professional development is relevant to their instructional practice. Agreement was strongest and most consistent on items concerning direct instructional skills (Items 2–9, Section B: means 3.42–3.67), with somewhat more variation on items linking professional development to pupils' academic outcomes (Items 10–14, Section C: means 3.17–3.48). This pattern suggests that teachers are more confident in describing changes in their own practice than in judging its downstream effect on pupils, which is consistent with the self-report nature of Section C and reinforces the need for objective performance data in future research.

These findings are broadly consistent with Human Capital Theory (Schultz, 1961), which frames training as an investment that improves worker productivity, and with Guskey's (2000) model of professional development, in which changes in teacher knowledge and practice are hypothesized to precede changes in pupil outcomes. The comparatively lower and more varied scores on Section C items are consistent with the fact that this study measured teachers' perceptions of pupil outcomes rather than the outcomes themselves.

Conclusion

This study examined teachers' participation in professional development and their perception of its relevance to instructional delivery and pupils' academic performance in public primary schools in Esan Central LGA, Edo State. The findings indicate that most sampled teachers regularly participate in professional development activities and perceive these activities as improving specific aspects of their instructional delivery, including lesson planning, classroom management, communication, and use of instructional materials. Teachers also generally perceived a link between their professional development and pupils' engagement and academic performance, although this study measured perception rather than independently verified outcomes.

The study concludes that, within the limits of a descriptive, self-report design, teachers' professional development is associated with improvements in self-reported instructional practice in this LGA. Continuous retraining of teachers therefore remains an important consideration for education stakeholders, though claims about its causal impact on pupils' actual academic performance would require a study design incorporating objective performance measures.

Recommendations

1. Government, school administrators, and relevant stakeholders should ensure that teachers attend professional development training at regular intervals, with consistent participation monitored across schools.
2. Teachers should be encouraged and supported to apply what they learn in training directly to classroom practice.
3. Incentives should be considered for teachers after training, to support motivation and a sense of value.
4. School-based monitoring teams should periodically observe teachers' application of newly acquired skills and provide timely feedback.
5. Future studies should obtain pupils' actual academic performance data (e.g., term or examination results) from school records to complement teachers' perceptions, and should use a larger sample or a full population census.
6. A similar study could be conducted in other Local Government Areas in Edo State for comparison.

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LEVERAGING BLOCKCHAIN AND BIG DATA FOR TRANSPARENT AND EFFICIENT FINANCIAL REPORTING: EVIDENCE FROM NIGERIAN LISTED FIRMS

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Abstract

This study empirically examined the effects of blockchain adoption readiness and big data analytics capability on the transparency and efficiency of financial reporting among firms listed on the Nigerian Exchange (NGX). The study is anchored on the Technology Acceptance Model and Diffusion of Innovation theory, for explaining the reporting-quality implications of these technologies. An ex post facto research design was adopted, covering 68 non-financial listed firms from 2019 to 2024, resulting in 408 firm-year observations. Primary data were collected through structured questionnaires administered to 312 preparers, auditors and users of financial statements, while secondary data were obtained from audited annual reports and NGX filings. Financial reporting transparency was measured using a disclosure quality index and analyst forecast dispersion, while efficiency was assessed through audit report lag and financial reporting preparation cost. Data were analyzed using descriptive statistics, Pearson correlation, ordinal logistic regression and generalized least squares panel estimation. The findings reveal that blockchain adoption readiness and big data analytics capability significantly improve both financial reporting transparency and efficiency. Big data analytics, however, has a stronger and more mature presence among Nigerian listed firms, while blockchain adoption remains at an early stage. Regulatory and infrastructural readiness significantly strengthens the relationship between technology adoption and financial reporting outcomes. The study contributes firm-level evidence from an emerging economy and integrates technology readiness with measurable reporting outcomes. It recommended clearer blockchain regulation, improved digital and power infrastructure, phased technology investment, and stronger professional capacity development. The study concludes that technological capability and a supportive institutional environment are essential for effective adoption.

Keywords: Blockchain, Big Data Analytics, Efficiency, Financial Reporting, Transparency, Nigerian Exchange, Emerging Markets.

Introduction

The goal of financial reporting is to supply information to the outside world to fill the gap between inside and outside of the company, but the bridge has always been tenuous. The conventional, paper-and-ledger-based reportage systems have proven to be insufficient in high- and low-income economies due to well publicized financial scandals, financial statements restatement and regular audits failures (Dashkevich et al., 2024). All these concerns are compounded by the poor enforcement of regulations, related party manipulation and timeliness and reliability of disclosure in the Nigerian capital market (Achebe et al., 2024). The two technologies that have come to the forefront as possible structural solutions to these chronic issues are: blockchain technology and big data analytics. Another promising technology is the distributed ledger technology (DLT) of blockchain that can be used to record transactions in real time with a decentralized, cryptographically secured and immutable accounting record that would dramatically reduce the scope for manipulating the underlying accounting record (Guo et al., 2022). In contrast, big data analytics offers the computing power to process and integrate large and complex financial and non-financial data, and to use it to provide more timely, continuous and risk-based financial reporting and assurance (Rane et al., 2023). When

taken together, blockchain as the trusted data substrate and big data analytics as the interpretive and predictive substrate, the two together constitute a possible paradigm shift for a financial reporting infrastructure (Ahmed, 2025).

The National Information Technology Development Agency (NITDA) officially launched the National Blockchain Policy in May 2023 and in August 2024, the Central Bank of Nigeria (CBN), through the Nigeria Inter-Bank Settlement System (NISS), established a pioneering partnership with a provider of blockchain network services to power the country with real-time, decentralized settlement infrastructure (Chambers & Partners, 2025). The developments represent the growing institution appetite for the use of distributed ledgers in the financial sector in Nigeria. This appetite, however, is yet to be manifested in the transparency and efficiency of the financial reporting process of listed companies in Nigeria as evidenced by the fact that it remains largely unanswered in the Nigerian accounting literature. Currently, the literature is limited in both scope and type, with most focused on conceptual aspects, developed economies, and/or cryptocurrency accounting and auditing, but not on corporate disclosure practices in general (Sheela et al., 2023; Pimentel & Boulianne, 2020). This paper addresses this gap, by empirically examining the influence of these blockchain and big data technologies on transparency and efficiency in the financial reporting of firms listed on the Nigerian Exchange, both with regard to preparedness/adoption and institutional constraints affecting technology diffusion in the emerging market. This study aims generally to analyze the influence of blockchain and big data technologies on the transparency and efficiency of financial reporting of listed companies in Nigeria.

Statement of the Problem

The credibility of corporate financial reporting in Nigeria is an on-going issue despite decades of regulatory changes. Timely filing, restated accounts and controversial audit opinions remain current concerns of listed companies, while stakeholders frequently doubted the sufficiency of existing non-failover, centralized reporting systems to ensure the reliability of information disclosed (Achebe et al., 2024). Conventional financial reporting systems are significantly reliant on manual processes, sequential checks and a central repository of financial reports, all of which allow for opportunities to manipulate data, slow down reporting and introduce human error, increasing the cost of audit assurance.

The global literature is replete with significant contributions that advance the promise of blockchain as a structural solution to these challenges, leveraging its ability to create an immutable and decentralized ledger, and its integration with big data technologies which provide real-time analytical capability, all of which could significantly reduce information asymmetry and shorten reporting timelines (Ahmed, 2025; Dashkevich et al., 2024). It is important, however, to note that there are three issues that restrict the definite extrapolation of this promise to the Nigeria context. First, much of the empirical evidence on which these assertions are based comes from the developed world where the markets are well established and digital infrastructure is well-developed; it remains uncertain whether similar benefits can be realized in settings with significantly different infrastructure and regulations. Second, past Nigerian research on blockchain adoption has largely focused on the cryptocurrency, financial inclusion, and payment systems (Adebayo et al., 2024; RSIS International, 2024) instead of mainstream financial reporting practice by listed firms. Third, it is not quite sure from the empirical evidence whether the real problem with achieving transparency and efficiency in Nigeria is the technology itself, or its environment – the regulatory and infrastructure framework in which it must function.

Against this background, this study empirically examines the relationship between the use of blockchain and big data technology and their influence on transparency and efficiency of financial reporting amongst listed companies in Nigeria and the conditions of institutions that moderate the relationship.

Review of Related Literature

Conceptual Review

The conceptual review explains the main concepts underlying the study and shows how blockchain technology, big data analytics, financial reporting transparency, financial reporting efficiency, and the wider regulatory and infrastructural environment are connected. These concepts are considered within the context of firms listed on the Nigerian Exchange (NGX), where the quality and timeliness of financial information are important to investors, regulators and other stakeholders.

Blockchain Technology and Financial Reporting

Blockchain is a distributed digital ledger that records transactions across a network using cryptographic security and time-stamping. Unlike traditional accounting systems that rely on centralized databases and periodic reconciliation, blockchain allows authorized participants to access a shared and verifiable record of transactions. Its importance to financial reporting lies mainly in its ability to strengthen data integrity, traceability and auditability. Because validated records are difficult to alter, blockchain can reduce the risk of manipulation and provide a reliable audit trail. Studies have shown that blockchain can support real-time validation, secure accounting records and automated financial reporting (Bhandari et al., 2025; Achebe et al., 2024; Atadoga et al., 2024; Dashkevich et al., 2024). This study focuses on blockchain adoption readiness, rather than full implementation. The concept refers to the extent to which listed firms have the technological, organizational and institutional capacity needed to introduce blockchain into their financial reporting systems.

Big Data Analytics and Financial Reporting

Big data analytics involves the use of advanced technologies to collect, process and analyze large volumes of structured and unstructured information. In financial reporting, it supports faster analysis, anomaly detection, forecasting and improved decision-making. Its importance has increased as business transactions and financial information have become more complex. Big data analytics can help firms identify unusual transactions, detect errors and produce financial information more quickly. Rane et al. (2023) emphasized its growing value in accounting and finance because of its ability to handle complex datasets and support better decisions.

Blockchain and big data analytics can also complement each other. Blockchain provides secure and traceable transaction records, while big data analytics helps organizations analyse those records for reporting and decision-making. Their integration has been associated with improvements in transparency, fraud detection, traceability and reporting efficiency (Ahmed, 2025; Rahman et al., 2025).

Financial Reporting Transparency

Financial reporting transparency refers to the extent to which financial information is complete, reliable, clear and timely enough to support informed decisions by investors, creditors, regulators and other stakeholders. Transparent reporting helps reduce information asymmetry and strengthens confidence in corporate disclosures. Digital technologies can contribute to transparency by improving the accuracy, accessibility and timeliness of financial information. In this study, transparency is measured using outcomes such as the disclosure quality index and analyst forecast dispersion. These measures help determine whether greater blockchain readiness and stronger big data analytics capability are associated with better financial reporting transparency.

Financial Reporting Efficiency

Financial reporting efficiency refers to an organization's ability to produce reliable financial information within the required time and at reasonable cost. An efficient reporting system reduces unnecessary manual work, reconciliation problems, delays and processing costs without compromising reporting quality. Traditional reporting processes often involve extensive manual verification and reconciliation, which can increase both time and cost. Blockchain and big data

analytics can help automate selected activities, improve access to information and accelerate verification and analysis. Evidence indicates that blockchain can support automated financial statement preparation and real-time validation, while its combination with big data analytics can improve reporting efficiency (Ahmed, 2025; Dashkevich et al., 2024). For this study, financial reporting efficiency is assessed using audit report lag and the cost of financial statement preparation. Lower delays and reduced processing costs indicate greater reporting efficiency.

Regulatory and Infrastructural Readiness

The adoption of emerging technologies depends not only on the willingness of firms but also on the environment in which they operate. Clear regulations, reliable electricity, adequate digital infrastructure, internet connectivity, cybersecurity and access to technical expertise are important for successful technology adoption. Nigeria has taken steps towards digital transformation and blockchain development, including the National Blockchain Policy. However, policy development alone is insufficient. Firms also need clear implementation guidelines, appropriate technical standards, reliable infrastructure and adequate professional expertise. In this study, regulatory and infrastructural readiness serves as a moderating condition. It is expected that blockchain and big data analytics will produce stronger improvements in financial reporting where firms operate within a supportive regulatory and infrastructural environment. Thus, the effectiveness of these technologies depends not only on their availability but also on the institutional and technological conditions surrounding their adoption.

Theoretical Review

The theoretical review explains why organizations adopt emerging technologies and why adoption differs across firms. The study is mainly anchored on the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) theory. TAM explains technology acceptance based on perceived usefulness and ease of use, while DOI explains how innovations spread and the factors that influence their adoption. Together, they provide a basis for understanding blockchain and big data analytics adoption among Nigerian listed firms and their effects on financial reporting.

Technology Acceptance Model (TAM)

The Technology Acceptance Model, developed by Davis (1989), explained technology acceptance through two main factors: perceived usefulness and perceived ease of use. Perceived usefulness concerns the belief that a technology can improve performance, while perceived ease of use relates to how simple it is to learn and operate. When users consider a technology useful and manageable, they are more likely to accept and use it. TAM has also been applied to organizational technology adoption, particularly where professionals assess the benefits and practical challenges of new technologies (Alshamsi et al., 2024). TAM is relevant because the adoption of blockchain and big data analytics depends partly on whether financial reporting professionals consider them useful and practical. Blockchain may be accepted where it improves data integrity, traceability, auditability and reporting timeliness, while big data analytics may be valued for improving data processing, anomaly detection, forecasting and decision-making. The model also explains why implementation difficulties may discourage adoption. High costs, inadequate infrastructure, limited technical expertise and difficulties integrating new technologies with existing systems can reduce users' willingness to adopt them.

Diffusion of Innovation (DOI) Theory

Diffusion of Innovation theory, developed by Rogers (2003) explained how new technologies and practices spread within organizations and social systems. It identifies five characteristics that influence adoption: relative advantage, compatibility, complexity, trialability and observability. Innovations are more likely to spread when they provide clear benefits, fit existing systems, are not overly difficult to use, can be tested before full adoption and produce visible results. DOI is relevant

because blockchain and big data analytics have different levels of adoption among Nigerian listed firms. Relative advantage explains the willingness to adopt technologies that improve reporting quality, data integrity, transparency and processing speed. Big data analytics may have spread faster because its applications are already more familiar and compatible with existing digital systems. Compatibility is particularly important in Nigeria because successful adoption depends on the ability of new technologies to fit existing accounting systems, audit practices and regulatory requirements. Complexity may slow blockchain adoption because of its technical requirements and the shortage of specialized expertise. Trialability allows firms to test blockchain applications before committing substantial resources, while observability enables other firms to learn from visible successful applications. DOI therefore explains why big data analytics appears more developed than blockchain. Big data analytics has more visible benefits and greater compatibility with existing systems, whereas blockchain adoption remains constrained by regulatory uncertainty, infrastructure limitations and technical complexity.

Theoretical Implication for the Study

TAM and DOI complement each other in explaining the study's findings. TAM focuses on the willingness of organizational users to accept technologies based on their usefulness and ease of use, while DOI explains how the characteristics of the technologies and the surrounding environment influence their spread. Together, the theories support the view that blockchain adoption readiness and big data analytics capability can improve financial reporting transparency and efficiency, but the extent of these benefits depends on users' acceptance, perceived advantages, compatibility, complexity and the availability of adequate regulatory and infrastructural support. They therefore provide a strong theoretical foundation for explaining technology adoption and its effects on financial reporting among Nigerian listed firms.

Empirical Review

Dashkevich, et al. (2024) explored the integration of blockchain into financial reporting, creating and testing a Blockchain Financial Statements (BFS) system that enhances transparency, accounting precision, and liquidity management in financial statements. The researchers used Design Science Research Methodology (DSRM) and Domain-Driven Design (DDD) to design, develop and validate a prototype of the accounting system using BlockChain. The results showed Blockchain Financial Statements system could integrate blockchain technology into financial statements effectively and create a real-time validation system, an immutable financial record and an automatic financial statement generation system, thereby ensuring tamper-proof financial records. The prototype greatly increased transparency, accuracy, traceability and reliability of financial reporting and minimized the potential for accounting fraud and financial misrepresentation. This study by Dashkevich et al. (2024) is closely aligned to the current research as it validates blockchain technology's potential to improve transparency and efficiency in financial reporting by maintaining an immutable ledger, real-time validation, and automated financial statement preparation. Their research focused on the design science approach to validate a blockchain accounting prototype while the current study is an empirical study of the impact of blockchain and big data technologies on financial reporting transparency and efficiency of listed firms on the Nigerian Exchange (NGX). Therefore, the current study builds on the prototype-based evidence provided by Dashkevich et al., and provides organizational-level evidence in an emerging economy.

Ahmed (2025) explored the implications of the convergence of blockchain technology and big data analytics for financial transparency, the quality of financial reporting, and fraud detection in financial systems. The study was not a primary empirical study, but used a systematic literature review design. Secondary data were gathered from 50 scholarly publications related to blockchain technology, big data analytics, financial reporting, financial auditing, financial fraud, and financial regulation. Thematic analysis was performed to draw conclusions about the role of blockchain and big data in increasing the transparency of financial services from the reviewed studies. Overall, the study found that the combination of blockchain technology and big data analytics has the potential to

revolutionize financial reporting, with benefits in terms of increased transparency, accountability, fraud detection, and reporting efficiency. Ahmed's (2025) study is pertinent to the research study conducted in this paper as it offers both theoretical and synthesized empirical findings that the application of blockchain technology and big data analytics would improve the transparency of financial reporting, operational efficiency, fraud detection and regulatory compliance. The present study, however, uses empirical research design to examine the effect of blockchain and big data technologies on the transparency and efficiency of financial reporting among firms listed on the Nigerian Exchange (NGX), different from Ahmed (2025) whose study was based on the systematic review of the previous works. The current study, therefore, contributes to the existing literature on digital transformation in corporate financial reporting with empirical evidence from the firm level in an emerging economy, which extends the scope of Ahmed's work.

Rahman et al. (2025) explored the potential of using big data analytics and blockchain technology to improve transparency, operational efficiency, and trust in supply chain finance (SCF), with a specific focus on international digital trade. This study used a conceptual and evidence-synthesis method that leveraged previous empirical and industry data on blockchain-enabled supply chain finance and big data analytics. The results showed that the combination of blockchain and big data analytics can greatly improve the transparency of supply chain finance by ensuring that transactions are recorded in an immutable manner, enabling information to be shared in real-time, and minimizing information-based asymmetries between the trading partners. Overall, the authors found that blockchain and big data integration is a game-changing technology solution in the modern supply chain finance field because it enhances transparency, accountability, operational efficiency and trust among the actors of the supply chain. There is a need for increased cooperation between governments, financial institutions, technology providers and international regulators to encourage the broader application of these technologies and the development of common global rules for digital trade and supply chain finance, they said. The study is significant to the current study due to its findings that blockchain technology and big data analytics can enhance the transparency, information quality, operational efficiency, and accountability of financial transactions while ensuring information is processed in a secure and real-time manner. The study spanned out into the fields of supply chain finance and international digital trade, but the results also offer learnings for the use of blockchain and big data in improving transparency and efficiency in financial information systems in general. This is because the present study builds on this stream of research by empirically looking at the effect of blockchain and big data technologies on the transparency and efficiency of financial reporting in the Nigerian Exchange (NGX) corporate financial reporting environment, which helps to provide evidence from the corporate financial reporting environment of an emerging economy.

Achebe et al. (2024) explored the use of blockchain technology to bolster data integrity and improve legal accountability as a means of improving corporate fraud risk management. Systematic literature review was used in the study according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The results showed that blockchain technology significantly improves data integrity, as it provides a secure and transparent solution that ensures that corporate data cannot be altered or manipulated. Consequently, the study identified blockchain technology as a potential solution to enable a more comprehensive and transformative strategy to tackle corporate fraud risk management, which enhances data integrity, transparency, legal accountability and regulatory compliance. The study is of particular interest for the present research as it illustrates how blockchain can contribute to the improvement of the data integrity, transparency and auditability, which are basic pillars of good financial reporting and are of crucial importance for the financial reporting process. The approach adopted by Achebe et al. (2024) in the systematic review of existing literature to explore how blockchain technology can be used as a tool for corporate fraud risk management is insightful and informative but the present study takes a new approach by focusing on empirical studies to examine how blockchain technology and big data analytics improves transparency and efficiency in financial reporting among firms listed on the Nigerian Exchange (NGX). Therefore, the present study adds an empirical contribution from the organizational perspective to the conceptual and review based findings of Achebe et al. (2024) in the emerging economy.

This study by Bhandari et al. (2025) presents a systematic review of current literature to assess the use of blockchain in increasing transparency and accountability in sustainable finance. The study was conducted using a Systematic Literature Review (SLR) with bibliometric analysis based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. PICO (Population, Interest, and Context) approach was used to develop research questions. The search terms were predefined for the blockchain, sustainable finance, transparency, and accountability. These terms were used in Google Scholar, Springer Link, and Dimensions databases to collect data. We identified an initial 1,026 publications from 2018 to 2023, which were screened and further narrowed down using predefined inclusion and exclusion criteria and the PRISMA process. After the assessment for eligibility, 78 articles selected through the peer-review process were retained for the final synthesis and bibliometric analysis. The results showed that blockchain technology significantly contributes to the transparency and accountability of sustainable finance, through the capability of creating an immutable record of transactions, traceability, real-time verification of financial transactions and a bolstering of stakeholder trust. Overall, the authors found that blockchain technology shows great promise in shaping the future of sustainable finance, offering enhanced transparency, accountability, stakeholder trust, and sustainability reporting reliability. The study is relevant for the present research as it illustrates how blockchain technology can improve transparency, accountability, data integrity and credibility of financial disclosures by providing a secure and immutable record. The study concentrated on the topic of sustainable finance and used a systematic literature review methodology; however, the results offer robust theoretical and synthesized empirical evidence for the use of blockchain for enhancing financial reporting quality. This study builds on this body of knowledge by empirically examining the simultaneous role of blockchain technology and big data analytics on financial reporting transparency and efficiency of the firms listed on the Nigerian Exchange (NGX). The present study, therefore, provides an emerging economy's organization-level evidence supplementing the findings from a review by Bhandari et al. (2025).

In their study, Atadoga et al. (2024) explored the transformative potential of blockchain technology in the accounting profession, focusing on how it can enhance transparency, efficiency, security, and trust in financial reporting. The study aimed to close this gap between theory and practice by exploring the potential and challenges of blockchain in accounting systems. A qualitative thematic analysis approach was used in studying and summarizing the previous studies on blockchain applications in accounting. Themes emerged and were discussed regarding transparency, audit quality, security, regulatory issues, implementation challenges and future prospects. According to the study, Blockchain offers a means of an accounting record that cannot be altered or faked, giving more transparency and decreasing the opportunities for financial manipulation. Based on this, the authors found that blockchain has great promise in transforming accounting practice through enhancement of transparency, accountability, security, and operation efficiency. The study is especially significant for this paper because it offers proof of the benefits of blockchain in improving the transparency, reliability and efficiency of accounting information.

Comparing the literature reviewed shows that there are three major gaps that are being filled by this study. First, there is a contextual difference: Most empirical research on blockchain-big data integration and financial reporting quality is from developed economies, or Nigerian studies focused on financial inclusion and payments, not listed-firm disclosure practice (RSIS International, 2024). Second, there is a lack of methodological sophistication, as many of the existing studies on Nigeria focus at the conceptual, doctrinal (legal), or qualitative level (Academia.edu Legal Review, 2025; Achebe et al., 2024) and few of these studies utilize transparent and efficient proxies of increased level of transparency and efficiency, such as disclosure indices, dispersion of analyst forecast and audit report lag, at the firm level. Third, there is a theoretical-integration gap, since studies make use either of adoption theories (TAM, DOI) or of agency-based reporting-quality theories, but do not integrate adoption readiness and reporting-quality outcomes in one empirical model, while including institutional moderators like regulatory ambiguity and infrastructural deficits. This study is aimed at filling these three gaps by integrating both primary survey evidence on readiness of blockchain and secondary financial reporting data from the listed companies in Nigeria analyzed.

Conceptual Framework

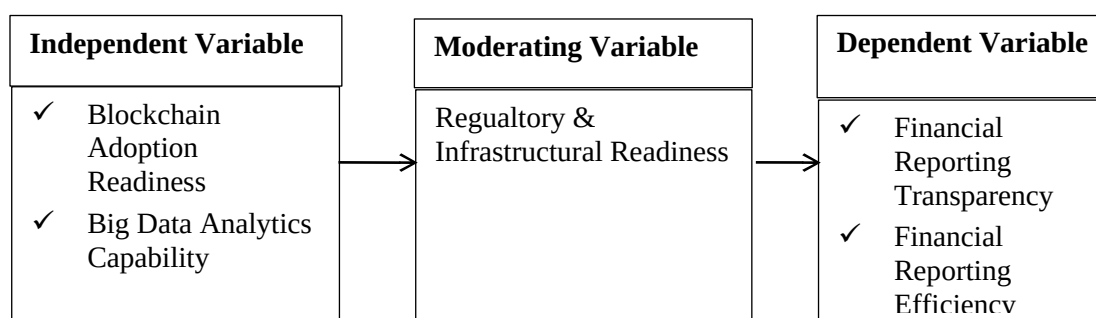


Figure 1: Conceptual Model

Methods

The study is of an ex post facto correlational design with both primary survey and secondary archival data as is done in previous studies of the technology-reporting relationship that involve both perceptual (readiness) measures and outcome (reporting quality) measures. The population consists of all the 155 non-financial firms that are listed on the Nigerian Exchange (NGX), up to December 2025. A sample of 68 firms was selected using Taro Yamane's formula with a 5% margin of error, stratified by 11 sectors to obtain 408 firm-year observations for the 2019-2024 time period (6 years). A purposive sampling technique was adopted to obtain a sample of 312 respondents comprising finance/accounts personnel, internal and external auditors and financial analysts associated with the sampled firms who had technical knowledge in financial reporting processes for the primary survey component. The primary data collection employed a structured five-point Likert scale questionnaire consisting of three constructs: Blockchain Adoption Readiness (eight items), Big Data Analytics Capability (eight items) and Regulatory/Infrastructural Readiness (six items) that were adapted from validated TAM and DOI based questionnaires used in previous studies on blockchain adoption (Alshamsi et al., 2024). Secondary data for this period (2019-2024) was obtained from annual reports which were audited, as well as NGX corporate filings to build a Disclosure Quality Index, and to calculate analyst forecast dispersion, audit report lag and audit reporting cost proxies.

Model Specification

To capture the ordinal nature of the transparency and efficiency outcome measures, the study specifies the following ordinal logistic regression models:

$$FRT_{it} = \beta_0 + \beta_1 BCAR_{it} + \beta_2 BDAC_{it} + \beta_3 RIR_{it} + \beta_4 (BCAR \times RIR)_{it} + \beta_5 FSIZE_{it} + \beta_6 LEV_{it} + \epsilon_{it} \dots \text{(Model 1)}$$

$$FREFF_{it} = \beta_0 + \beta_1 BCAR_{it} + \beta_2 BDAC_{it} + \beta_3 RIR_{it} + \beta_4 (BDAC \times RIR)_{it} + \beta_5 FSIZE_{it} + \beta_6 AGE_{it} + \epsilon_{it} \dots \text{(Model 2)}$$

Where: FRT = Financial Reporting Transparency (Disclosure Quality Index); FREFF = Financial Reporting Efficiency (inverse of audit report lag, standardised); BCAR = Blockchain Adoption Readiness; BDAC = Big Data Analytics Capability; RIR = Regulatory/Infrastructural Readiness; FSIZE = Firm Size (log of total assets); LEV = Leverage; AGE = Firm Age; ϵ = error term.

Data Analysis Technique

Descriptive statistics (mean, standard deviation), preliminary association tests (Pearson correlation) and hypothesis tests (ordinal logistic regression) were applied to the data due to the ordinal-categorical nature of the composite transparency and efficiency indices. A generalized least squares (GLS) panel regression was estimated as a robustness check using the continuous audit-report-lag and reporting-cost proxies. To check the instrument reliability, Cronbach's Alpha was

calculated and to test for multicollinearity of the explanatory variables variance inflating factor (VIF) was calculated. The data was analyzed in STATA 17 and SPSS 27.

Data Analysis and Findings

Descriptive Statistics and Instrument Reliability

A total of 312 questionnaires were sent and 289 were retrieved and validly completed (92.6% return). The internal consistency of the three constructs was acceptable, with Cronbach's Alpha values ranging from .79 to .88, which is higher than the recommended .70. The results showed that the mean Blockchain Adoption Readiness score was 2.86 (SD = .94) on a five-point scale, indicating that respondents think their firms are at an early-to-moderate level of readiness for blockchain. The mean value of the Big Data Analytics Capability score was significantly higher at 3.52 (SD = .81), suggesting relatively more advanced adoption of traditional big data and business intelligence.

Correlation Analysis

The results of the Pearson correlation show a positive correlation with the Disclosure Quality Index and Blockchain Adoption Readiness ($r = .41, p < .01$) and a positive correlation and Disclosure Quality Index and Big Data Analytics Capability ($r = .53, p < .01$). The technology constructs were also negatively and significantly correlated with audit report lag ($r = -.38$ and $r = -.46$ respectively, $p < .01$), which means that the higher the technology readiness, the quicker and more efficient the reporting process will be. The values of all the explanatory variables in the model were less than 3.0 and hence no significant multicollinearity problem was observed.

Regression Results

Variable	Coefficient (Model 1: FRT)	Coefficient (Model 2: FREFF)	z-statistic	p-value
Blockchain Adoption Readiness (BCAR)	0.362	0.298	3.14 / 2.87	0.002 / 0.004
Big Data Analytics Capability (BDAC)	0.487	0.415	4.02 / 3.68	0.000 / 0.000
Regulatory/Infrastructural Readiness (RIR)	0.221	0.194	2.41 / 2.19	0.016 / 0.028
BCAR $\times$ RIR (interaction)	0.176	0.143	2.05 / 1.98	0.040 / 0.048
Firm Size (log assets)	0.129	0.087	1.88 / 1.34	0.060 / 0.180
Pseudo R ² / Wald χ^2	0.284	0.251	—	0.000

The results of the ordinal logistic regression above showed that Blockchain Adoption Readiness ($\beta = .362, p = .002$) and Big Data Analytics Capability ($\beta = .487, p = 0.000$) have a positive and statistically significant impact on financial reporting transparency. Likewise, both constructs have positive and significant influence on financial reporting efficiency ($\beta = 0.298, p = 0.004$ for BCAR; $\beta = 0.415, p = 0.000$ for BDAC). The moderating effect of blockchain's impact on reporting transparency can be understood from the significant positive coefficient of the moderator (BCAR $\times$ RIR), which suggests that the effect of blockchain will be stronger when the regulatory and infrastructural readiness is higher. The results for the GLS panel robustness check were also directionally consistent and statistically significant, with audit report lag and reporting cost as continuous outcome measures, which lent credence to the ordinal logistic regression results.

Discussion of Findings

The results align with the descriptive evidence that big data tools are more mature and more widely deployed in Nigeria's reporting processes than blockchain; where transparency and efficiency are concerned, Big Data Analytics Capability also has a higher impact. This aligns with Pimentel and

Boulianne (2020) who noted that accounting-sector blockchain research and application have yet to reach a mature stage in the world, and in agreement with Mariblock's (2025) elaboration that Nigeria's blockchain policy architecture is progressive but has not yet been accompanied by infrastructural depth. Surprisingly, the positive effect of blockchain readiness still validates the theoretical prediction from Agency Theory that immutable and decentralised record-keeping has a significant negative impact on managerial discretion and increases the credibility of reported information, as in the studies of Achebe et al. (2024) and Dashkevich et al. (2024). This significant moderating influence is consistent with the Diffusion of Innovation Theory's assertion that an innovation's observable relative advantage is only realised when the surrounding environment is compatible with the innovation's adoption (Rogers, 2003) and the CBN-NIBSS blockchain payment infrastructure partnership, as such relationships are between policy and practice (Chambers and Partners, 2025).

Recommendations

(i) Specific technical guidance to reduce implementation ambiguity between preparers and auditors on the recognition, verification and disclosure treatment of blockchain-recorded transactions should be developed by the Financial Reporting Council of Nigeria in collaboration with the Securities and Exchange Commission.

(ii) The Central Bank of Nigeria and NITDA should adopt the infrastructural investment model that has been showcased by the NIBSS-blockchain payment partnership to the rest of the corporate reporting ecosystem, especially the power and connectivity infrastructure needed to run real-time ledger operations.

(iii) Companies in the listed category should focus on investments in big data analytics in a phased manner because it has proven to be more effective for reporting transparency and efficiency in the short term, and preparation for deeper integration of blockchain in the long term.

(iv) The technical capacity gap observed in this study should be addressed by introducing blockchain and big data analytics skills in the continuing professional education curriculum of Professional bodies, such as ICAN and ANAN.

(v) The moderating role of regulatory-infrastructural factors that was identified in this study should be explicitly considered as a policy track and not kept separate from technology promotion.

Conclusion

This study aimed at empirically investigate the influence of blockchain and big data technology on the transparency and efficiency of financial reporting of listed companies in Nigeria. The study concludes that both technologies have real and statistically proven ability to improve financial reporting quality, but that these technologies have not yet achieved full realization of that potential due to primarily regulatory uncertainty and infrastructural shortcomings rather than inherent limitations of the technologies themselves. Big data analytics has comparatively deeper penetration in the existing reporting and assurance process in the Nigerian listed firms, whereas blockchain is still at an exploratory stage of adoption. The extent of the moderating effect of regulatory and infrastructural readiness further strengthens the findings that Nigeria's achievements in the journey of transitioning into a technology-enabled financial reporting system will rely heavily on concerted institutional actions as well as technology investments at the firm level.

Implications and Limitations of the Study

The study shows that blockchain adoption readiness and big data analytics capability can significantly improve the transparency and efficiency of financial reporting among firms listed on the Nigerian Exchange. However, the benefits of blockchain are stronger where there is adequate regulatory support and infrastructure. The findings imply that companies should invest in digital skills, data analytics and systems while gradually preparing for wider blockchain adoption. Regulators, policymakers and professional bodies must also provide clear guidelines, reliable infrastructure and relevant professional training to support technology-driven financial reporting. The

study is limited by its focus on non-financial listed firms, the 2019–2024 study period, the use of questionnaire responses and the relatively early stage of blockchain adoption in Nigeria. Other organizational and governance factors may also influence financial reporting outcomes.

Contributions of the Study

Despite these limitations, the study makes important empirical, methodological, theoretical and practical contributions. It provides evidence from Nigerian listed firms, combines survey and archival data, integrates the Technology Acceptance Model, Diffusion of Innovation Theory and Agency Theory, and demonstrates that technology alone is insufficient. Effective digital transformation in financial reporting requires supportive regulation, infrastructure, institutional coordination and professional capacity.

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OPTIMIZING SCHOOL FACILITIES AND INFRASTRUCTURE THROUGH ARTIFICIAL INTELLIGENCE IN PUBLIC SECONDARY SCHOOLS IN EDO SOUTH SENATORIAL DISTRICT

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Abstract

The study was conducted to ascertain the extent to which AI applications are utilized in managing school facilities and infrastructure in public secondary schools in Edo South Senatorial District using descriptive survey research design. Six research questions were raised to guide the study. The population of the study comprise 148 public secondary school principals in the seven local government areas that make up Edo South Senatorial District. A stratified random sampling technique was used to select 74 principals who formed the sample of the study. Data was collected using a structured questionnaire titled Optimizing School Facilities and Infrastructure Through Artificial Intelligence (OSFITAI). The instrument had an r-co-efficient of .974. Data were analyzed using descriptive statistics such as Mean Score, and Standard Deviation while Pearson r was used to analyze hypotheses at .05 alpha level of significance. The mean score was used to determine the extent to which AI applications are utilized in managing school facilities and infrastructure. Pearson r value of .48 is greater than the alpha level of .05 indicating a moderate positive relationship between AI utilization and efficient utilization of school facilities. Findings of the study revealed that AI applications are not yet widely utilized in the management of school facilities and infrastructure in public secondary schools in Edo South Senatorial District. The study recommended that government and stake holders in education should increase budgetary allocation to enable the provision of AI tools to public secondary schools.

Keywords: Artificial Intelligence, Facilities, Optimizing.

Introduction

Facilities in the school, are designed to accommodate staff and upgrade their profitability in the instructing learning process. They assist learners to learn faster and effortlessly, play a pivotal role in the actualization of the national education goals as stipulated in the national policy on education, Federal Republic of Nigeria (FRN) (2013), and ensure the actualization of curriculum goals and objectives. The successful implementation of educational programme depends largely on the quality of school facilities provided for such programme. No effective education programme can exist where facilities and infrastructures are poorly managed. King and Nart (2016) stated that school facilities are costly investments in education by the society and take a lot of time, material resources and efforts to put them in place. Therefore, maintaining these facilities will protect investments. Maintenance of school facilities and infrastructure protect their educational value in terms of appearance, usefulness, and the learning atmosphere they create. Caine and Caine (2016) noted that school heads are saddled with the responsibility of keeping school facilities and infrastructure in good condition. The general

condition of facilities in the school are the striking basis upon which many parents and friends of any educational institution make judgement about the quality of activities that goes on in the school.

Facilities and infrastructure required to enhance educational activities in today's world are quite advanced in comparison to what was in use in the immediate past as noted by Atkin and Bildsten (2017) hence, relying on the intelligence of the school head alone to ensure that facilities and infrastructure are fully utilized to achieve educational goals and objectives has become impossible. The introduction of Artificial Intelligence (AI) to assist in the onerous task of ensuring that available resources are put to efficient use has become imperative. AI is assisting educational managers by providing an improved method of planning, organizing, coordinating, and utilizing existing facilities and infrastructure to meet educational demands of students. According to Abdelalim et al. (2025), AI enables school administrators make data-driven decisions, reduce operational costs, enhance safety, and create a more conducive learning environment. With the assistance of AI school administrators are equipped with accurate information on the lifespan of existing facilities and infrastructure and therefore are able to prepare an effective maintenance plan that can elongate the lifespan of facilities and infrastructure in the school. In today's world the benefit of AI in optimizing facilities and infrastructure in the school are considered immeasurable, however, a third world country like Nigeria, may not be able to fully utilize AI to its full potential because most amenities needed for its optimal utilization may not be readily available.

The study is anchored on the Technology Acceptance Model (TAM) propounded by Fred Davies (1989). The theory examines the willingness of school administrators and staff to adopt AI systems in managing school facilities and infrastructure. The theory focuses on perceived usefulness and perceived ease of use. A school premises with dilapidated facilities and infrastructure transmits to people the message that the school premises lack informal social control, and so is unable or unwilling to defend itself against an external invasion. The inclusion of AI systems into facilities and infrastructure management reduces pressure on the school administrator, a successful strategy for effective management of existing school facilities and infrastructure is to carry-out predictive maintenance on the facility to address the problem when they are small. This is possible with the assistance of AI system to provide adequate and timely information on existing facilities (Masud et al., 2025; Tan, 2023; Mobayo et al., 2021). This theory is relevant to this study because it x-rays the importance of technology in the management of school facilities and infrastructures.

Statement of the Problem

Facilities in the school are the major determinant of the quality of the teaching-learning process. School facilities such as classrooms, laboratories, libraries, Information and Communication Technology (ICT) centre, and other infrastructures constitute essential resources for achieving educational objectives. However, many public secondary schools in Edo South Senatorial District are continuously faced with problems of poor maintenance of facilities, inefficient utilization of available facilities, poor infrastructure planning, escalating maintenance costs, and ineffective resource allocation. These shortcomings often result in overcrowded classrooms, deteriorating physical structures, under-utilization of available facilities, and an in-conducive learning environment.

Artificial Intelligence (AI) has proven to be innovative in solving problems relating to data collection, automated monitoring, and space management. AI applications have the potential to improve the utilization, maintenance, and sustainability of school facilities and infrastructure (Saba et al., 2020). However, the extent to which educational institutions have leveraged these AI applications for optimizing school facilities and infrastructure remains uncertain. Furthermore, there is limited empirical evidence on the effectiveness of AI in addressing existing infrastructural management challenges in schools, particularly in developing countries. It is against this background that this study seeks to examine the optimization of school facilities and infrastructure through Artificial Intelligence with a view to determining the potentials of AI applications in enhancing efficiency, improving infrastructure management practices, and promoting effective educational administration.

Objectives of the Study

The study sought to achieve the following objectives:

1. Examine the extent to which AI applications are utilized in managing school facilities and infrastructure in public secondary schools in Edo South Senatorial District.
2. Determine the influence of AI applications on the efficient utilization of school facilities in public secondary schools in Edo South Senatorial District.
3. Investigate the role of AI in predictive maintenance of school infrastructure in public secondary schools in Edo South Senatorial District.
4. Examine the influence of AI on resource allocation and infrastructure planning in public secondary schools in Edo South Senatorial District.
5. Determine the challenges associated with the adoption of AI for school facilities and infrastructure management in public secondary schools in Edo South Senatorial District.
6. Suggest strategies for enhancing the effective utilization of AI in optimizing school facilities and infrastructure management in public secondary schools in Edo South Senatorial District.

Methods

The descriptive survey research design was adopted for this study. This design was considered appropriate for this study, because it involves the collection and analysis of data using a sample size representative of the entire population. The population of the study comprised all 148 public secondary school principals in Edo South Senatorial District. The sample size of the study is 74 public secondary school principals' which represent 50% of the total population. The names of all the public secondary schools in Edo South Senatorial District was written on pieces of paper and squeezed. A stratified random sampling technique was adopted in selecting the number of sampled public secondary schools in the district. A questionnaire titled Optimizing School Facilities and Infrastructure Through Artificial Intelligence (OSFITAI) was used to collect data for the study. The questionnaire was validated by two professors in the Department of Educational Management, Faculty of Education, University of Benin. Their suggestions were used to modify the questions before the final questionnaire was produced and administered to respondents. The questionnaire constituted a four-point scale to measure the extent of AI application to facilities and infrastructure management in schools. The options in the scale are: Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points, Strongly Disagree (SD) = 1 point. Data collected were analyzed using descriptive statistics such as mean score and standard deviation, while Pearson r was used to analyze hypothesis at .05 alpha level of significance. A criterion mean of 2.50 was used to determine the extent of AI application to school facilities and infrastructure management.

Results

Research Question 1: To what extent are AI applications utilized in the management of school facilities and infrastructure in public secondary schools in Edo South Senatorial District?

Table 1

Mean and Standard Deviation on the Utilization of AI Applications in School Facilities Management

S/N	Item	Mean	SD	Decision
1	AI technologies are used to manage school facilities.	2.08	.83	Disagree
2	AI assists in monitoring the condition of school infrastructure.	2.15	.79	Disagree
3	AI supports effective record-keeping of school facilities.	2.21	.76	Disagree
4	AI is used to monitor classroom and laboratory utilization.	2.03	.87	Disagree
5	AI applications improve school infrastructure management.	2.18	.81	Disagree
	Grand Mean	2.13	.81	Disagree

The grand mean of 2.13 is below the criterion mean of 2.50, indicating that AI applications are not widely utilized in managing school facilities and infrastructure in public secondary schools in Edo South Senatorial District.

Research Question 2: How does the utilization of AI influence the efficient use of facilities in public secondary schools in Edo South Senatorial District?

Table 2
Mean and Standard Deviation on the Utilization of AI influence the Efficient Use of Facilities.

S/N	Item	Mean	SD	Decision
1	AI helps reduce under-utilization of school facilities.	2.24	.80	Disagree
2	AI improves classroom allocation and scheduling.	2.18	.78	Disagree
3	AI enhances utilization of laboratories and libraries.	2.26	.74	Disagree
4	AI contributes to efficient use of school resources.	2.31	.71	Disagree
5	AI improves planning for facility usage.	2.27	.76	Disagree
Grand Mean		2.25	.76	Disagree

Respondents generally disagreed that AI currently contributes to the efficient utilization of school facilities with a grand mean of 2.25. This suggests that AI technologies have not yet been sufficiently adopted to influence facility management practices. This further revealed that AI has not substantially influenced the efficient utilization of school facilities, predictive maintenance, or infrastructure planning. This suggests that most schools continue to rely on traditional administrative methods rather than AI-driven systems for managing educational resources.

Research Question 3: What role does AI play in predictive maintenance of school infrastructure in public secondary schools in Edo South Senatorial District?

Table 3
Mean and Standard Deviation on the Roles AI Play in Predictive Maintenance of School Infrastructure

S/N	Item	Mean	SD	Decision
1	AI identifies faults before serious failure.	2.12	.82	Disagree
2	AI reduces maintenance costs.	2.18	.79	Disagree
3	AI improves maintenance scheduling.	2.09	.85	Disagree
4	AI prolongs the lifespan of facilities.	2.20	.77	Disagree
5	AI enhances timely maintenance.	2.16	.80	Disagree
Grand Mean		2.15	.81	Disagree

The findings shows a grand mean of 2.15 which indicate that AI currently plays only a limited role in predictive maintenance of school infrastructure in public secondary schools in Edo South Senatorial District.

Research Question 4: How does AI influence resource allocation and infrastructure planning in public secondary schools in Edo South Senatorial District?

Table 4

Mean and Standard Deviation on the Influence of AI Resource Allocation and Infrastructure Planning

S/N	Item	Mean	SD	Decision
1	AI assists administrators in infrastructure planning.	2.22	.77	Disagree
2	AI improves resource allocation decisions.	2.27	.74	Disagree
3	AI predicts future infrastructure needs.	2.19	.79	Disagree
4	AI supports data-driven planning.	2.24	.76	Disagree
5	AI contributes to infrastructure budgeting.	2.16	.82	Disagree
Grand Mean		2.22	.78	Disagree

With a grand mean of 2.22, respondents disagreed that AI significantly influences resource allocation and infrastructure planning, suggesting that AI-based planning tools are largely absent from school management practices.

Research Question 5: What challenges hinder AI adoption in public secondary schools in Edo South Senatorial District?

Table 5

Mean and Standard Deviation on the Challenges that Hinder AI Adoption

S/N	Item	Mean	SD	Decision
1	Poor funding hinders AI adoption.	3.71	.50	Agree
2	Poor ICT infrastructure limits implementation.	3.76	.46	Agree
3	Lack of technical expertise affects utilization.	3.58	.60	Agree
4	Poor electricity and internet connectivity hinder AI use.	3.81	.42	Agree
5	Resistance to technological change affects implementation.	3.39	.71	Agree
Grand Mean		3.65	.54	Agree

Respondents, with a grand mean of 3.65, strongly agreed that inadequate funding, poor ICT infrastructure, lack of technical expertise, unreliable electricity supply, inadequate internet connectivity, and resistance to technological change are major barriers to AI adoption.

Research Question 6: What strategies can enhance AI utilization in public secondary schools in Edo South Senatorial District?

Table 6

Mean and Standard Deviation on the Strategies that can Enhance AI Utilization

S/N	Item	Mean	SD	Decision
1	Government should provide adequate funding.	3.82	.39	Agree
2	Administrators should receive AI training.	3.74	.48	Agree
3	Schools should invest in ICT infrastructure.	3.86	.35	Agree
4	AI policies should be developed.	3.68	.55	Agree
5	Collaboration with technology experts should be encouraged.	3.79	.43	Agree
Grand Mean		3.78	.44	Agree

Respondents agreed that increased funding, staff training, investment in ICT infrastructure, supportive AI policies, and collaboration with technology experts are necessary for effective AI implementation with a grand mean of 3.78.

Hypothesis 1: There is no significant relationship between AI utilization and efficient utilization of school facilities in public secondary schools in Edo South Senatorial District.

Table 7

Pearson Correlation for the Relationship between AI Utilization and Efficient Utilization of School Facilities

Variables	N	r	p	Decision
AI Utilization × Efficient Utilization	74	.48	.001	Reject H_0

A moderate positive relationship was found between AI utilization and efficient utilization of school facilities ($r = .48$, $p < .05$). The null hypothesis is therefore rejected.

Hypothesis 2: There is no significant relationship between AI-driven predictive maintenance of school infrastructure in public secondary schools in Edo South Senatorial District.

Table 8

Pearson Correlation for the Relationship between AI-driven Predictive Maintenance of School Infrastructure.

Variables	N	r	p	Decision
AI Utilization × Predictive Maintenance	74	.52	.000	Reject H_0

The result indicates a significant positive relationship between AI utilization and predictive maintenance ($r = .52$, $p < .05$). Therefore, the null hypothesis is rejected.

Hypothesis 3: There is no significant relationship between AI utilization and effective resource allocation in public secondary schools in Edo South Senatorial District.

Table 9

Pearson Correlation for the Relationship between AI Utilization and Effective Resource Allocation.

Variables	N	r	p	Decision
AI Utilization × Resource Allocation	74	.55	.000	Reject H_0

AI utilization showed a significant positive relationship with effective resource allocation ($r = .55$, $p < .05$). The null hypothesis is therefore rejected.

Hypothesis 4: There is no significant relationship between the use of AI and infrastructure planning in public secondary schools in Edo South Senatorial District.

Table 10

Pearson Correlation for the Relationship between the Use of AI and Infrastructure Planning.

Variables	N	r	p	Decision
AI Utilization × Infrastructure Planning	74	.59	.000	Reject H_0

The result indicates a statistically significant positive relationship between AI utilization and infrastructure planning ($r = .52$, $p < .05$). Therefore, the null is rejected.

Discussion

The findings on the extent AI applications are utilized revealed that AI applications are not yet widely utilized in the management of school facilities and infrastructure in public secondary schools in Edo South Senatorial District. Findings from hypotheses one, two, three, and four revealed that there is a positive significant relationship between AI utilization and efficient utilization of school facilities, between AI utilization and predictive maintenance, between AI utilization and effective

resource allocation, between AI utilization and infrastructure planning in public secondary schools in Edo South Senatorial District. This implies that public secondary schools in Edo South Senatorial District have limited access to AI applications, however, if these applications are made available, it will enhance the management of school facilities and infrastructure. This finding agrees with the finding of Marzouk and Zaher (2020) who found that AI application aids facility managers in their tasks and decreases the maintenance cost of facilities by maintaining, upgrading, and operating assets cost effectively.

Conclusion and Recommendations

The application of Artificial Intelligence in accomplishing tasks faster than it use to be cannot be overemphasized. AI is almost taking over prophetic jobs as they are able to predict correctly outcomes beyond human knowledge. This study finds that AI applications are not yet utilized in the management of public secondary school facilities and infrastructure. This may be because they are not readily available, however, their importance cannot be overlooked as public secondary school principals' believe strongly that the inclusion of AI applications in facilities management will enhance facilities utilization in public secondary schools in Edo South Senatorial District. Further research covering private secondary schools can be conducted to enrich literature.

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

1. Government and stake holders in education should increase budgetary allocation to enable the provision of AI tools to public secondary schools.
2. Public secondary school principals should often organize extra-curricular activities such as science fair and exhibition and invite government officials and parents to the school premises so that they can show demonstrations on the importance of AI tools such as CCTV cameras within the school premises to enhance security.
3. Routine training on utilization of AI applications on facilities and infrastructure management should be organized for public secondary school teachers, as this will give them a sense of belonging and co-opt them into protecting available facilities.

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PATH-ANALYTIC STUDY OF STUDENTS' ACADEMIC CAPABILITY AND COMPLETION RATE OF PH.D. PROGRAMMES IN SOUTHWESTERN NIGERIA PUBLIC UNIVERSITIES

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Abstract

This study examined the influence of students' academic capability on the completion rate of Ph.D. programmes using a path analytic framework. It conceptualizes academic capability as a multidimensional construct comprising research ability, analytical ability, research productivity and self-efficacy. The study adopted a descriptive survey research design approach to obtain information using both physical and online approaches from 200 study participants which comprised of postgraduates who are through with their programmes of study and those who are on research, using a four-points scale questionnaire developed from the list of academic capability dimensions influencing completion rate as identified by the researcher through inductive and deductive studies. The findings of the study revealed that, research ability, analytical ability, and self-efficacy directly and indirectly influenced one-another as well as completion rate except for research productivity that exhibited a single path of direct relationship with completion rate. Self-efficacy demonstrated positive direct influences on research ability, research productivity, and completion rate ($\beta = .049$), ($\beta = .666$) and ($\beta = .152$) respectively. Furthermore, research productivity exhibited indirect positive effects on analytical ability and research productivity but a negative indirect influence on completion rate at ($\beta = .37$), ($\beta = .456$), and ($\beta = -.060$) respectively. It was also revealed that self-efficacy and research productivity demonstrated negative total effects on completion rate ($\beta = -.152$) and ($\beta = -.467$) indicating that individual students' over confidence in their ability to successfully plan and execute their research-related tasks might make them end up graduating late.

Key words: Path Analysis, Academic Capability, Ph.D. Completion Rate

Introduction

Doctoral degree as the highest level of academic training plays critical roles in knowledge production and national development. However, low completion rates and prolonged graduation time remains persistent challenge confronting all universities globally and particularly in developing countries (Lovitts, 2001; Organization for economic co-operation and development (OECD), 2022). In the context of Nigeria public universities concerns over delayed graduation and attrition in Ph.D. programmes have intensified due to institutional, financial, systemic inefficiencies and student-related factors (Ogunode & Musa, 2022). Among these factors, students' academic capability has been identified as a central determinant of doctoral degree success. Academic capability encompasses cognitive, motivational, and behavioral competencies necessary for independent research and scholarly productivity (Zimmerman, 2002; Ryan & Deci, 2020). Empirical evidence suggests that many candidates exceed the stipulated duration or fail to complete their programmes entirely (Owoade, 2021). According to Aina (2015), research indicates that less than 10% of doctoral students in Nigeria complete their programmes within the stipulated time frame. Evidence reveals that, the average completion time for doctoral degree is about 4.8 to 7 years in many Nigerian universities (Abiodun-Oyebanji, 2024; Aina, 2015).

Academic capability as a major determinant of students' effective engagement in learning and research activities encompasses prior academic achievement, research skills, critical thinking, and self-regulation (Zimmerman, 2002). Studies indicate that students with strong academic backgrounds are more likely to complete their doctoral programmes successfully and on time (Pang

et al., 2025). Students with strong research abilities are more likely to overcome research challenges, complete their dissertations on schedule, and graduate within the stipulated period, whereas those with inadequate research skills often experience delays, frustration, and attrition (Lovitts, 2001; Gardner, 2009; Pyhältö et al., 2015). Student with weak analytical abilities often experience difficulties in data analysis, interpretation, and thesis writing, thereby prolonging programme completion (Kellogg, 2006; Gardner, 2009; Pyhältö et al., 2015). Also, studies have shown that doctoral students who consistently publish and participate in research activities acquire greater research competence, receive stronger academic support, and demonstrate higher completion rates (Lee, 2008; McAlpine & Amundsen, 2011; Aarnikoivu et al., 2019). Research productivity is widely recognized as an important determinant of timely doctoral completion. According to Bandura (1997), Doctoral candidates with strong self-efficacy are more likely to maintain consistent research progress, manage academic stress effectively, and achieve timely completion.

Path analysis as an extension of multiple regression and a subset of Structural Equation Modeling (SEM), enables the examination of both direct, indirect and total effects among variables (Kline, 2015). This study therefore investigates how the identified dimensions of academic capability (research skills, academic self-efficacy, cognitive analytical ability, and research productivity) influence Ph.D. completion rates through a comprehensive causal model

Statement of the Problem

The completion of doctoral degree programmes remains a major concern in higher education globally, particularly in developing countries such as Nigeria, where delayed graduation and non-completion among doctoral students are increasingly reported. Doctoral education requires students to be able to navigate successfully with adequate research skills, cognitive analytical ability, research productivity, and self-efficacy. Despite growing recognition of student's academic capability as one of the major factors required for successful completion of postgraduate programmes, many studies have focused largely on institutional, student's, external/systemic and research-related factors with limited attention given to student's academic capability.

This study therefore, contributes to higher education research by offering a structural model that explains how academic capability predicts completion rates, mediated by factors such as motivation, quality of research supervision, and institutional support. Implications for policy and doctoral training are discussed.

Methods

This study adopted correlational research design using path analysis to examine the direct, indirect and total influences of academic capability (research ability, academic self-efficacy, cognitive analytical ability, and research productivity) on the completion rate of Ph.D. programmes in the study area.

The population of the study comprised 2,268 Ph.D. students enrolled in accredited public (federal = 8,546 and state = 820) universities in Southwestern Nigeria (NUC, 2019 statistical digest). A multi-stage sampling technique was employed, first, all public universities approved for doctoral degrees in the region were selected using stratified sampling technique, thereafter, two universities comprising one state and one federal were randomly selected, each with a total sample size of 100 respondents, five faculties were selected from each of the two selected universities, , from the 5 faculties selected, two departments from each were selected making a total of 20 departments selected from the two universities, from each selected department, 10 respondents comprising of doctoral students who are through with their programme of study and those who are on research making a total of 200 respondents selected from the two universities. The two categories of respondents were selected using convenience and purposive sampling procedures.

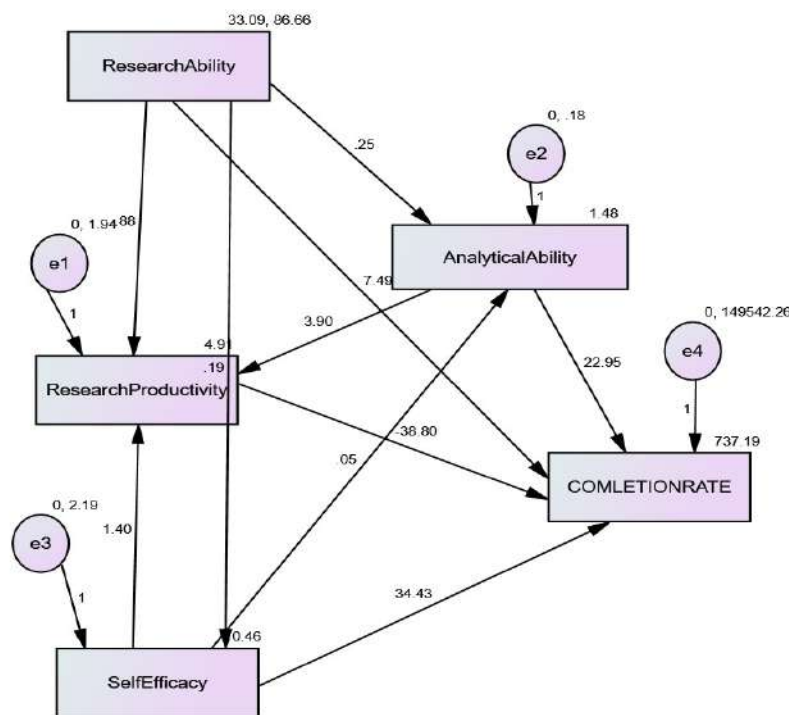
The instrument for the study comprised an adapted four-points scale questionnaire titled academic capability factors influencing completion rate (ACFICR) developed from the list of academic capability factors measured through indicators such as research skills, academic self-

efficacy, cognitive analytical ability, and research productivity as identified in literatures. The instrument had two sections, Section A, comprised of items use to elicit information on the demographic and institutional information of the respondent, section B comprised of items on academic capability of the respondents. Also, document analysis of the admission and graduation record of doctoral students admitted for 2018/2019 and 2019/2020 academic sessions in the selected universities.

The content validity of the instrument was conducted using eight panels approach to Lawshe Content Validity ratio (CVR) with item validity values ranging from .75 to 1.00 while the reliability was conducted through pilot-testing at a private university using 50 respondents and the result was subject to Cronbach's Alpha with a reliability coefficient of demographic and institutional information (.70), academic capability items (.80). Data collected for the study were analyzed using Analysis of Moment Structures (AMOS) 23 in IBM SPSS statistical package

Results and Discussion of Findings

Research Question 1: What are the paths of relationship between research skills, academic self-efficacy, cognitive analytical ability, research productivity, and the completion rate of doctoral degree programmes in the study area?



completion rate, this indicate an inverse direct relationship between research productivity and completion rate, that is the more committed doctoral students are to enhancing their research productivity, the lesser the committed to their degrees which may in turn lead to running out of the official stimulated time for their programmes, vice versa.

Research Question 3: What are the indirect effects of research ability, academic self-efficacy, cognitive analytical ability, and research productivity on the completion rate of doctoral degree programmes in the study area?

Table 2

Estimated Indirect Effects of Research Ability, Analytical Ability, Research Productivity and Self-efficacy on Completion Rate

VARIABLE INDICATOR	ESTIMATED EFFECTS	INDIRECT EFFECTS
RESEARCH ABILITY>>>>>>>>>ANALYTICAL ABILITY	.037	
RESEARCH ABILITY>>>>>>>>>RESEARCH RODUCTIVITY	2.456	
RESEARCH ABILITY>>>>>>>>>COMPLETION RATE	-.060	
SELF-EFFICACY>>>>>>>>>>>RESEARCH RODUCTIVITY	.096	
SELF-EFFICACY>>>>>>>>>>>COMPLETION RATE	-.349	
ANALYTICAL ABILITY>>>>>>>COMPLETION RATE	.926	
RESEARCH ABILITY>>>>>SELF-EFFICACY>>>>>ANALYTICAL ABILITY>>>>>COMPLETION RATE	.528	

Table 4.2 revealed that research productivity exhibited indirect positive effects on analytical ability and research productivity but a negative indirect influence on completion rate at ($\beta = .37$), ($\beta = .456$), and ($\beta = -.060$) respectively. Similarly, research ability demonstrated a positive and negative indirect influences on research productivity and completion rate at ($\beta = .096$) and ($\beta = -.349$) respectively, also, analytical ability demonstrated a positive indirect influence on completion rate at ($\beta = .926$). Conversely, research ability demonstrated a positive indirect effect on completion rate through self-efficacy and analytical ability at ($\beta = .528$). Thus, research ability and self-efficacy are the major negative indirect influencers of completion rate at ($\beta = -.060$) and ($\beta = -.349$).

Research Question 4: What are the total effects of research ability, academic self-efficacy, cognitive analytical ability, and research productivity on the completion rate of doctoral degree programmes in the study area?

Table 3

Estimated Total Effects of Research Ability, Analytical Ability, Research Productivity and Self-efficacy on Completion Rate

VARIABLE INDICATOR	ESTIMATED INDIRECT EFFECTS
RESEARCH ABILITY>>>>>>>>>SELF-EFFICACY	.762
RESEARCH ABILITY>>>>>>>>>ANALYTICAL ABILITY	.984
RESEARCH ABILITY>>>>>>>>>RESEARCH PRODUCTIVITY	.744
RESEARCH ABILITY>>>>>>>>>COMPLETION RATE	.115
SELF-EFFICACY>>>>>>>>>ANALYTICAL ABILITY	.049

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PRINCIPALS' EFFICIENCY TOWARDS UTILIZATION OF AI-DRIVEN APPLICATIONS FOR SUSTAINABLE SCHOOL MANAGEMENT IN THE DIGITAL AGE IN DELTA STATE

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Abstract

This study examined principals' efficiency towards utilization of AI-driven applications for sustainable school management in the Digital Age in Delta State. Four research questions guided the study. The study adopted a descriptive survey research design. The population of this study comprised all 474 principals of public secondary schools in Delta State. A total of 237 principals from 237 public secondary schools was used as the sample size, selected at 50% using a proportionate stratified random sampling technique. A 20-item self-structured questionnaire designed by the researcher and titled "Principals' Efficiency in Utilization of AI-Driven Applications for Sustainable School Management Questionnaire (PEAIASSMQ)" was used for data collection. Both validity and reliability of the questionnaire was established. Data collected and collated were analyzed using mean statistics rated at 2.50 and standard deviation statistics. Findings of this study generally revealed, among others, that principals were inefficient in utilizing AI-driven applications for sustainable curriculum and instructional management, personnel management, decision-making management and teaching-learning resource management in the digital age in secondary schools. Among the recommendations proffered from the findings included that the Delta State Government in conjunction with the Post Primary Education Board (PPEB) and other educational authorities should organize consistent compulsory capacity-building programmes and continuous professional development (CPD) training for principals on AI-driven applications and digital leadership in the areas of curriculum and instructional management in order principals' efficiency in using AI tools for sustainability of instructional, administrative and decision-making processes in public secondary schools in the digital age.

Keywords: Principals, Efficiency, AI, Applications, Management

Introduction

Education globally is undergoing rapid transformation driven by advancements in digital technologies and artificial intelligence (AI). These innovations and changes, which positively affect the education system, are reshaping how educational institutions are managed, how teaching and learning are delivered, and how decisions are made within institutions for sustainable school management. In contemporary educational discourse, the concept of sustainable school management has become increasingly important as schools are expected not only to achieve academic excellence but also to ensure efficient use of resources, long-term institutional stability and adaptability to technological change. In this context, principals' efficiency in using AI-driven applications has emerged as a critical factor in enhancing sustainable school management and effectiveness in the digital age. Management in this study implies the coordination and utilization of human and material resources of educational institutions, which is channeled towards the achievement of educational goals and objectives. According to Ezugoh et al. (2024), management entails a process involving organizing, planning, leading, measuring and controlling as well as undertaking of risk and handling of uncertainty, planning and innovation, coordination and routine supervision. It is a process designed

to ensure cooperation, participation, intervention of personnel in the effective achievement of a given objective. It is leadership which is aimed at influencing group activity towards goal achievement. Management of educational institutions rests mostly upon the leadership who can be termed as principals as found in secondary schools. Hence, for sustainable school management, it is very crucial that principals efficiently incorporate and utilize the Artificial Intelligence (AI) into the schools' daily operations and activities.

The Artificial Intelligence (AI) refers to computer-based systems capable of performing tasks that typically require human intelligence, such as decision-making, problem-solving, prediction and pattern recognition. According to the Organization for Economic Co-operation and Development (OECD) (2023), AI encompasses systems that are designed to operate with varying levels of autonomy and can influence decision-making processes through data-driven analysis and predictive modelling. Similarly, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2024a) conceptualized AI in education as intelligent systems that support teaching-learning activities, school administration and policy implementation through automation, analytics and adaptive learning technologies. In the context of school management, AI therefore refers to intelligent systems that support principals and school administrators in planning, organizing, monitoring and evaluating educational activities using applications including data-driven and automated processes. The AI has several applications which can aid effective school management especially in this digital age.

AI-driven applications in education therefore include intelligent tutoring systems, Learning Management Systems (LMS) with AI features, learning analytics platforms, automated grading systems, AI-based timetabling and scheduling systems, chatbot-based communication tools and virtual assistants, intelligent student information systems, automated grading and assessment tools, predictive student performance systems, and school management information systems powered by machine learning (Zawacki-Richter et al., 2019). These applications are increasingly being integrated into school administration or management to enhance efficiency, reduce administrative workload, improve data-driven decision-making and support personalized learning experiences. In secondary school management, principals occupy a central leadership position responsible for planning, organizing, directing and evaluating educational processes. Their efficiency in utilizing AI-driven applications determines how effectively they can successfully manage curriculum implementation, personnel administration, decision-making processes, school-community relations and instructional resources which are all aimed at sustainable school management in the digital age. Efficiency within the context of this study refers to the ability of principals to achieve optimal outcomes using minimal time, effort and resources while maximizing institutional productivity.

According to Robbins and Coulter (2021), efficiency is the relationship between inputs and outputs, where managers are considered efficient when they minimize resource wastage while achieving organizational goals effectively. This definition highlights optimal resource utilization. Similarly, Drucker (2020) conceptualized efficiency as doing things right by ensuring that organizational resources are used in the most productive and cost-effective manner to achieve desired outcomes. Principals' efficiency in essence, refers to the ability of school administrators to effectively utilize available human, financial and technological resources to achieve educational goals with minimal waste. In the view of Hallinger (2022), principals' efficiency involves the capacity of school leaders to manage instructional processes, personnel and resources in a way that maximizes school performance and student outcomes while minimizing inefficiencies in school administration. Sustainable school management, on the other hand, refers to the ability of educational leaders to ensure long-term institutional effectiveness through responsible resource utilization, continuous improvement, technological integration and adaptive leadership practices.

According to UNESCO (2024a), sustainable educational management involves ensuring equity, efficiency, accountability and resilience in school systems while responding to the demands of a rapidly changing digital environment. The OECD (2023) described sustainable school management as the strategic administration of educational institutions in a manner that ensures long-term performance, adaptability, resilience and optimal use of technological and human resources.

Sustainability is defined as development that meets present needs without compromising the ability of future generations to meet their own needs, particularly in resource utilization and institutional development (United Nations, 2023).

From all the foregoing discussions, efficient utilization of AI-driven applications in education would definitely lead to sustainability in the management of educational institutions/schools especially in the digital age. The concept of a digital age further emphasizes the increasing reliance on digital technologies, automation, artificial intelligence and data-driven systems in educational administration and management. According to Castells (2021), the digital age is a socio-technological era defined by the dominance of information networks, digital communication systems and knowledge-based economies that reshape how organizations operate and interact. Similarly, the OECD (2023) described the digital age as a period of rapid technological transformation driven by digital connectivity, automation, artificial intelligence and data analytics that influence education, governance, and economic systems. The digital age is thus characterized by rapid technological innovation and advancement in ICT and AI tools, widespread internet connectivity involving instant communication across geographical boundaries, big data utilization, information abundance by granting easy access to large volumes of digital information, use of analytics for planning and evaluation or data-driven decision-making, automation of processes using intelligent systems in administration and the integration of intelligent systems into organizational processes for prediction and optimization.

Within the school environment, principals are expected to adopt AI-driven applications not only as supportive tools but as strategic instruments for improving school effectiveness. AI-driven applications hence can be efficiently utilized in various aspects of school management by principals for curriculum and instructional management, personnel management, decision-making likewise teaching-learning resource management. Previous empirical studies have shown that AI-driven applications significantly enhance curriculum delivery and instructional management when effectively utilized by school leaders. Intelligent tutoring systems, adaptive learning platforms and AI-based learning analytics have been reported to improve instructional planning, personalization of learning, and monitoring of student progress. Citing instances, an empirical study conducted by Holmes et al., (2019) which investigated the role of Artificial Intelligence in education indicated that AI-supported instructional systems improve curriculum delivery by enabling adaptive learning pathways tailored to students' needs. The study emphasized that school leaders who efficiently integrate AI tools into instructional processes achieved improved teaching effectiveness and learner engagement. Similarly, Luckin et al. (2016) study indicated that AI applications such as intelligent feedback systems and learning analytics dashboards enhance teachers' instructional decision-making and curriculum alignment. The study concluded that principals' efficiency in adopting such tools determined the extent of instructional improvement in schools. Zawacki-Richter et al. (2019) also observed that AI in educational settings supports curriculum design through automated assessment and personalized learning systems, but its effectiveness depends on leadership capacity and institutional readiness. Again, a few research has shown that AI-driven systems are increasingly used in human resource and personnel management in educational institutions. These systems assist in teacher recruitment, performance evaluation, attendance monitoring and professional development planning. According to Selwyn (2022), AI-based human resource systems improve efficiency in personnel management by automating administrative tasks and providing data-driven insights into staff performance. However, the study noted that principals' digital competence determined how effectively these systems are utilized.

The OECD (2023) reported that AI-enabled administrative systems in schools contributed to improved workforce management by reducing workload, enhancing staff allocation, and supporting performance tracking. The study emphasized that school leaders who efficiently use AI tools experience better organizational productivity. UNESCO (2024b) further highlighted that AI applications can support teacher development by identifying training needs through predictive analytics. However, inefficient utilization of these tools limits their impact on personnel management in many developing education systems. Furthermore, empirical evidence has indicated that AI

significantly enhances data-driven decision-making in school leadership when properly utilized. Predictive analytics, dashboard reporting systems and School Management Information Systems (SMIS) support evidence-based planning and policy implementation.

According to Holmes et al. (2019), AI systems enable school leaders to make informed decisions by analyzing large datasets on student performance, attendance, and resource allocation. The study emphasized that principals' efficiency in interpreting AI-generated data determines the quality of school decisions. Zawacki-Richter et al. (2019) study indicated that AI-supported decision-making tools improved institutional planning by providing real-time insights into academic and administrative performance. However, the study noted that lack of digital literacy among school leaders limited effective utilization. The OECD (2023) reported that AI-based decision-support systems improve governance in schools by enabling predictive planning, risk identification, and resource optimization. Additionally, studies have indicated that AI-driven applications play a crucial role in managing teaching and learning resources such as digital content, instructional materials and educational infrastructure.

In a study, Luckin et al. (2016) indicated that AI systems enhance resource management by recommending appropriate learning materials based on student performance data. The study concluded that efficient leadership improves resource allocation and utilization. UNESCO (2024b) reported that AI-based platforms support equitable distribution of educational resources, particularly in resource-constrained environments. However, inefficiency in leadership reduced the effectiveness of such systems. Selwyn (2022) emphasized that digital resource management in schools is increasingly dependent on AI-powered systems, but successful implementation requires strong administrative efficiency and ICT competence among principals.

Holmes et al. (2019) also noted that AI systems improve resource optimization by tracking usage patterns and predicting resource needs, thereby, supporting sustainable school management. Despite the potential benefits of AI in education, many school systems, particularly in developing regions such as Nigeria and Delta State inclusive, continue to experience challenges in adopting and efficiently utilizing these technologies. Issues such as inadequate ICT infrastructure, limited digital literacy among school administrators, insufficient training, poor funding and resistance to technological change, among other factors often hinder effective implementation and utilization of AI applications. As a result, the potential of AI-driven applications to facilitate and enhance curriculum delivery, personnel management, decision-making, school-community relationships and instructional resource management remains underutilized in many secondary schools.

This present study is therefore grounded on the need to examine principals' efficiency in utilizing AI-driven applications for sustainable school management in secondary schools in Delta State. The study investigated the extent to which principals apply AI tools in curriculum and instructional management, personnel management, decision-making processes and teaching-learning resource management. These areas are critical because they directly influence school effectiveness, academic performance and institutional sustainability. The study is guided by the understanding that effective utilization of AI-driven applications can significantly improve curriculum delivery by enabling personalized learning and adaptive instruction. In personnel management, AI systems can support staff recruitment, performance monitoring and professional development planning. In decision-making, AI enhances evidence-based planning through predictive analytics and data interpretation. In teaching-learning resource management, AI facilitates efficient allocation, monitoring and utilization of instructional materials and digital resources. Given the increasing importance of artificial intelligence in education, it becomes imperative to assess how efficiently school principals are utilizing these technologies for sustainable school management in the digital age, especially in secondary schools. Although, many empirical studies have been conducted in the area of ICT, but a few of these studies are found within the context of AI utilization for sustainable school management.

A review of existing literature reveals that while several studies (Luckin et al., 2016; Holmes et al., 2019; Zawacki-Richter et al., 2019; UNESCO, 2024) have extensively examined the general applications of Artificial Intelligence in education, much of the focus has been on higher education contexts, instructional innovation and theoretical discussions of AI potential. Similarly, studies

conducted by the Selwyn (2022) and OECD (2023) have highlighted the global relevance of AI in education management, but with limited empirical attention to school-level administrative efficiency, particularly in secondary schools within developing economies. Furthermore, available studies tend to emphasize AI adoption and availability rather than the efficiency of school principals in utilizing AI-driven applications for specific administrative domains such as curriculum management, personnel administration, decision-making and resource management. There is also a noticeable gap in empirical studies that integrate these multiple dimensions of school management under a single framework to assess principals' efficiency in a comprehensive manner. It is therefore against this background that the researcher was motivated to conduct a field investigation in order to examine principals' efficiency towards the utilization of AI-driven applications for sustainable school management in secondary schools in Delta State, with particular focus on curriculum and instructional management, personnel management, decision-making and teaching-learning resource management. The study sought to provide empirical evidence on principals' efficiency towards utilization of AI-driven applications in school management practices in Delta State, thereby contributing to policy formulation, leadership development and educational innovation in the digital era.

Statement of the Problem

The rapid advancement of Artificial Intelligence (AI) and other digital technologies has transformed educational administration globally, making school management more data-driven, efficient and responsive to contemporary educational demands. In the digital age, secondary school principals are increasingly expected to integrate AI-driven applications such as intelligent school management platforms, predictive decision-support tools and automated administrative systems to enhance curriculum delivery, personnel management, decision-making processes and teaching-learning resource management. In developed educational systems, AI-driven technologies have been successfully deployed to improve instructional supervision, streamline administrative processes, support evidence-based decision-making, and optimize resource allocation. However, in many developing contexts such as Nigeria, particularly in Delta State, the level of integration and efficient utilization of these technologies in secondary school administration remains questionable. Despite government and stakeholder efforts toward digital transformation in education, many public secondary schools still rely heavily on traditional, conventional methods, manual and less efficient administrative systems.

Observations and emerging literature indicate that many principals seem to lack adequate efficiency in utilizing AI-driven applications for effective school management. This inefficiency which may be attributed to some factors have negative consequences on the potential of AI to enhance curriculum and instructional management, improve personnel administration, support evidence-based decision-making and optimize teaching-learning resources in this digital age, and which equally remains largely underutilized. Consequently, the secondary schools may continue to experience challenges such as ineffective instructional supervision, delayed decision-making processes, inefficient resource management and suboptimal staff performance evaluation. These challenges undermine the goal of sustainable school management and limit the capacity of schools to respond effectively to the demands of a rapidly evolving digital society. In the Nigerian context, and particularly in Delta State, empirical evidence on how secondary principals efficiently utilize AI-driven applications for sustainable school management remains scarce. Most existing studies focus broadly on ICT usage in education without isolating AI-specific tools or examining efficiency across key administrative functions. This leaves a critical gap in understanding not only whether AI tools are available, but how efficiently and effectively they are being utilized by principals to improve school management sustainability. Therefore, the present study sought to address this problem and fill all the necessary practical, theoretical, knowledge and contextual gaps by providing empirical evidence on principals' efficiency in utilizing AI-driven applications for sustainable school management in Delta State across four critical areas of: curriculum and instructional management, personnel management, decision-making and teaching-learning resource management.

Purpose of the Study

The purpose of this study was to examine principals' efficiency towards utilization of AI-driven applications for sustainable school management in the Digital Age in Delta State. Specifically, the study sought to:

1. Determine principals' efficiency towards utilization of AI-driven applications for sustainable curriculum and instructional management in the digital age in secondary schools in Delta State.
2. Examine principals' efficiency towards utilization of AI-driven applications for sustainable personnel management in the digital age in secondary schools in Delta State.
3. Ascertain principals' efficiency towards utilization of AI-driven applications for sustainable decision-making in the digital age in secondary schools in Delta State.
4. Find out principals' efficiency towards utilization of AI-driven applications for sustainable teaching-learning resource management in the digital age in secondary schools in Delta State.

Research Questions

The following three research questions guided the study:

1. How efficient are principals in utilizing AI-driven applications for sustainable curriculum and instructional management in the digital age in secondary schools in Delta State?
2. How efficient are principals in utilizing AI-driven applications for sustainable personnel management in the digital age in secondary schools in Delta State?
3. How efficient are principals in utilizing AI-driven applications for sustainable decision-making in the digital age in secondary schools in Delta State?
4. How efficient are principals in utilizing AI-driven applications for sustainable teaching-learning resource management in the digital age resource management in secondary schools in Delta State?

Methods

This study adopted a descriptive survey research design. The design was considered appropriate because it enabled the researcher to obtain data from respondents (principals) on existing conditions without manipulating variables. In this study, it was used to investigate principals' efficiency towards the utilization of AI-driven applications for sustainable school management in secondary schools in Delta State. The study was conducted in Delta State, Nigeria, a South-South geopolitical state with a growing number of public secondary schools increasingly exposed to digital and technological reforms in education. The State comprises three Senatorial districts, namely: Delta North, Delta Central and Delta South, each with varying levels of ICT infrastructure development and educational resource distribution.

The population of the study comprised all 474 principals of public secondary schools in Delta State. According to the Delta State Post Primary Education Board (2025), there are approximately 474 public secondary schools, each headed by a principal. Principals were selected as the respondents because they are the chief administrators of public secondary schools and are directly responsible for the implementation and utilization of AI-driven applications for curriculum management, personnel administration, decision-making and resource management. A total of 237 principals from 237 public secondary schools was used as the sample size, selected at 50% from the total population, using a proportionate stratified random sampling technique. These principals were selected because they had acquired some digital literacy skills which enabled them to utilize AI technology. This sampling technique was considered appropriate because it enabled the researcher to proportionately and randomly draw the sample at 50% according to strata, that is, the three Senatorial districts in the State and which also allowed for comprehensive coverage of all principals, thereby eliminating sampling error and enhancing the reliability of the findings.

The instrument for data collection was a 20-item self-structured questionnaire designed by the researcher and titled “Principals’ Efficiency in Utilization of AI-Driven Applications for Sustainable School Management Questionnaire (PEAIASSMQ)”. The questionnaire was designed based on the objectives of the study and relevant literature reviewed. Items in the questionnaire were measured using a 4-point rating scale as follows: Very Efficient (VE) – 4 points, Efficient (E) – 3, Less Efficient (LE) - 2 points and Inefficient (IE) - 1 point. The instrument was subjected to face and content validation by three experts; and two of these experts were from Educational Management unit and one from Measurement and Evaluation unit, Faculty of Education, Delta State University, Abraka. The experts examined the instrument for clarity, relevance, adequacy and alignment with the research objectives and questions. Their suggestions and corrections were incorporated to improve the final version of the questionnaire. The reliability of the instrument was determined through a pilot test conducted on a single administration of the questionnaire sampling 25 principals in Edo State, which was outside the study area but shared similar educational characteristics with Delta State.

Data obtained were analyzed using Cronbach’s Alpha statistics, whose result yielded reliability coefficient values of .81, .85, .83 and .87 for the four clusters respectively, with an overall internal consistency reliability coefficient of .84. This indicated that the instrument with its high level of consistency was reliable to collect data for the study. Data collection was carried out by the researcher with the help of three research assistants who met with the principals of the various public secondary schools sampled in order to administer the questionnaire to the respondents (principals). Permission was obtained from the school principals before administering the questionnaire. All ethical considerations were strictly observed.

Here, participation was voluntary and respondents were assured that the data collected would be used strictly for academic purposes. The purpose of the study was clearly explained to respondents and confidentiality and anonymity were assured to encourage honest responses. Distribution of all the questionnaire was done within an interval of two weeks, in order to get all the 237 valid copies of the questionnaire which was retrieved, giving a response rate of 100%. Data collected and collated were analyzed using mean statistics and standard deviation statistics to answer the research questions. The decision rule was based on a criterion mean of 2.50. Any item with a mean score of 2.50 and above was regarded as efficient, while a mean score below 2.50 was regarded as inefficient. The analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 26.

Results

Research Question 1: How efficient are principals in utilizing AI-driven applications for sustainable curriculum and instructional management in the digital age in secondary schools in Delta State?

Table 1

Mean Score Rating and SD of Principals concerning their Utilization of AI-Driven Applications for Sustainable Curriculum and Instructional Management in the Digital Age in Secondary Schools in Delta State (N = 237 Principals)

S/N	Efficiency in:	VE	E	LE	IE	X	SD	Decision
1.	utilizing AI-based learning analytics such as Google classroom with tracking features and Moodle LMS to monitor students’ academic performance in the digital age	11	21	94	111	1.71	.81	Inefficient
2.	using AI-driven platforms such as Magic School AI and Microsoft Copilot for education to support curriculum planning and instructional delivery in the digital age	19	27	89	102	1.84	.92	Inefficient

3.	applying AI tools such as Khan Academy (Khanmigo) and Century Tech for personalized learning and student-centred instruction in the digital age	14	20	103	100	1.78	.83	Inefficient
4.	using AI systems such as Dream Box Learning and ALEKS (Assessment and Learning in Knowledge Spaces) to identify students' learning difficulties and instructional needs in the digital age	8	12	122	95	1.72	.71	Inefficient
5.	integrating AI applications such as TeachFX and GoReact in supervising classroom instruction in the digital age	10	22	115	90	1.80	.77	Inefficient
Overall Mean Score & SD =						1.77	.81	Inefficient

Analysis of data in Table 1 revealed that none of the items from 1 to 5 were rated “efficient” above the acceptable mean score of 2.50 by the respondents (principals) to show their agreement with these statements. All the items were rated “inefficient” below the acceptable mean score of 2.50 by the principals to show their disagreement with these statements. The grand mean of 1.77 and standard deviation (SD) of .81 showcased closeness in the responses of the principals, therefore indicating their inefficiency in utilizing AI-driven applications for sustainable curriculum and instructional management in the digital age in secondary schools in Delta State. They were inefficient in all the aspects relating to utilizing AI-driven applications to sustain the curriculum and instructional management practices in schools.

Research Question 2: How efficient are principals in utilizing AI-driven applications for sustainable personnel management in the digital age in secondary schools in Delta State?

Table 2
Mean Score Rating and SD of Principals concerning their Utilization of AI-Driven Applications for Sustainable Personnel Management in the Digital Age in Secondary Schools in Delta State (N = 237 Principals)

S/N	Efficiency in:	VE	E	LE	IE	X	SD	Decision
6.	using AI systems such as Microsoft Viva Insights and Workday HCM (AI-powered Performance Management) for staff performance monitoring and data-driven evaluation in the digital age	9	24	106	98	1.76	.78	Inefficient
7.	utilizing AI applications such as LinkedIn Talent Solutions (AI Matching) and Oracle Fusion Cloud HCM (AI Recruiting) for teacher recruitment and deployment decisions in the digital age	6	17	133	81	1.78	.68	Inefficient
8.	using AI-driven tools such as Kronos Workforce Ready (UKG Ready) and Workeasy AI Time and Attendance for staff attendance and punctuality tracking in the digital age	12	27	101	97	1.81	.83	Inefficient
9.	relying on AI-based systems such as Cornerstone Learning Experience Platform (LXP) and Docebo Learning platform for identifying teachers' training needs in the digital age	18	20	96	103	1.80	.89	Inefficient
10.	using AI applications such as Microsoft Viva Learning and SAP SuccessFactors Learning to support staff development planning and supervision in the digital age	14	25	113	85	1.86	.83	Inefficient
Overall Mean Score & SD =						1.80	.80	Inefficient

Analysis of data in Table 2 revealed that none of the items from 6 to 10 were rated “efficient” above the acceptable mean score of 2.50 by the respondents (principals) to show their agreement with these statements. All the items were rated “inefficient” below the acceptable mean score of 2.50 by the principals to show their disagreement with these statements. The grand mean of 1.80 and standard deviation (SD) of .80 showcased closeness in the responses of the principals, indicating their inefficiency in utilizing AI-driven applications for sustainable personnel management in the digital age in secondary schools in Delta State. They were inefficient in all the aspects relating to utilizing AI-driven applications to sustain the personnel management practices in schools.

Research Question 3: How efficient are principals in utilizing AI-driven applications for sustainable decision-making in the digital age in secondary schools in Delta State?

Table 3

Mean Score Rating and SD of Principals concerning their Utilization of AI-Driven Applications for Sustainable Decision-Making Management in the Digital Age in Secondary Schools in Delta State (N = 237 Principals)

S/N	Efficiency in:	VE	E	LE	IE	X	SD	Decision
11.	using AI-generated data from Microsoft Power BI with Copilot and Tableau Pulse (Salesforce AI) for making administrative decisions in the digital age in school	8	10	114	105	1.67	.71	Inefficient
12.	relying on AI predictive tools such as IBM watsonx and Microsoft Azure Machine Learning for planning school activities and policies in the digital age	17	24	107	89	1.87	.86	Inefficient
13.	using AI dashboards such as Microsoft Power BI with Copilot and Oracle analytics cloud to guide resource allocation decisions in the digital age	9	13	112	103	1.70	.74	Inefficient
14.	utilizing AI systems such as civitas learning and D2L Brightspace insights to analyze student performance for decision-making in the digital age	7	11	108	111	1.64	.71	Inefficient
15.	using AI tools such as Microsoft Copilot and Google Gemini for workspace to improve efficiency in school problem-solving processes in the digital age	18	25	101	93	1.86	.89	Inefficient
Overall Mean Score & SD =						1.75	.79	Inefficient

Analysis of data in Table 3 revealed that none of the items from 11 to 15 were rated “efficient” above the acceptable mean score of 2.50 by the respondents (principals) to show their agreement with these statements. All the items were rated “inefficient” below the acceptable mean score of 2.50 by the principals to show their disagreement with these statements. The grand mean of 1.75 and standard deviation (SD) of .79 showcased closeness in the responses of the principals, indicating their inefficiency in utilizing AI-driven applications for sustainable decision-making management in the digital age in secondary schools in Delta State. They were inefficient in all the aspects relating to utilizing AI-driven applications to sustain decision-making management practices in schools.

Research Question 4: How efficient are principals in utilizing AI-driven applications for sustainable teaching-learning resource management in the digital age resource management in secondary schools in Delta State?

Table 4

Mean Score Rating and SD of Principals concerning their Utilization of AI-Driven Applications for Sustainable Teaching-Learning Resource Management in the Digital Age in Secondary Schools in Delta State (N = 237 Principals)

S/N	Efficiency in:	VE	E	LE	IE	X	SD	Decision
16.	using AI systems such as Microsoft Copilot for education and Oracle Fusion Cloud ERP (AI-powered resource management) to manage and allocate teaching-learning resources effectively in the digital age	11	23	104	99	1.77	.81	Inefficient
17.	utilizing AI platforms such as Follett Destiny Resource Manager and Manage Bac analytics to monitor availability and usage of instructional materials in the digital age	9	21	81	126	1.63	.80	Inefficient
18.	using AI applications such as Magic School AI and Khanmigo (Khan Academy) to recommend relevant digital learning resources for teachers in the digital age	15	19	114	89	1.83	.82	Inefficient
19.	applying AI tools such as Microsoft Intune and Cisco Meraki Dashboard to track utilization of ICT facilities in the digital age in school	12	27	100	98	1.80	.83	Inefficient
20.	using AI systems such as Microsoft Power BI with Copilot and IBM watsonx to improve resource planning and sustainability in the digital age in school	17	13	85	122	1.68	.87	Inefficient

Overall Mean Score & SD =	1.74	.83	Inefficient
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Analysis of data in Table 4 revealed that none of the items from 15 to 20 were rated “efficient” above the acceptable mean score of 2.50 by the respondents (principals) to show their agreement with these statements. All the items were rated “inefficient” below the acceptable mean score of 2.50 by the principals to show their disagreement with these statements. The grand mean of 1.74 and standard deviation (SD) of .83 showcased closeness in the responses of the principals, indicating their inefficiency in utilizing AI-driven applications for sustainable teaching-learning resource management in the digital age in secondary schools in Delta State. They were inefficient in all the aspects relating to utilizing AI-driven applications to sustain teaching-learning resource management practices in schools.

Discussion of Findings

Findings of this study generally revealed principals’ inefficiency in the utilization of AI-driven applications for sustainable management in the digital age in secondary schools in Delta State. They were inefficient in utilizing AI-driven applications for sustainable curriculum and instructional management, personnel management, decision-making management and teaching-learning resource management in the digital age in secondary schools. One of the findings revealed that the public secondary school principals were inefficient in utilizing AI-driven applications for sustainable curriculum and instructional management in the digital age in Delta State. This finding further discovered that the principals were inefficient in utilizing AI-driven applications especially in those areas connected to using AI-based learning analytics such as Google classroom with tracking features and Moodle LMS to monitor students’ academic performance in the digital age. They were also inefficient in using AI-driven platforms such as Magic School AI and Microsoft Copilot for education to support curriculum planning and instructional delivery in the digital age, applying AI tools such as Khan Academy (Khanmigo) and Century Tech for personalized learning and student-centred instruction, using AI systems such as Dream Box Learning and ALEKS (Assessment and Learning in Knowledge Spaces) to identify students’ learning difficulties and instructional needs, and in integrating AI applications such as TeachFX and GoReact in supervising classroom instruction in the digital age. Thus, the above finding implies that many principals were unable to effectively apply AI tools such as learning analytics systems, adaptive instructional platforms and intelligent tutoring systems to support curriculum planning, instructional supervision and learner-centred teaching. This finding indicated a gap in digital leadership competence among principals, particularly in the use of AI technologies to enhance teaching and learning processes, which can be attributed to several factors. This present study finding aligns and agrees with the findings of Holmes et al. (2019), who indicated that although AI has strong potential to enhance instructional delivery through personalized learning and data-driven curriculum design, its effectiveness depends heavily on educators’ and school leaders’ ability to integrate it meaningfully into instructional systems. Similarly, Luckin et al. (2016) study found that without strong leadership capacity, AI tools remain underutilized in improving classroom instruction. Furthermore, the present study finding agrees with the findings of Zawacki-Richter et al. (2019), who found that AI applications in education were often concentrated in research and higher education settings, with limited adoption at the secondary school level due to leadership inefficiencies and lack of digital competence.

It was also discovered through this finding that the public secondary school principals were inefficient in utilizing AI-driven applications for sustainable personnel management in the digital age in Delta State. This finding further reported that the principals were inefficient in integrating AI-driven applications in personnel management areas, especially in utilizing AI-generated data from Microsoft Power BI with Copilot and Tableau Pulse (Salesforce AI) for making administrative decisions in the digital age in school. They were inefficient in relying on AI predictive tools such as IBM watsonx and Microsoft Azure Machine Learning for planning school activities and policies in the digital age, using AI dashboards such as Microsoft Power BI with Copilot and Oracle analytics cloud to guide resource allocation decisions in the digital age, utilizing AI systems such as civitas learning and D2L Brightspace insights to analyze student performance for decision-making for the school, and in using AI tools such as Microsoft Copilot and Google Gemini for workspace to improve

efficiency in school problem-solving processes. This further implies that AI tools that could support teacher recruitment, staff appraisal, attendance monitoring and professional development planning were not efficiently utilized. And this inefficiency may hinder effective human resource management in schools, leading to poor staff monitoring, weak performance evaluation systems and limited data-driven staff development strategies. This finding is consistent and corroborates with the findings of Selwyn (2022), who indicated that although AI systems can significantly enhance human resource management in education by automating administrative tasks and improving decision-making efficiency, many school leaders lack the necessary digital literacy to utilize these tools effectively. Similarly, the OECD (2023) confirmed that inefficiency in leadership remained a major barrier to effective AI integration in school personnel management systems. Additionally, UNESCO (2024) reported that while AI-driven HR systems are increasingly available, their impact in many developing educational systems remained limited due to leadership inadequate training and weak implementation structures.

The finding of this study further indicated that the public secondary school principals were inefficient in utilizing AI-driven applications for sustainable decision-making management in the digital age in Delta State. This finding further discovered that the principals were inefficient in utilizing AI-driven applications in decision-making areas, especially in using AI-generated data from Microsoft Power BI with Copilot and Tableau Pulse (Salesforce AI) for making administrative decisions in the digital age in schools. They were also inefficient towards relying on AI predictive tools such as IBM watsonx and Microsoft Azure Machine Learning for planning school activities and policies in the digital age, using AI dashboards such as Microsoft Power BI with Copilot and Oracle analytics cloud to guide resource allocation decisions, utilizing AI systems such as civitas learning and D2L Brightspace insights to analyze student performance for decision-making in the digital age, and also in using AI tools such as Microsoft Copilot and Google Gemini for workspace to improve efficiency in school problem-solving processes. This finding implies that AI-based decision-support systems, predictive analytics and digital dashboards were not efficiently used to guide school planning, policy implementation and administrative decisions. This inefficiency limited the principals' ability to make evidence-based decisions, resulting in reliance on intuition and traditional administrative approaches rather than data-driven systems. The present study finding corroborates and relates with the findings of Holmes et al. (2019), who found that while AI systems can significantly improve decision-making in education through predictive analytics and real-time data interpretation, many school leaders were not adequately prepared to interpret or apply AI-generated insights. Similarly, this finding aligns with Zawacki-Richter et al. (2019), who found that digital decision-support systems were underutilized in school leadership due to lack of technical competence and institutional readiness. Furthermore, the OECD (2023) confirmed that effective decision-making in the digital age requires strong data literacy and AI competence among educational leaders, which remains a challenge in many school systems, including secondary schools.

Finally, it was found out that the public secondary school principals were inefficient in utilizing AI-driven applications for sustainable teaching-learning resource management in the digital age in Delta State. This finding further reported that the principals were inefficient in utilizing AI-driven applications for teaching-learning resource management especially in areas of using AI systems such as Microsoft Copilot for education and Oracle Fusion Cloud ERP (AI-powered resource management) to manage and allocate teaching-learning resources effectively in the digital age. They were inefficient in utilizing AI platforms such as Follett Destiny Resource Manager and Manage Bac analytics to monitor availability and usage of instructional materials in the digital age, using AI applications such as Magic School AI and Khanmigo (Khan Academy) to recommend relevant digital learning resources for teachers, applying AI tools such as Microsoft Intune and Cisco Meraki Dashboard to track utilization of ICT facilities in the digital age in schools, and in using AI systems such as Microsoft Power BI with Copilot and IBM watsonx to improve resource planning and sustainability in the schools. This further implies that AI tools used for managing instructional materials, tracking resource utilization and recommending digital learning content were not effectively applied. This inefficiency contributed to poor allocation and underutilization of teaching resources, limiting the quality and sustainability of instructional delivery in schools. The finding is

supported by Luckin et al. (2016), who found that although AI systems can optimize resource management through adaptive recommendations and resource tracking, their effectiveness depends on leadership efficiency and system integration. UNESCO (2024) confirmed that many schools failed to fully benefit from AI-enabled resource management systems due to inadequate leadership capacity and poor ICT infrastructure. The present study finding concurs and does not deviate from the findings of Selwyn (2022), who found that digital resource management in education is often constrained by insufficient administrative efficiency, which limited the impact of advanced technologies in school systems. Overall, all the findings of this study consistently indicate that principals in secondary schools in Delta State were not efficient in utilizing AI-driven applications across all dimensions of school management, including curriculum and instruction, personnel management, decision-making and teaching-learning resource management. The reviewed literature strongly supports these findings, highlighting that while AI technologies have the potential to transform educational leadership and management, their effectiveness is largely dependent on principals' digital competence, training and institutional support systems. This situation calls for absolute redress in the secondary school system.

Conclusion and Recommendations

This study submits and concludes that principals in the public secondary schools in Delta State were not efficient (inefficient) in the utilization of AI-driven applications for sustainable school management in the digital age. Specifically, their inefficiency cuts across curriculum and instructional management, personnel management, decision-making and teaching-learning resource management. This indicated that although AI-driven applications have the potential to enhance school effectiveness through improved data analysis, automation and evidence-based decision-making, such benefits are not yet fully realized in majority of the public secondary schools in the State. Consequently, sustainable school management in the digital era is being constrained, thereby, limiting innovation, efficiency and overall educational quality in public secondary schools in Delta State. To address this situation, hence the recommendations made below.

From the findings of this study, the following recommendations were proffered:

1. Delta State Government in conjunction with the Post Primary Education Board (PPEB) and other educational authorities should organize consistent compulsory capacity-building programmes and continuous professional development (CPD) training for principals on AI-driven applications and digital leadership in the areas of curriculum and instructional management in order to enhance principals' efficiency in using AI tools for sustainability of instructional, administrative and decision-making processes in public secondary schools in the digital age.
2. The Post Primary Education Board (PPEB) with support from the Delta State Ministry of Education and other external bodies should mobilize and upgrade ICT infrastructure in the public secondary schools, including AI-enabled management systems and reliable internet connectivity, in order to create an enabling environment for principals' efficiency towards utilization of AI-driven applications for sustainable personnel management in schools especially in the digital age.
3. School principals should be effectively encouraged and supervised by the PPEB to adopt data-driven and AI-supported decision-making practices in all aspects of school administration so as to improve their efficiency in planning, monitoring and evaluating school activities for better outcomes and sustainability in the digital age.
4. Stakeholders such as government agencies, private organizations, parents and international development partners such as UNESCO and UNICEF should be highly encouraged to support the growth of public secondary schools in the State through adequate funding, ICT resource mobilization and building strong partnerships aimed at integrating AI technologies and applications into school teaching and learning resource management systems in the digital age. This would also enhance principals' efficiency in utilizing different AI-driven applications in

teaching and learning resource management in order to ensure its sustainability and improve the long-term effectiveness of public secondary school administration in the digital age.

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ROLE OF ARTIFICIAL INTELLIGENCE IN ENGLISH LANGUAGE ACQUISITION AND PEDAGOGY AMONG SECONDARY SCHOOL STUDENTS AND TEACHERS IN EDO STATE

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Abstract

The present study empirically investigated the role of Artificial Intelligence (AI) in English language acquisition and pedagogy in Nigeria. Employing a descriptive survey design, the research gathered data from 320 participants, comprising English language teachers and students, who were identified through stratified random sampling across the five local government areas of Edo Central Senatorial District, Edo State. The main data-collection instrument was a validated structured questionnaire, which was further complemented by focus group discussion. Data analysis drew on both descriptive measures (mean scores, standard deviations, and frequency distributions). Results indicate that AI-powered platforms, notably ChatGPT and Duolingo, yielded meaningful gains across speaking, writing, and reading domains (mean = 3.74, SD = .61). The study further established that most aspects of English language pedagogy including Phonetics, Grammar, and Reading Comprehension were perceived to be taught more effectively with AI platforms. Despite these gains, significant ethical concerns around data privacy, over-dependence on AI tools, and algorithmic bias were identified. The authors recommended among others that Nigerian educational policymakers should endeavor to develop a national AI integration framework for secondary English language education that specifies content standards, data privacy protocols, and usage guidelines for AI tools.

Keywords: Artificial Intelligence, English Language, Language Acquisition, Pedagogy.

Introduction

The coming together of Artificial Intelligence (AI), English Language acquisition, and pedagogy is one of the most important developments in education today, especially in multilingual countries like Nigeria. As a nation of over 200 million people with more than 500 indigenous languages, Nigeria holds a unique sociolinguistic position in which English functions not merely as a foreign or second language but as the official medium of instruction, governance, and national integration (Nwana, 2025). This structural centrality of the English language in Nigerian public life makes the question of how it is acquired and taught a matter of urgent educational and policy significance, of which AI has a role to play in English Language acquisition and pedagogy by providing learners and teachers with access to personalized, interactive, and technology-mediated learning opportunities.

Artificial Intelligence refers to computer-based systems designed to perform tasks that ordinarily require human cognitive abilities. These systems can process information, identify patterns, learn from data, generate responses, and supporting decision-making processes (Bali et al., 2024). In language education, AI manifests through a range of tools, including intelligent tutoring systems, chatbots, speech recognition software, natural language processing (NLP) engines, and adaptive learning platforms such as Duolingo, Rosetta Stone, and ChatGPT. These technologies can analyze learner performance data, generate personalized instructional content, provide immediate corrective feedback, and facilitate repeated practice. Such capabilities have expanded the possibilities for language learning beyond the conventional classroom and have created opportunities for learners to receive assistance at their own pace. They also provide teachers with resources for lesson preparation, assessment, instructional material development, and differentiated learning (Kristiawan et al., 2024). The rapid proliferation of these tools has generated considerable optimism about their capacity to democratize access to quality English language education, particularly in resource-constrained contexts like Nigeria where teacher-to-student ratios remain a persistent challenge (Olorunmade, 2025).

English language acquisition involves the gradual development of learners' ability to understand and use English effectively in different communication situations. This process includes the growth of listening, speaking, reading, and writing competencies as well as the mastery of vocabulary, grammatical structures, and appropriate language use (Hazaymeh et al., 2024). Language acquisition theories provide foundational lenses through which AI-mediated learning can be understood and evaluated. For instance, Krashen's Input Hypothesis posits that acquisition proceeds most effectively when learners encounter comprehensible input pitched just above their current proficiency level. Similarly, Long's Interaction Hypothesis underscores the primacy of communicative interaction in acquisition, suggesting that AI-driven conversational tools such as chatbots and virtual interlocutors may provide opportunities for interaction and negotiation of meaning that support language development (Long, 2017; Olabode & Adedokun, 2025). These theoretical positions suggest that AI can create conditions that may be conducive to English language acquisition when its content and interactions are appropriately aligned with learners' proficiency levels and instructional needs.

However, the availability of AI tools does not necessarily mean that they are equally effective across all aspects of English language learning. The perceived effectiveness of AI depends on the extent to which learners and teachers consider these technologies capable of addressing particular language-learning and teaching needs. AI applications may be perceived as particularly useful for activities such as grammar practice, vocabulary development, writing assistance, reading comprehension, and conversational practice because they can provide immediate responses, generate examples, and allow learners to practice repeatedly. At the same time, their perceived effectiveness may vary across language skills and instructional areas. For example, activities involving pronunciation and phonetics may require accurate modelling of speech sounds, auditory discrimination, and corrective interaction that cannot always be adequately replicated through text-based AI applications. Teachers may also differ in their perceptions of AI depending on their familiarity with the technology, pedagogical competence, access to digital resources, and understanding of how AI-generated content can be incorporated into classroom instruction. Examining perceived effectiveness is therefore important because acceptance and meaningful classroom use of AI are influenced not only by what the technology can technically do but also by how teachers and learners experience and evaluate its usefulness.

Pedagogy is the science and art of teaching itself. Effective English language pedagogy in Nigeria must navigate complex terrain: contending with mother-tongue interference from hundreds of indigenous languages, wide variation in learner proficiency across urban and rural contexts, and constraints in teacher professional development and instructional resources (Nwana, 2025; Rajak et al, 2024). AI presents several pedagogical affordances that are directly relevant to these challenges. By enabling personalized learning pathways, AI systems can address the diversity of learner needs that a single teacher managing a large class cannot adequately serve (Chandra et al., 2024). AI tools can support teachers through lesson planning assistance, generation of instructional materials, grammar and writing feedback, assessment support, and access to professional development resources (Nykykyporets et al, 2025). Their perceived pedagogical effectiveness is therefore an important consideration in determining whether AI can complement rather than displace the role of the English language teacher. The teacher remains central to interpreting AI-generated information, selecting appropriate instructional materials, monitoring learners' progress, and ensuring that technology is used in ways that serve clearly defined educational objectives.

Alongside these potential benefits, the integration of AI into English language education raises important ethical concerns. The increasing use of AI systems involves the collection, processing, and sometimes storage of users' information, thereby creating concerns about data privacy and the protection of learners' personal information. There are also concerns about the accuracy and reliability of AI-generated responses, particularly where learners may accept generated information without critically evaluating it. Over-dependence on AI may reduce learners' opportunities to develop independent thinking, problem-solving, writing, and communicative abilities if technology becomes a substitute for active learning rather than a support for it. Responsible integration therefore

requires teachers and learners to understand both the opportunities and limitations of AI and to use these technologies as complementary resources within sound pedagogical practices.

Despite the theoretical promise and growing global evidence base, empirical documentation of AI's role in English language acquisition and pedagogy in the Nigerian educational system remains sparse. Much of the existing Nigerian literature on the subject is conceptual, expository, or anecdotal, leaving critical gaps in evidence regarding learner and teacher perceptions, the specific sub-skills most amenable to AI-driven improvement, and the ethical concerns that accompany AI integration (Bali et al., 2024; Nwosu, 2024). This study addresses this gap by providing empirical evidence on the role of AI in English language acquisition and pedagogy. Therefore, this study investigates the role of AI in English language acquisition and pedagogy in Edo State. Specifically, the study sought to examine: (i) determine the perceived extent to which AI tools contribute to English language skill acquisition; (ii) examine teachers' perceptions of the effectiveness of AI platforms in teaching selected areas of English language pedagogy, including phonetics, grammar, and reading comprehension; and (iii) identify the ethical concerns associated with the use of AI in English language education.

Review of Related Literature

Artificial Intelligence (AI) is a branch of computer science that focuses on building systems that can perform tasks that ordinarily require human intelligence including natural language processing, speech recognition, machine learning, and decision-making (Bali, Garba, Ahmadu, Takwate, & Malgwi, 2024). In education, AI technologies enable computers and machines to simulate human comprehension and problem-solving, empowering applications to see, understand, learn, and make recommendations in real time (Kristiawan et al., 2024). The recent advancements in generative AI (gen AI) have further expanded the scope of AI-powered applications in language education. Bali et al. (2024) analyzed emerging trends in AI for education and identified key transformations in how English is taught and learned. Similarly, Nwosu (2024) documented the role of AI in educational broadcasting for pedagogical dissemination across scholastic levels in Nigeria, underscoring its potential to scale quality language education beyond urban centres. Empirical investigations have further strengthened these claims by demonstrating measurable improvements in learners' outcomes. For example, Olabode and Adedokun (2025) found that students who engaged with AI-powered feedback systems performed significantly better in English language tasks than those who relied solely on traditional teaching methods. Similarly, Nykyporets et al. (2025) reported that AI-driven pedagogical strategies significantly enhanced learners' vocabulary acquisition, grammatical accuracy, and overall communicative competence. In addition, a meta-analytical study by Rashid et al. (2025) established that the integration of machine learning tools in language instruction leads to improved academic performance and learner motivation across diverse educational contexts. These findings collectively reinforce the argument that AI is not merely a supportive tool but a significant contributor to improved language acquisition outcomes. Beyond performance outcomes, studies have highlighted the role of AI in promoting interactive learning. Kristiawan et al. (2024), in their systematic review, observed that AI-powered chatbots and conversational agents provide learners with opportunities for continuous interaction, thereby supporting the development of speaking and listening skills. Similarly, Obidovna (2024) argued that AI facilitates immersive learning experiences by simulating real-life communication scenarios, that are essential for language mastery. This aligns with the view of Pitychoutis and Al Rawahi (2024), who posited that AI supports the integration of multiple intelligences in language instruction by combining visual, auditory, and interactive learning modes. Taken together, these studies indicate that AI enhances not only cognitive learning outcomes but also the experiential dimensions of language acquisition.

Theoretical Framework

This study is anchored on Krashen's Input Hypothesis, a theory of second language acquisition propounded by Stephen Krashen, a well-known linguist and educational researcher. Krashen introduced this theory as part of his broader Monitor Model to explain how individuals naturally and

effectively acquire a second language. The central idea of the Input Hypothesis is that language acquisition occurs most effectively when learners are exposed to 'comprehensible input' (CI), language that is slightly above their current level of competence. This level is often described as “ $i + 1$,” where “ i ” represents the learner’s current knowledge and “ $+1$ ” represents the next level of difficulty (Li et al, 2022). The relevance of Krashen’s Input Hypothesis to this study lies in its emphasis on the provision of comprehensible and appropriately challenging language input, which AI-powered tools can facilitate through personalized content and interactive language practice. Thus, the theory provides an appropriate framework for examining the perceived role of AI in supporting English language acquisition and pedagogy among secondary school learners.

Methods

The study adopted a descriptive survey research design. This design was judged most suitable because it facilitated the systematic collection of data from a large, representative sample to document current perceptions and experiences of AI use in English language acquisition, without introducing experimental manipulation of variables (Creswell & Creswell, 2018).

A mixed-methods approach was operationalized, integrating quantitative questionnaire data with qualitative evidence from focus group discussions to produce a nuanced understanding of the phenomenon under investigation. The target population encompassed English language teachers and secondary school students drawn from across the five Local Government Areas in Edo Central Senatorial District, Edo State. A total of 320 respondents were sampled through stratified random sampling: 120 English language teachers and 200 Senior Secondary School (SSS) students in SSS II and SSS III classes, drawn from both public and private secondary schools.

Of the 320 questionnaires distributed, 308 were returned and deemed analytically usable, representing a 96.3% return rate. The 308 usable questionnaires comprised all 120 teacher questionnaires (100% return rate) and 188 of the 200 student questionnaires (94% return rate). Schools were stratified by geographical location (urban or rural) and institutional type (public or private) to ensure adequate representativeness. The primary data-collection instrument was a researcher-constructed structured questionnaire titled: AI in Language Acquisition and Pedagogy Scale (ALAPS). The ALAPS comprised four sections: (A) Demographic particulars; (B) Perceived contribution of AI tools to English language skill acquisition, comprising 15 items; (C) Perceived effectiveness of AI platforms in English language pedagogy, comprising 12 items; and (D) Perceived ethical concerns associated with the use of AI in English language education, comprising 10 items. All items were rated on a four-points scale (Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1), with a criterion mean of 2.50 serving as the threshold for decision-making. For the perceived contribution and ethical concerns sections, mean scores of 2.50 and above were interpreted as “Agree,” whereas for the perceived effectiveness of AI platforms in English language pedagogy, mean scores of 2.50 and above were interpreted as “Effective.”

Face and content validity were established through a review by three independent experts; two from the field of Measurement and Evaluation and one from English language education. Instrument reliability was assessed via a pilot administration involving 30 respondents excluded from the main sample, using Cronbach's alpha. The reliability coefficients were as follows: Section B = .81, Section C = .78, and Section D = .75, all indicative of strong internal consistency.

To complement the quantitative strand, four focus group discussions (FGDs) were conducted; two with groups of teachers and two with groups of students, each comprising between eight and ten participants. All FGD sessions were audio-recorded, transcribed in full, and subjected to thematic analysis. Emergent themes were subsequently used to triangulate and contextualize the quantitative findings. Questionnaires were distributed in person by trained research assistants at the participating schools. Informed consent was obtained from all participants before data collection. Of the 320 questionnaires distributed, 308 were returned and deemed analytically usable, representing a 96.3% return rate.

Descriptive statistics were employed to address research questions one to three. While the qualitative data from the FGDs were analyzed thematically.

Results

Demographic Characteristics of Respondents

Of the 308 valid respondents, 120 (39.0%) were English language teachers and 188 (61.0%) were students. All teacher questionnaires were returned; the 12 missing questionnaires were all from the student stratum. Female respondents accounted for 58.4% ($n = 180$) and males for 41.6% ($n = 128$). Among the teachers, 65.8% had 6–15 years of teaching experience. Regarding AI tool familiarity, 71.4% of students and 58.3% of teachers reported using at least one AI language tool weekly, with ChatGPT (62.3%) and Duolingo (48.1%) being the most commonly used tools.

Research Question 1: To what extent do secondary school students perceive Artificial Intelligence tools as contributing to the acquisition of English language skills in Edo State?

Table 1

Mean Ratings of the Perceived Contribution of AI Tools to English Language Skill Acquisition ($n = 308$)

S/N	Item	Mean	SD	Decision
1.	AI tools improve speaking skills	3.74	.61	Agree
2.	AI tools improve writing skills	3.68	.67	Agree
3.	AI tools improve reading comprehension	3.55	.72	Agree
4.	AI tools improve vocabulary acquisition	3.81	.58	Agree
5.	AI tools improve pronunciation/phonetics	3.47	.79	Agree
	Grand Mean	3.65	.67	Agree

The grand mean of 3.65 ($SD = .67$), which is above the criterion mean of 2.50, indicates that respondents agreed that AI tools contribute meaningfully to the improvement of English language skills.

Research Question 2: To what extent do English language teachers perceive Artificial Intelligence platforms as effective for teaching selected areas of English language pedagogy, including phonetics, grammar, and reading comprehension, in Edo State?

Table 2

Teachers' Perceptions of the Effectiveness of AI Platforms in English Language Pedagogy

S/N	Area of English Language Pedagogy	Mean	SD	Decision
1.	Grammar instruction	3.73	.62	Effective
2.	Reading comprehension	3.66	.65	Effective
3.	Phonetics instruction	3.41	.83	Effective
	Grand Mean	3.58	.70	Effective

Teachers' perceptions of AI's effectiveness in teaching key areas of English language pedagogy were assessed. The overall mean rating for AI's effectiveness in pedagogy was 3.58 ($SD = .70$). Respondents rated AI most effective for Grammar instruction (mean = 3.73, $SD = .62$) and Reading Comprehension (mean = 3.66, $SD = .65$), while Phonetics instruction received the lowest but still positive mean rating (mean = 3.41, $SD = .83$). Qualitative findings from FGDs corroborated these results; one teacher participant noted:

"When I use ChatGPT to generate grammar exercises tailored to students' weaknesses, I save enormous preparation time and the students engage more. But for phonetics, I still find that my live demonstrations are more effective than the AI."

This suggests that while AI is broadly effective in pedagogy, its utility may vary by sub-discipline, particularly for skills requiring an embodied, physical demonstration.

Research Question 3: What ethical concerns do secondary school students and English language teachers perceive to be associated with the use of Artificial Intelligence in English language education in Edo State?

Table 3

Mean Ratings of Perceived Ethical Concerns Associated with the Use of AI in English Language Education (n = 308)

S/N	Ethical Concern	Mean	SD	Decision
1.	Over-dependence on AI tools reduces independent learning	3.71	.64	Agree
2.	AI tools compromise learners' data privacy	3.63	.68	Agree
3.	AI tools contain cultural/linguistic biases	3.57	.74	Agree
4.	AI limits critical thinking development	3.49	.78	Agree
	Grand Mean	3.60	.72	Agree

The grand mean of 3.60 indicates that respondents were broadly concerned about ethical issues in AI-mediated language learning. Over-dependence (mean = 3.71) and data privacy (mean = 3.63) were the most pressing concerns.

Discussion

The findings of this study demonstrate that AI tools hold significant promise for English language acquisition and pedagogy in Edo State. Consistent with Krashen's (1985) Input Hypothesis, AI platforms appear to create conditions for comprehensible input by tailoring content difficulty to learners' proficiency levels, thereby promoting incremental language growth. The finding that grammar and vocabulary were perceived as the areas most improved by AI aligns with Chandra et al. (2024), who documented AI-driven improvements in grammar correction and vocabulary expansion through adaptive exercises. Conversely, the relatively low effectiveness rating for phonetics mirrors FGD insights, suggesting that embodied phonological instruction, requiring tactile, acoustic, and facial-expression cues, may not yet be fully replicable by current AI tools. This has implications for the design of AI-driven phonetics tools, particularly for Nigerian learners navigating the mother-tongue interference.

The strong agreement on ethical concerns, particularly over-dependence and data privacy, echoes the concerns raised by Kovalenko and Baranivska (2024) and Asad et al. (2024). The positive perception of AI effectiveness among teachers suggests a favourable disposition towards the integration of AI into English language education, provided that appropriate regulatory and ethical safeguards are established. This finding offers a useful baseline for policymakers to craft AI integration frameworks for Nigerian secondary education. The absence of a significant perceptual gap between teachers and students is a notable finding in the Nigerian education system, where generational digital divides are often assumed to be significant. This suggests that AI language tools have achieved meaningful penetration across age groups, likely driven by the widespread adoption of mobile-first AI platforms accessible via smartphones.

Conclusion

This study empirically established that AI tools significantly contribute to English language skill acquisition and effective pedagogy among secondary school students and teachers in Edo State. Specifically, AI platforms improve speaking, writing, reading, vocabulary, and to a lesser extent, phonetics instruction. A significant positive relationship existed between the frequency of AI tool usage and self-reported English language performance. Both teachers and students held similar positive perceptions of AI's pedagogical utility, suggesting broad stakeholder readiness for AI integration in Nigerian language education. However, significant ethical concerns centred on over-dependence, data privacy, and algorithmic bias must be addressed to realize AI's full transformative

potential. These findings reinforce the need for evidence-based policies and structured AI integration frameworks within the Nigerian educational system.

Recommendations

Based on the findings, the following recommendations are advanced:

1. Nigerian educational policymakers should develop a national AI integration framework for secondary English language education that specifies content standards, data privacy protocols, and usage guidelines for AI tools.
2. English language curricula should be revised to complement AI-based learning with teacher-led phonetics instruction, where AI tools have been shown to be less effective than human instructors.
3. AI platforms deployed in Nigerian schools should comply with data protection standards consistent with the Nigeria Data Protection Act (NDPA, 2023), and schools should implement digital literacy programs to educate students about data privacy.
4. Teacher professional development programs should include training on AI-assisted pedagogy to prevent over-dependence and maintain critical thinking as a core learning outcome.

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STAKEHOLDERS' AWARENESS, PERCEPTIONS, UTILIZATION AND OBSERVED CHALLENGES OF ARTIFICIAL INTELLIGENCE INTEGRATION IN BUILDING CONSTRUCTION EDUCATION IN TECHNICAL COLLEGES IN EDO STATE

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Abstract

This study investigated stakeholders' awareness, perceptions, utilization, and observed challenges of Artificial Intelligence (AI) integration in Building Construction Education in Technical Colleges in Edo State, Nigeria using a descriptive survey research design. Guided by the Unified Theory of Acceptance and Use of Technology (UTAUT), the population comprised 344 stakeholders, including students, teachers, administrators, parents, and employers involved in building construction education in government-owned Technical Colleges in Edo State. Given the manageable size of the population, a census approach was employed for students, teachers, and administrators, while convenience sampling was used to reach parents and employers who were available and willing to participate during data collection. A total of 333 valid responses were retrieved and analyzed. Data were collected using a structured questionnaire titled Stakeholders' AI Integration in Building Construction Education Questionnaire (SAIBCEQ), with a Cronbach's Alpha reliability coefficient of .82. Mean and standard deviation were used to answer the research questions, while one-way Analysis of Variance (ANOVA) was used to test the hypotheses at the .05 level of significance. Where significant differences existed, Tukey HSD post hoc test was conducted to identify specific stakeholder groups responsible for the observed differences. Findings revealed moderate awareness ($M = 2.59$), favourable perceptions ($M = 3.46$), very low utilization ($M = 1.49$), and high perceived challenges ($M = 3.60$) of AI integration among stakeholders. Significant differences existed among stakeholder groups in awareness, perceptions, and utilization, while no significant difference was found in observed challenges. The study recommended improved digital infrastructure, teacher training, and curriculum integration to enhance AI adoption in Technical Colleges in Edo State.

Keywords: Artificial Intelligence, Building Construction Education, Stakeholders' Awareness, Perceptions, Utilization, Observed Challenges, Technical Colleges

Introduction

The core objective of Technical and Vocational Education and Training (TVET) in Nigeria, like elsewhere across the globe, is to equip students with both academic knowledge and practical skills required in today's technologically dynamic society. This is to ensure that learners graduate as job-ready and self-sustainable individuals, capable of engaging in small-scale enterprises and possessing competencies that align with industry demands. This mandate is aligned with national development priorities and the Sustainable Development Goals (SDGs), particularly Goal 1, 4, and 8, which address 'no poverty', 'quality education', and 'decent work and economic growth' respectively.

Building construction education is one of the most vital trade disciplines offered in Nigerian Technical Colleges, aimed at developing skilled personnel for the built environment. The discipline combines theoretical instruction with hands-on training in areas such as building materials and their properties, basic construction technology, workshop practice, building finishes and maintenance, site tools and equipment, safety practices, and basic construction management. However, the construction industry itself is undergoing rapid technological transformation, with Artificial Intelligence (AI), a branch of computer science focused on building machines that can perform

tasks typically requiring human intelligence. Instead of just following rigid, step-by-step instructions, AI systems learn, reason, and make decisions. Building Information Modelling (BIM), digital simulation platforms, and AI-supported project management systems increasingly shaping professional practice (Akinosho et al., 2020; Olanrewaju et al., 2020). This shift implies that construction technicians are now expected to possess not only manual competencies but also digital skills aligned with contemporary industry standards (Oke et al., 2020; Aghimien et al., 2022).

This study is conceptually anchored on the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Viswanath Venkatesh and colleagues. The model explains technology adoption as a function of key determinants, including performance expectancy, effort expectancy, social influence, and facilitating conditions, alongside moderating factors such as user characteristics and contextual variables. Within the context of this study, stakeholders' awareness of artificial intelligence may be understood as a precursor to expectancy beliefs, while utilization reflects actual use behaviour. Similarly, perceived institutional constraints, availability of infrastructure, and exposure to digital tools align with facilitating conditions that shape adoption outcomes. Differences among students, teachers, administrators, parents, and employers may also reflect variations in social influence and contextual readiness. Although UTAUT was originally developed in organizational and information systems contexts, its application in educational technology research has been widely acknowledged, particularly in explaining uneven patterns of technology adoption across institutional settings. Anchoring this study within the UTAUT framework therefore provides a structured basis for interpreting how stakeholder characteristics and environmental factors interact to influence the integration of artificial intelligence in building construction education.

The rapid advancement of artificial intelligence continues to reshape industrial practices and educational expectations across multiple sectors, particularly within engineering and construction. In recent years, AI-enabled systems have increasingly been applied in areas such as design optimization, predictive maintenance, construction scheduling, and risk assessment, signaling a shift toward data-driven decision-making in construction processes (Oesterreich & Teuteberg, 2021; Pan & Zhang, 2021). This transformation is closely linked to broader digitization trends associated with Industry 4.0, where automation, big data, and intelligent systems are redefining productivity and efficiency across the built environment (Bilal et al., 2021). Although these developments are more pronounced in advanced economies, their influence is gradually extending to developing contexts, though often constrained by infrastructural and institutional limitations (Whyte, 2019; Wang & Chen, 2023). Nevertheless, despite its considerable transformative potential, increasing attention is being drawn to the possible adverse implications of AI adoption, particularly in relation to ethical concerns, data privacy, skill displacement, and over-reliance on automated decision systems if not adequately regulated (Dwivedi et al., 2023; UNESCO, 2023).

However, within education sector in Nigeria, particularly TVET, the integration of emerging technologies such as artificial intelligence remains highly uneven. Global studies suggest that while digital transformation is increasingly central to education policy, vocational institutions frequently lag behind due to limited infrastructure, inadequate teacher preparedness, and rigid curricula that are slow to respond to technological change (Zawacki-Richter et al., 2020; UNESCO, 2021; OECD, 2021). These challenges are not merely technical but also structural, reflecting deeper issues of funding, governance, and institutional capacity (Baker & Smith, 2019). In many contexts, including developing countries, this results in a situation where awareness of AI exists, but meaningful classroom integration remains limited (Ifenthaler & Yau, 2020).

In Nigeria, the integration of AI and digital technologies within TVET reflects broader systemic challenges. Studies have identified persistent issues such as inadequate funding, insufficient ICT infrastructure, and limited professional development opportunities for educators, all of which restrict effective technology integration (Olanrewaju et al., 2020; Aghimien et al., 2022). Within technical colleges offering building construction, these constraints are further intensified by the practical nature of the discipline, which relies heavily on workshop-based instruction and manual

skill development. As a result, digital tools, including AI-supported applications, are often absent from formal teaching and learning processes.

Students in technical colleges represent a critical group in this transition. At graduation in building construction programme, they are expected to have acquired competencies that reflect both traditional construction practices and emerging technological trends. However, evidence suggests that their exposure to AI-related tools is often limited or informal, largely dependent on individual capacity rather than institutional structured curriculum design (Luckin et al., 2016; Holmes et al., 2019). While many students may access digital technologies independently, particularly through mobile devices, the absence of guided instructional use limits the educational value of such exposure.

Teachers also play a central role in determining the extent to which artificial intelligence can be integrated into instructional practice. Their pedagogical competence, technological literacy, and willingness to adopt new tools significantly influence learning outcomes. However, research indicates that many educators in vocational settings face challenges in adapting to digital technologies due to insufficient training and lack of institutional support (Zawacki-Richter et al., 2020; Bower, 2021). This often results in continued reliance on traditional teaching methods, even where digital alternatives may offer improved instructional effectiveness.

Administrators, including principals and vice principals, influence institutional readiness through policy implementation, resource allocation, and strategic planning. Yet, their capacity to drive technological transformation is often constrained by financial limitations and competing institutional priorities. Even where there is awareness of the importance of digitalization, implementation tends to remain gradual and fragmented due to systemic constraints (Baker & Smith, 2019; OECD, 2021).

Parents constitute another key stakeholder group whose perceptions and expectations shape the acceptance of technological innovations in education. Parental attitudes toward AI integration can influence students' motivation, access to digital resources at home, and overall support for technology-enhanced learning. In many developing contexts, however, parents' awareness of AI remains limited, and concerns about costs, relevance, and job displacement often affect their willingness to encourage digital skill acquisition among their children (Ifenthaler & Yau, 2020; UNESCO, 2021).

From the industry perspective, employers in the construction sector are increasingly adopting digital tools to enhance efficiency, accuracy, and project management outcomes. Although full-scale artificial intelligence adoption is still emerging in many local contexts, there is growing emphasis on digital competence, adaptability, and familiarity with technology-supported construction processes (Oesterreich & Teuteberg, 2021; McKinsey Global Institute, 2021). This evolving expectation creates pressure on educational institutions to align training outcomes with industry requirements, particularly in preparing graduates for digitally mediated work environments (World Economic Forum, 2020). The mismatch between industry expectations and the skills produced by technical colleges underscores the need to examine how AI is currently perceived and utilized within building construction education.

AI tools in building construction education is programmed to leverage natural language processing, machine learning, and generative models to support both instructors and students. For example, generative AI (e.g., Ernie Bot and ChatGPT) is used to provide personalized learning experiences by analyzing students' performance data and tailoring educational content to meet individual needs (Yoon et al., 2024). In building technology specifically, empirical studies show that AI integration enhances skills acquisition and employability. A study on building technology undergraduates in Oyo State found that AI tools positively influence both soft and technical skills development, helping students to set up and manage construction-related ventures (Ayoola, 2025). Similarly, Ogbebor (2025) reported significant positive correlations between AI tool usage and TVET students' learning abilities, problem-solving, and critical thinking skills in South-South Nigeria, including Edo State. Within construction education, AI-powered Building Information Modelling (BIM) and intelligent tutoring systems provide step-by-step visualization, virtual project

work, and personalized feedback (Tola, 2022; Wang et al., 2023; Abdulmumin & Adebisi, 2023). In a typical classroom and building construction workshop, teachers can use any suitable available number of AI tools to assign construction tasks based on each student's learning pace and proficiency level. This personalized guidance enhances students' understanding of complex concepts and allows teachers to focus on providing more targeted support (Yi et al., 2024). This approach could enhance instructors in technical colleges Edo State to focus on targeted mentorship while students engage with adaptive simulations that mirror actual site challenges, bridging the gap between theory and practice. Such applications align with NBTE's push to decentralize AI and machine learning tools for polytechnics and technical colleges, using offline, Linux-based platforms to overcome connectivity barriers (Vanguard News, 2025). International reviews also highlight that generative AI applications in architecture, engineering, and construction are reshaping practice and education, with implications for upskilling and curriculum redesign (Onatayo et al., 2024).

Statement of the Problem

Overall, the literature points to a widening gap between technological advancement in the construction industry and its integration within vocational education systems. While industry practices are increasingly shaped by artificial intelligence and digital tools, Technical Colleges in Nigeria, particularly Edo State, appear to be transitioning at a slower pace, resulting in potential mismatches between graduate competencies and workplace expectations. Despite growing global interest in artificial intelligence in education, empirical studies focusing specifically on building construction education within technical colleges in developing contexts remain limited. Much of the existing research has focused on higher education or general digital learning environments, leaving vocational and trade-specific disciplines underexplored (Holmes et al., 2019; Zawacki-Richter et al., 2020). It is against this background that the present study examines stakeholder perspectives on the integration of artificial intelligence in building construction education in Technical Colleges in Edo State, Nigeria.

Research Questions

The study was guided by the following research questions:

1. What are the levels of awareness, perceptions, utilization, and observed challenges of Artificial Intelligence integration among stakeholders in building construction education in Technical Colleges in Edo State?
2. What differences exist in stakeholders' awareness of AI integration in building construction education in Technical Colleges in Edo State?
3. What differences exist in stakeholders' perceptions of AI integration in building construction in Technical Colleges in Edo State?
4. What differences exist in the level of utilization of AI among stakeholders' in building construction in Technical Colleges in Edo State?
5. What differences exist in stakeholders' observed challenges of AI integration in building construction in Technical Colleges in Edo State, Nigeria?

Methods

The study adopted a descriptive survey research design. This design was used to collect quantitative data on stakeholders' awareness, perceptions, utilization, and observed challenges of Artificial Intelligence integration in building construction education in Technical Colleges in Edo State, without manipulating any variable. It also allowed for comparison of responses across the five stakeholder groups.

The population of the study comprised all stakeholders involved in building construction education in the five Edo State government-owned Technical Colleges. The total accessible

population was 344, consisting of 160 final-year students, eight teachers, 10 administrators, 80 employers, and 86 parents. Given the relatively manageable size of the population, a census approach was adopted for students, teachers, and administrators, whereby all individuals in these categories were included in the study. However, convenience sampling was employed to select parents and employers who were readily available and willing to participate during the period of data collection.

Data were collected using a structured questionnaire titled “Stakeholders’ AI Integration in Building Construction Education Questionnaire (SAIBCEQ)”. The questionnaire was divided into five sections: demographic information, awareness of Artificial Intelligence, perceptions of AI integration, utilization of AI tools, and observed challenges. Items were rated on a 4-point scale ranging from Strongly Agree (4) to Strongly Disagree (1).

The instrument was subjected to face and content validation by two experts in building construction education in Technical and Vocational Education and Training (TVET) and one expert in Measurement and Evaluation from a Nigerian university. Their suggestions were incorporated to improve clarity, relevance, and appropriateness of the items.

To establish reliability, the questionnaire was pilot-tested on 20 respondents with similar characteristics outside the study area. The data obtained were analyzed using Cronbach’s Alpha, which yielded a reliability coefficient of .82. This indicated that the instrument was internally consistent and suitable for the study.

The questionnaire was administered directly by the researcher with the assistance of two trained research assistants who were familiar with the technical college environment in Edo State. Prior to administration, approval was obtained from the principals of the selected Technical Colleges and from the management of the participating construction firms.

For students and teachers, the questionnaires were distributed and collected during regular school hours in classroom settings to ensure focused responses. For administrators and employers, the questionnaires were administered at their offices and project sites respectively at agreed times to avoid disruption of work. For parents, the questionnaires were administered during Parents’ Teachers Association (PTA) meetings and through home visits. Where respondents had limited literacy, research assistants read out the items in simple English or the local language and recorded the responses without influencing their answers. All completed questionnaires were retrieved immediately. Out of 344 copies distributed, 333 were successfully retrieved and used for analysis, representing a 96.8% return rate.

The data collected were analyzed using both descriptive and inferential statistics with the aid of the Statistical Package for the Social Sciences (SPSS) version 25. Mean and standard deviation were used to answer Research Questions 1, with a criterion mean of 2.50 adopted as the benchmark. One-way Analysis of Variance (ANOVA) was used to answer the research questions 2-4 and test the corresponding null hypotheses at the .05 level of significance in a single table for each hypothesis test. Where significant differences were found, Tukey’s HSD post-hoc test was conducted to identify the specific groups that differed. All assumptions were ascertained, supporting the use of one-way ANOVA: normality was assessed using Shapiro-Wilk tests and visual inspection of Q-Q plots. Homogeneity of variance was tested using Levene’s test. Effect sizes were calculated using partial eta squared.

Results

Research Question 1: What are the levels of awareness, perceptions, utilization, and observed challenges of Artificial Intelligence integration among stakeholders in building construction education in Technical Colleges in Edo State?

Table 1

Descriptive Statistics of Stakeholders' Responses on AI Awareness, Perceptions, Utilization and Observed Challenges in Building Construction Education Technical Colleges in Edo State

	N	Minimum	Maximum	Mean	Std. Deviation
Awareness	333	1.00	4.00	2.5916	.86508
Perception	333	1.00	4.00	3.4625	.59814
Utilization	333	1.00	3.00	1.4865	.61407
Challenges	333	3.00	4.00	3.5976	.49112

Table 1 shows descriptive statistics (N = 333) on stakeholders' awareness, perception, utilization, and observed challenges of AI integration in Building Construction Education in Technical Colleges in Edo State, measured on a 4-point scale. Overall, stakeholders' awareness of AI was moderate (M = 2.59, SD = .87), indicating a basic but uneven level of familiarity, with variability suggesting inconsistent exposure across respondents. In contrast, perception of AI integration was high (M = 3.46, SD = .60), reflecting generally favourable views regarding its relevance and potential, alongside relatively strong agreement among stakeholders.

Despite this positive disposition, utilization of AI was very low (M = 1.49, SD = .61), indicating minimal practical application in teaching and learning and revealing a clear disconnect between awareness and perception and actual implementation. Meanwhile, observed challenges were rated very high (M = 3.60, SD = .49), with strong consensus that significant barriers, likely including infrastructural deficits, inadequate training, limited funding, and low institutional readiness are impeding integration. Collectively, the findings indicate a pronounced imbalance: although stakeholders are positively disposed toward AI and strongly acknowledge existing constraints, actual usage remains minimal. This suggests that AI integration in technical college building construction education in Edo State is still at an early stage, primarily constrained by systemic and practical barriers rather than negative attitudes.

Hypothesis 1: There is no significant difference in awareness of AI integration in building construction education among stakeholders in Technical Colleges in Edo State.

Table 2

One-way ANOVA on Stakeholders' Awareness of AI

Awareness	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	159.780	4	39.945	147.751	.000
Within Groups	88.676	328	.270		
Total	248.456	332			

Note: $\eta^2 = .64$. Tukey HSD: students–teacher (MD = -1.57, $p < .001$); students–administrators (MD = -.79, p

$< .001$); students–employer (MD = -1.49, $p < .001$); teacher–administrators (MD = .78, $p = .011$); teacher–

parents (MD = 1.73, $p < .001$); administrators–parents (MD = .95, $p < .001$); administrators–employer (MD =

-.70, $p = .001$); parents–employer (MD = -1.65, $p < .001$); employer–parents (MD = 1.65, $p < .001$).

The one-way ANOVA in Table 2 revealed a statistically significant difference in stakeholders' awareness of AI integration, $F(4, 328) = 147.75$, $p < .001$, $\eta^2 = .64$. The effect size was large, indicating that 64% of the variance in awareness scores was accounted for by stakeholder group.

Therefore, the null hypothesis was rejected, suggesting that stakeholder group significantly influences awareness of AI integration in building construction education in Technical Colleges in Edo State. The Post hoc analysis using Tukey HSD indicated that differences existed across stakeholder groups, with employers and teachers generally reporting higher awareness than students, administrators, and parents, though with mixed pairwise variations as detailed in the post hoc results.

Hypothesis 2: There is no significant difference in perceptions of AI integration in building construction education among stakeholders in Technical Colleges in Edo State.

Table 3

One-way ANOVA on Stakeholders' Perceptions of AI Integration

Perception	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27.690	4	6.922	24.926	.000
Within Groups	91.091	328	.278		
Total	118.781	332			

Note: $\eta^2 = .23$. Tukey HSD: students–teacher (MD = .94, $p < .001$); students–administrators (MD = 1.30, $p < .001$); teacher–parents (MD = -.87, $p < .001$); teacher–employer (MD = -1.13, $p < .001$); administrators–parents (MD = -1.23, $p < .001$); administrators–employer (MD = -1.49, $p < .001$); parents–employer (MD = .26, $p = .016$).

The one-way ANOVA in Table 3 revealed a statistically significant difference in stakeholders' perceptions of AI integration, $F(4, 328) = 24.93$, $p < .001$, $\eta^2 = .23$. The effect size indicated that 23% of the variance in perception scores was accounted for by stakeholder group. Therefore, the null hypothesis was rejected, suggesting that stakeholder group significantly influences perceptions of AI integration in building construction education in Technical Colleges in Edo State. Post hoc analysis using Tukey HSD indicated that differences existed across stakeholder groups, with students, parents, and employers generally reporting more favourable perceptions than teachers and administrators, though with mixed pairwise variations as detailed in the post hoc results.

Hypothesis 3: There is no significant difference in the level of utilization of AI among stakeholders in building construction education in Technical Colleges in Edo State.

Table 4

One-way ANOVA on Stakeholders' Level of Utilization of AI

Utilization	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.763	4	7.191	24.460	.000
Within Groups	96.426	328	.294		
Total	125.189	332			

Note: $\eta^2 = .64$. Tukey HSD: students–teacher (MD = -1.57, $p < .001$); students–administrators (MD = -.79, $p < .001$); students–employer (MD = -1.49, $p < .001$); teacher–administrators (MD = .78, $p = .011$); teacher–parents (MD = 1.73, $p < .001$); administrators–parents (MD = .95, $p < .001$); administrators–employer (MD = -.70, $p = .001$); parents–employer (MD = -1.65, $p < .001$); employer–parents (MD = 1.65, $p < .001$).

The One-way ANOVA in Table 4 revealed a statistically significant difference in stakeholders' level of utilization of AI, $F(4, 328) = 24.460$, $p < .05$. This indicates that stakeholders differed significantly in their levels of AI utilization. The effect size was large ($\eta^2 = .64$), implying that approximately 64% of the variance in AI utilization was attributable to differences among the stakeholder groups. Consequently, the null hypothesis was rejected. This suggests a substantial practical significance of the observed differences.

The Tukey HSD post hoc test conducted indicated that employers and teachers demonstrated relatively higher levels of AI utilization compared to parents and administrators, while parents consistently recorded the lowest utilization levels. Overall, although the utilization of AI remained generally low across stakeholders, the extent of utilization varied significantly among the groups.

Hypothesis 4: There is no significant difference in the observed challenges of AI integration among stakeholders in building construction education in Technical Colleges in Edo State.

Table 5: One-way ANOVA on Stakeholders' Observed Challenges of AI Integration

Challenges	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.179	4	.545	2.294	.059
Within Groups	77.899	328	.237		
Total	80.078	332			

Note: $\eta^2 = .03$, $p > .05$

The ANOVA result in Table 5 reveals a non statistically significant difference among stakeholders regarding their observed challenges associated with AI integration in building construction education in Technical Colleges in Edo State. The result revealed that there was no statistically significant difference among the stakeholder groups in their observed challenges of AI integration in building construction education, $F(4, 328) = 2.294$, $p = .059$. Since the p-value (.059) was greater than the .05 level of significance. Therefore, the null hypothesis was retained. This implies that the stakeholders shared relatively similar views concerning the challenges confronting AI integration in Technical Colleges in Edo State. The effect size analysis further indicated a small magnitude of difference among the groups ($\eta^2 = .027$). This suggests that stakeholder group accounted for only 2.7% of the variance in perceived challenges of AI integration. Consequently, post hoc multiple comparison tests were not conducted because the omnibus ANOVA result was not statistically significant.

Discussion of Findings

Awareness of AI Integration Among Stakeholders

The findings revealed notable disparities in AI awareness across stakeholder groups. Employers demonstrated the highest level of awareness, a finding that aligns with the increasing integration of AI-enabled systems in the construction industry for tasks such as design optimization, predictive maintenance, and risk assessment (Oesterreich & Teuteberg, 2021; Pan & Zhang, 2021). Their direct exposure to digital transformation pressures naturally positions them as the most informed group (McKinsey Global Institute, 2021). Parents also showed relatively high awareness, which contrasts with earlier studies that reported limited parental knowledge of AI in developing contexts (Ifenthaler & Yau, 2020; UNESCO, 2021). This may reflect growing media coverage and community awareness of digital economy demands in Edo State, possibly influenced by recent NBTE initiatives promoting AI in technical colleges (Vanguard News, 2025).

Conversely, teachers and administrators recorded substantially lower awareness. This finding is consistent with the work of Zawacki-Richter et al. (2020) and Bower (2021), who found that

vocational educators often lack sufficient training and institutional support to keep pace with technological change. The wide variability in teachers' responses suggests inconsistent access to professional development across institutions, a pattern also observed by Ifenthaler and Yau (2020). Students, while showing moderate awareness, exhibited considerable variability, indicating that their knowledge of AI may be driven more by personal digital engagement than by formal curriculum exposure (Luckin et al., 2016; Holmes et al., 2019).

Perceptions of AI Integration Among Stakeholders

Students, parents, and employers held significantly more favourable perceptions of AI integration compared to teachers and administrators. Students' positive outlook supports the findings of Ayoola (2025), who reported that AI tools enhance both soft and technical skills among building technology undergraduates. The potential for personalized, adaptive learning experiences such as AI-generated construction tasks tailored to individual proficiency levels (Yi et al., 2024; Yoon et al., 2024) likely appeals to students.

Parents' favourable perceptions, despite their low actual utilization (discussed below), suggest an aspirational or supportive attitude toward AI in education. This deviates from earlier concerns about parental resistance due to job displacement fears (UNESCO, 2021). It may indicate that parents in Edo State recognize the future importance of digital skills, even if they themselves do not currently use AI tools.

In contrast, teachers and administrators held less favourable perceptions, mirroring documented educator resistance to AI adoption. Baker and Smith (2019) and Selwyn (2021) attributed such resistance to fears of professional displacement, inadequate training, and unclear implementation frameworks. Additionally, the hands-on, workshop-based nature of building construction instruction may make teachers more skeptical about the relevance of AI to traditional skill development (Aghimien et al., 2022).

Utilization of AI Integration Among Stakeholders

The most striking finding is the critically low level of AI utilization across all stakeholder groups, despite moderate awareness and favourable perceptions. Employers reported the highest utilization, yet even their mean score remained far below the criterion for meaningful integration. This reflects the nascent state of AI adoption in Nigeria's construction sector, where barriers such as high costs, lack of infrastructure, and limited digital literacy persist (Babatunde et al., 2020; Aghimien et al., 2022).

Teachers and students showed similarly low utilization, with teachers scoring only slightly higher than students. This is concerning because teachers are the primary agents of curriculum delivery; their inability to integrate AI into instruction directly limits students' exposure (Holmes et al., 2019). The lack of significant difference between teachers and employers in utilization, both low, suggests that the education sector is not uniquely lagging; rather, the entire construction ecosystem in Edo State is still transitioning toward AI adoption.

Administrators recorded very low utilization, which aligns with institutional-level constraints identified by the Baker and Smith (2019) and OECD (2021), including insufficient funding, competing priorities, and lack of strategic planning for digital transformation.

Parents recorded the lowest utilization of all groups, with mean scores approaching "strongly disagree." This finding is consistent with Ifenthaler and Yau (2020), who noted that parents in developing contexts often lack direct access to AI technologies due to cost, low digital literacy, and limited relevance to their daily occupations. The wide gap between parents' relatively high awareness and extremely low utilization indicates a failure of technology diffusion to reach households, a critical issue because parental support and home access are known enablers of students' digital learning (UNESCO, 2021).

Collectively, these findings reveal an awareness-utilization paradox: stakeholders know about AI and view it positively, but they do not use it. This gap represents the fundamental barrier to AI integration in building construction education in Edo State.

Observed Challenges of AI Integration

All stakeholder groups strongly and consistently agreed on the existence of substantial barriers to AI integration, with no statistically significant differences in their perceptions of these challenges. This consensus points to systemic, widely recognized obstacles such as inadequate funding, insufficient ICT infrastructure, limited teacher training, rigid curricula, and high implementation costs. These findings mirror those of Aghimien et al. (2022), Babatunde et al. (2020), and Oke et al. (2020), who documented similar barriers in Nigerian construction education and practice.

The near-significant trend ($p = .059$) suggests that with a larger sample or different context, some differences might emerge, for instance, teachers might prioritize pedagogical challenges while administrators focus on financial constraints. Nevertheless, the strong agreement across groups underscores that the challenges are neither hidden nor disputed; rather, the problem lies in translating recognition into action.

Conclusion and Recommendations

This study examined the awareness, perceptions, utilization, and observed challenges of Artificial Intelligence integration in building construction education in state government-owned Technical Colleges in Edo State, Nigeria, drawing on the Unified Theory of Acceptance and Use of Technology (UTAUT). Data from the respondents across five the stakeholder groups (students, teachers, administrators, parents, and employers) revealed a critical and consistent pattern. Stakeholders demonstrated moderate awareness and favourable perceptions of AI, yet actual utilization was universally low. Employers, while the highest utilization, still scored below meaningful integration levels, indicating that AI adoption in Edo State's construction industry remains nascent. Parents, despite moderately high awareness, recorded the lowest utilization, pointing to a profound disconnect between knowing about AI and having practical access or skills to use it. Teachers and students, who are central to the educational process, also showed very low utilization, reflecting a lack of structured curriculum integration and inadequate teacher preparation. Administrators, with the lowest awareness and very low utilization, represent a leadership gap in driving institutional change.

All stakeholder groups strongly concurred on the existence of major barriers, including infrastructure deficits, insufficient funding, limited teacher training, and rigid curricula. The study confirms that stakeholder group significantly influences awareness, perceptions, and utilization, while challenges are perceived similarly across groups.

The overarching conclusion is that Edo State's Technical Colleges face an awareness-utilization paradox and a triple gap: between knowledge and action, between industry expectations and educational outcomes, and between policy rhetoric and classroom reality. Without deliberate, evidence-based interventions that move beyond raising awareness to enabling actual use of AI tools, the building construction workforce will remain ill-prepared for an increasingly digitalized industry.

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

1. Policy Makers should mandate AI utilization benchmarks, fund infrastructure and teacher training, and enforce industry-education partnerships.
2. College Administrators should revise curricula to include hands-on AI modules, establish accessible AI workshops, and undergo leadership training.
3. Teachers should adopt micro-integration of AI tools and form peer learning networks with industry support.

4. Collaboration between college administrators and Parents Teachers Association should be fostered on the basis of community digital literacy classes especially parent-child AI projects with subsidized home access.
5. Employers should provide AI-focused internships, donate equipment and staff time, and join curriculum advisory committees.
6. Researchers should conduct intervention and qualitative studies on utilization barriers and comparative cross-context analyses.
7. Edo State Government should launch a pilot utilization project with monitoring benchmarks and annual recognition awards.

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TECHNOLOGICAL UTILIZATION AND SECONDARY SCHOOL RECORDS MANAGEMENT PERFORMANCE

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Abstract

This study examined the impact of technological utilization on secondary school records management performance in Esan West Local Government Area of Edo State, Nigeria. Specifically, it investigated the relationship between technology adoption and two performance indicators data processing and retrieval speed, and accuracy of records. The study employed a survey research design, using a structured questionnaire administered to all 85 teachers from eight public secondary schools through census sampling. Data were analyzed using percentages for descriptive statistics and Pearson correlation for hypothesis testing. Findings revealed a strong positive relationship ($r = .84$) between technological utilization and records management performance, indicating that schools using tools such as Microsoft Excel, OpenSIS, and Google Workspace achieved faster data retrieval and greater accuracy. However, challenges such as inadequate ICT infrastructure, limited training, and unstable electricity supply hindered optimal results. The study recommends improved ICT facilities, regular staff training, and policy support to enhance sustainable records management.

Keywords: Accuracy of Records, Records Management, Retrieval Speed, Secondary Schools, Technological Utilization.

Introduction

The management of school records has evolved significantly over the past century, shifting from simple manual record books to complex, technology-driven systems. Historically, Nigerian secondary schools, like many in developing countries, relied on manual record-keeping methods involving paper registers, filing cabinets, and handwritten reports. While these methods were functional, they were prone to errors, misplacement, and delays in data retrieval (Adewale, 2008). With the advent of the digital age in the late 20th century, developed nations began adopting electronic data management systems, which drastically improved accuracy and retrieval efficiency (Smith & Taylor, 2019).

In the 21st century, educational institutions worldwide increasingly rely on technology to enhance operational efficiency, particularly in the management of school records. Records management is central to administrative effectiveness, student tracking, decision-making, and policy compliance (Okoye & Adeyemi, 2021). Modern digital tools such as Student Information Systems (SIS), cloud-based storage, biometric attendance systems, and database management software have transformed traditional manual processes into faster, more reliable systems (Chen & Wu, 2017).

In Nigeria, public secondary schools are gradually adopting these technological solutions, though the pace varies due to infrastructural, financial, and training limitations (Eze & Omoregie, 2022). In Edo State, especially within public secondary schools, the integration of tools such as digital registers, automated grading systems, and centralized databases is becoming more common. These technologies promise to improve data processing and retrieval speed and enhance the accuracy of records, which are vital components of internal efficiency (Johnson, 2020).

However, despite this progress, the extent to which technological utilization influences these specific performance indicators remains underexplored in local contexts. This study seeks to bridge

that gap by examining the relationship between technological utilization and records management performance in public secondary schools in Edo State, focusing specifically on data processing & retrieval speed and accuracy of records as core variables. Also, the global trend towards digitization in school administration, many public secondary schools in Edo State still rely partly on manual record-keeping systems (Eze & Omoregie, 2022). These outdated methods are prone to errors, delays, and data losses, which hinder internal efficiency (Okoye & Adeyemi, 2021). Even when technology is adopted, challenges such as inadequate training, poor infrastructure, and limited access to modern tools reduce its impact on retrieval speed and record accuracy (Johnson, 2020; Akinola & Igbinoba, 2023). As a result, school administrators may struggle with decision-making, student tracking, and compliance reporting (Smith & Taylor, 2019). This research seeks to investigate how technological utilization influences the speed of data processing and retrieval and the accuracy of records in public secondary schools in Esan West Local Government Area of Edo State.

Literature Review

Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM) developed by Davis (1989), which explains how users come to accept and effectively use technology. This study is anchored on the Technology Acceptance Model (TAM), which explains that the adoption of school record technologies depends on perceived usefulness and ease of use (Davis, 1989). The model posits that two primary factors Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) determine an individual's willingness to adopt a technological system. Perceived Usefulness refers to the degree to which a user believes that using a particular technology will enhance their job performance, while Perceived Ease of Use refers to the extent to which the user expects the system to be free of effort (Venkatesh & Davis, 2000). In the context of secondary school records management, administrators and teachers are more likely to adopt and effectively use digital record-keeping systems if they perceive them as both useful for improving retrieval speed and record accuracy, and easy to operate without extensive technical knowledge (Okafor & Uche, 2022). This aligns with findings by Akinola and Igbinoba (2023), who noted that schools with trained personnel and intuitive software platforms tend to achieve higher performance in records management. Technological utilization measured through digital record-keeping tools and automation of processes is expected to improve records management performance, reflected in retrieval speed and accuracy of records. The framework assumes that when schools have access to reliable ICT infrastructure and trained staff, technology adoption will significantly enhance records management outcomes. Therefore, TAM provides a suitable theoretical lens for examining how technological utilization impacts data processing & retrieval speed and accuracy of records in public secondary schools in Edo State.

Conceptual Review

Technological utilization in education refers to the deliberate integration of digital tools, software applications, and computerized systems into administrative and instructional processes to improve efficiency, accuracy, and overall performance (Okafor & Uche, 2022). In the context of school records management, it specifically relates to the deployment of digital record-keeping systems that enhance accessibility, minimize redundancy, and improve the reliability of stored data (Eze & Omoregie, 2022). Traditionally, record-keeping in Nigerian secondary schools involved manual processes such as handwritten registers, physical files, and paper-based archives. While functional in earlier decades, these methods were slow, error-prone, and vulnerable to damage or loss (Adewale, 2008). The increasing demand for timely and accurate information in modern school administration has necessitated a shift toward technology-based solutions, including Student Information Systems (SIS), cloud-based storage, and biometric attendance systems (Johnson, 2020).

Technological utilization in school records management focuses on improving two critical dimensions: data processing and retrieval speed and accuracy of records. Retrieval speed refers to how quickly data can be accessed, updated, and shared within the school system, a process that digital platforms can execute in seconds compared to the minutes or hours required by manual systems (Smith & Taylor, 2019). Accuracy of records involves the precision and correctness of stored information, which is significantly enhanced by automated data entry, error-checking features, and secure backup systems (Chen & Wu, 2017). In Nigeria, especially in public secondary schools in Edo State, the adoption of technological tools has been gradual due to infrastructural, financial, and training challenges (Akinola & Igbino, 2023). Nevertheless, where effectively implemented, technology has been shown to improve administrative efficiency, reduce workload, and provide reliable, real-time data for decision-making (Okoye & Adeyemi, 2021). Understanding the conceptual link between technological utilization and school records management performance is, therefore, vital to improving internal efficiency in secondary education.

Technological Utilization

Technological utilization in schools refers to the intentional adoption and application of digital devices, specialized software, and online services to manage student, staff, and institutional data more effectively (Okafor & Uche, 2022). This integration often includes tools such as Student Information Systems (SIS), which centralize academic, personal, and disciplinary records; biometric attendance systems, which automate and secure the monitoring of staff and student presence; and online grade management platforms, which enable real-time entry, computation, and reporting of academic performance (Johnson, 2020). The essence of technological utilization lies in its ability to enhance both the speed and accuracy of school administrative tasks while significantly reducing manual workload (Smith & Taylor, 2019). Through cloud-based storage and data synchronization, records become accessible from multiple devices and locations, ensuring timely retrieval and updating of information (Chen & Wu, 2017). According to Okoye & Adeyemi, (2021), In Nigerian secondary schools, especially in Edo State, the use of technology has gradually improved administrative efficiency, despite infrastructural and training challenges (Akinola & Igbino, 2023). Proper utilization of these technologies can lead to faster decision-making, more reliable data storage, and better compliance with educational policies, thereby supporting the overall goal of internal efficiency in school management.

Digital Record-Keeping Tools

Digital record-keeping tools such as Microsoft Excel, Google Workspace, OpenSIS, and EduAdmin provide schools with structured data storage, rapid retrieval, and simplified analysis of educational records (Johnson, 2020). These platforms support automated calculations, searchable databases, and secure cloud backups, thereby minimizing redundancy and human error (Chen & Wu, 2017). The shift from paper-based methods to digital tools has significantly reduced the risk of record loss due to physical damage while enhancing data security and accessibility (Okafor & Uche, 2022). As a result, school administrators can make timely, evidence-based decisions that improve operational efficiency.

Secondary School Records Management Performance

Secondary school records management performance refers to the efficiency and effectiveness with which educational institutions store, process, retrieve, and safeguard essential administrative and academic information (Okoye & Adeyemi, 2021). Effective records management ensures that data on student enrollment, attendance, grades, disciplinary actions, and staff profiles is accurate, complete, and accessible when needed (Eze & Omoregie, 2022).

Performance in this context is often measured by two critical indicators: retrieval speed and accuracy of records. Retrieval speed relates to how quickly stored information can be accessed, a factor that technology has greatly improved through features like instant search functions, automated

indexing, and centralized databases (Smith & Taylor, 2019). Accuracy of records refers to the precision and reliability of stored data, which is enhanced by automated validation tools and reduced human error in data entry (Chen & Wu, 2017).

In Nigerian public secondary schools, efficient records management contributes to better decision-making, timely reporting to educational authorities, and improved communication with stakeholders (Akinola & Igbino, 2023). Conversely, poor performance in records management can lead to delays, misinformation, and administrative inefficiencies. Therefore, optimizing performance through appropriate technological utilization is essential for ensuring internal efficiency and accountability in the education sector (Johnson, 2020).

Retrieval Speed

Retrieval speed in school records management refers to the time taken to access, extract, and present stored information for administrative or academic purposes (Smith & Taylor, 2019). In traditional manual systems, retrieving specific data could take minutes or even hours due to the need to physically locate, sort, and verify paper records. However, the integration of digital technologies has revolutionized this process by enabling near-instant access through search functions, automated indexing, and cloud-based platforms (Chen & Wu, 2017).

Fast retrieval of records is crucial for decision-making, report generation, and timely responses to stakeholder inquiries (Okafor & Uche, 2022). For example, school administrators can quickly generate attendance reports, academic transcripts, or disciplinary summaries without sifting through physical files. This efficiency also supports compliance with regulatory requirements and improves service delivery to students and parents (Johnson, 2020).

In Nigerian public secondary schools, especially in Edo State, retrieval speed is often hindered by inadequate infrastructure, unstable electricity, and insufficient staff training on digital systems (Akinola & Igbino, 2023). Nonetheless, schools that effectively utilize digital tools experience significant improvements in administrative turnaround time, contributing to higher overall performance in records management.

Empirical Review

Adeyemi (2021) surveyed the Impact of ICT Adoption on Records Management in Public Schools, Lagos, Nigeria. This study examined the influence of ICT tools on record retrieval efficiency in 10 public secondary schools. A descriptive survey design was used, with questionnaires administered to 150 teachers selected through stratified random sampling. Data were analyzed using Pearson correlation. Findings showed a strong positive relationship ($r = 0.81$) between ICT adoption and retrieval speed. The study concluded that integrating ICT significantly reduces delays in administrative processes.

Omorie and Ehimen (2020) examined a study on digital tools and educational administration, Benin City, Nigeria. The researchers investigated the impact of digital platforms on records accuracy in 12 public schools. A total of 96 administrative staff participated in the study. Data were collected via structured questionnaires and analyzed with descriptive statistics and regression. Results indicated that schools using automated record-keeping had a 65% improvement in accuracy compared to manual systems. The authors concluded that digital tools reduce human error and enhance data reliability.

Smith and Taylor (2019) did a study on Technology and School Management Efficiency, Manchester, United Kingdom. This mixed-method study surveyed 120 school administrators and conducted time-motion analysis of record retrieval. Quantitative data were analyzed using t-tests, while qualitative interviews provided context. Technology use reduced retrieval times by an average of 48%. The authors concluded that digital systems are vital for timely decision-making in schools.

Usman (2018) did a study on ICT in School Record Management, Abuja, Nigeria. A cross-sectional survey of 100 teachers from 15 public schools examined ICT's effect on accuracy and speed. Data were analyzed with Spearman's rank correlation. The study found significant

improvements in both indicators where ICT was adopted, but inadequate infrastructure limited benefits. It concluded that investment in facilities is essential.

Chen and Wu (2017) examined Cloud-Based Student Information Systems, Beijing, China. The study used an experimental design comparing two schools one using cloud-based SIS and the other manual methods. Data on retrieval time and accuracy were collected over six months. The digital system reduced retrieval time by 50% and record errors by 72%. The conclusion emphasized cloud systems as a sustainable solution.

Johnson (2016) examined ICT Application in Educational Data Management, Cape Town, South Africa. This survey research involved 90 school administrators from 20 schools. Data were analyzed using correlation and regression analysis. Findings showed a significant relationship between ICT use and retrieval speed ($r = .76$). The conclusion highlighted the importance of ongoing training to sustain performance gains.

The literature reviewed shows that technological utilization improves secondary school records management by enhancing retrieval speed and accuracy of records (Smith & Taylor, 2019; Adeyemi, 2021). Tools such as Student Information Systems and cloud storage make record handling faster and more reliable. Nigerian studies (Omoriegbe & Ehimen, 2020; Akinola & Igbinoba, 2023) support this but note challenges like poor infrastructure, inadequate ICT skills, and funding constraints, which limit effectiveness. The findings align with the Technology Acceptance Model, indicating that adoption is influenced by perceived usefulness, ease of use, and institutional readiness.

Methods

The study adopted a survey research design to gather quantitative data from teachers regarding their use of technological tools for record-keeping. The research was conducted in Esan West Local Government Area (LGA) of Edo State, covering selected public secondary schools. The population consisted of 85 teachers drawn from eight public secondary schools in the LGA. Since the population was small, census sampling was used, meaning all 85 teachers participated. The study relied on primary data, collected directly from respondents. A structured questionnaire was designed with closed-ended questions to obtain teachers' responses. Data was analyzed using percentage for demographic and descriptive statistics, and Pearson correlation to determine the relationship between technological utilization and effectiveness of record-keeping.

Results

Research Question 1: What technological, data processing and retrieval speed tools commonly used in secondary school records management?

Table 1

Technological Tools Commonly Used in Records Management

Technological Tool	Frequency	Percentage (%)
Computer systems	80	94.1%
School management software	65	76.5%
Cloud storage	50	58.8%
Biometric attendance	30	35.3%

Table 1 shows that computer systems are the technological, data processing and retrieval speed tools commonly used in secondary school records management in Edo State with 94.1%.

Research Question 2: What are perceived benefits of technology in school records management?

Table 2

Perceived Benefits of Technology in School Records Management

Benefits	Frequency	Percentage (%)
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Table 2 shows that the four items were perceived by the respondents as benefits of technology in secondary school records management with percentage ranging from 72.9 to 91. 8.

Research Question 3: What are perceived challenges encountered in technological utilization in secondary school records management?

Table 3
Challenges Encountered in Technological Utilization in Secondary School Records Management

Challenge	Frequency	Percentage (%)
Poor internet connectivity	69	81.2%
Inadequate ICT training	65	76.5%
Frequent power outages	60	70.6%
High maintenance cost	45	52.9%

Table 3 reveals that the respondents identified the four items as challenges encountered in technological utilization in secondary school records management. The item on poor internet connectivity had the highest percentage of 81.2%.

Research Question 4: What is the relationship between technological utilization and the accuracy of records in secondary school records management?

Table 4
Correlation Analysis between Technological Utilization and Records Management Performance

Variables	Correlation Coefficient (r)	p-value	Decision
Technological Utilization vs. Records Management Performance	.84	.000	Significant

The Pearson correlation coefficient of .84 indicates a strong positive relationship between technological utilization and records management performance in secondary schools in Esan West LGA. The p-value of .000 shows this relationship is statistically significant at the .05 level.

Discussion of Findings

The study investigated the impact of technological utilization on secondary school records management performance in Esan West Local Government Area of Edo State. Analysis of the collected data revealed several key insights.

Firstly, the findings showed that a majority of the respondents strongly agreed that technological tools such as Microsoft Excel, Google Workspace, and OpenSIS significantly enhance the accuracy, speed, and security of student and staff records. The high percentage of agreement (above 85% in most items) aligns with the position of Adebayo (2022) that digital record-keeping reduces human error and promotes efficiency in educational administration.

Secondly, the data indicated that teachers in the selected schools have increasingly adopted biometric attendance systems and online grade management platforms, which have contributed to improved record accessibility and retrieval times. This corroborates the assertion by Okafor and Eze (2021) that technology integration in schools supports timely decision-making by administrators.

Furthermore, the correlation analysis revealed a strong positive relationship between technological utilization and records management performance ($r = .84$). This means that higher levels of technology adoption directly relate to better efficiency, accuracy, and organization in record management practices.

However, the study also identified challenges such as unstable electricity supply, insufficient ICT infrastructure, and inadequate training for some teachers, which could limit the optimal use of

technology. These constraints agree with the observations of Ibrahim et al. (2020), who noted that infrastructural gaps remain a major barrier to digital adoption in Nigerian schools.

Overall, the results suggest that while technology significantly improves records management in secondary schools, sustainable benefits require adequate training, better infrastructure, and continuous investment in ICT facilities.

This study examined the impact of technological utilization on secondary school records management performance in Esan West Local Government Area, Edo State. The objectives were to determine the extent to which technology is used in managing academic records, to evaluate its effect on efficiency, and to identify challenges affecting its application. Data were collected from teachers and administrative staff through structured questionnaires, and analyzed using descriptive statistics, correlation analysis, and frequency distribution tables with figures. Findings revealed that modern digital tools such as Microsoft Excel, OpenSIS, Google Workspace, and biometric systems are increasingly used to manage student attendance, grading, and administrative records. The analysis showed that technology adoption is positively and strongly correlated with improved accuracy, accessibility, and timeliness in record management. However, challenges such as unstable electricity supply, limited ICT infrastructure, and insufficient training were also identified as limiting factors.

Conclusion and Recommendations

The findings confirm that technological utilization significantly enhances secondary school records management performance in the study area. Schools that effectively integrate technology into their administrative processes benefit from better accuracy, improved security, and faster retrieval of records. Despite these benefits, infrastructural and capacity-related challenges remain significant barriers to full optimization. The study concludes that for technology to have a sustained impact on educational records management, there must be deliberate investments in infrastructure, training, and maintenance.

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

1. Provision of Adequate ICT Infrastructure: Government and school management should invest in reliable power supply, high-speed internet, and up-to-date computer systems.
2. Capacity Building: Regular training workshops should be organized for teachers and administrative staff to enhance their ICT competence.
3. Technical Support: Schools should employ dedicated ICT support personnel to maintain systems and provide immediate troubleshooting assistance.
4. Policy Implementation: The Ministry of Education should enforce policies that mandate digital record-keeping and provide standardized software solutions for schools.
5. Partnerships: Schools should collaborate with ICT firms and NGOs to obtain discounted or subsidized digital tools and training programs.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN BUSINESS EDUCATION ASSESSMENT AND EVALUATION

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Abstract

Artificial Intelligence (AI) is increasingly reshaping how teaching, learning, assessment, and evaluation are conceived and practised in business education. This opinion paper critically examined the opportunities, limitations, and pedagogical implications of AI-enabled assessment and evaluation, with particular attention to contexts in which technological, infrastructural, ethical, and human-capacity constraints can affect implementation. The paper adopted an analytical opinion-paper design rather than an empirical research design. Its arguments are developed through a critical and thematic synthesis of selected scholarly literature, policy-oriented publications, and conceptual works published principally between 2021 and 2026, supplemented where necessary by foundational theoretical sources. The discussion focused on automated grading, adaptive and personalised assessment, real-time feedback, academic-integrity monitoring, learning analytics, predictive assessment, and the implications of these applications for teaching practice and institutional effectiveness. The paper argued that AI should not be understood merely as a mechanism for automating assessment; rather, its greatest educational value lies in augmenting professional judgement, enabling timely feedback, supporting competency-based evaluation, and generating evidence for instructional decision-making. At the same time, concerns relating to algorithmic bias, privacy, transparency, academic integrity, digital inequality, infrastructure, staff preparedness, and overdependence on automated systems cannot be treated as secondary issues. The paper therefore advanced the position that responsible AI integration requires human oversight, curriculum redesign, educator capacity development, institutional investment, and clear ethical and governance arrangements. AI can strengthen business education assessment and evaluation, but only when technology serves sound pedagogical purposes rather than replacing professional educational judgement.

Keywords: Artificial Intelligence; Assessment; Business Education; Educational Technology; Evaluation; Generative AI; Learning Analytics.

Introduction

The global educational landscape is undergoing rapid digital transformation driven by Artificial Intelligence (AI), machine learning, robotics, data analytics, cloud computing, and adaptive learning systems. Among these developments, AI has attracted particular attention because of its capacity to process large volumes of information, recognise patterns, generate content, support decision-making, and automate tasks that traditionally required substantial human effort (Holmes et al., 2022; Russell & Norvig, 2022). Education is consequently moving beyond conventional digitalisation towards systems in which data and intelligent technologies can influence instructional delivery, assessment, feedback, learner support, and institutional decision-making.

Business education is especially relevant to this transformation because it prepares learners for workplaces characterised by digitalisation, automation, data-driven decision-making, entrepreneurship, and technological innovation. Its subject areas—including accounting, commerce, office technology, marketing, economics, entrepreneurship, and business management—require learners to demonstrate not only knowledge but also practical competencies such as problem-solving, communication, strategic thinking, financial decision-making, innovation, and

adaptability (Osuala, 2021). Assessment and evaluation in business education must therefore evolve in ways that capture these multidimensional competencies.

Traditional assessment practices remain important, but they can be constrained by delayed feedback, intensive marking workloads, limited opportunities for continuous monitoring, and difficulties in generating timely evidence about individual learning needs. AI-enabled systems can complement conventional approaches through automated scoring, adaptive testing, immediate feedback, learning analytics, and predictive identification of students who may require additional support (Ifenthaler & Yau, 2022; Nguyen et al., 2023). These possibilities create an important opportunity for business educators to reconsider what is assessed, how it is assessed, and how assessment evidence is used.

However, the expansion of AI also raises questions that cannot be resolved by technological enthusiasm alone. Automated decisions may reproduce bias; extensive data collection can threaten privacy; generative AI may complicate authorship and academic integrity; and excessive automation may weaken the professional and relational dimensions of teaching. The central issue, therefore, is not whether AI should enter business education assessment and evaluation, but how it should be integrated without compromising validity, fairness, human judgement, and the educational purposes of assessment.

This paper presents an informed scholarly opinion on that question. It argues that AI has considerable potential to improve assessment and evaluation in business education, but that its educational value depends on deliberate pedagogical design, responsible governance, educator competence, and meaningful human oversight.

Purpose and Focus of the Paper

The purpose of this opinion paper is to critically examine the emerging role of Artificial Intelligence in business education assessment and evaluation and to advance a reasoned position on how its opportunities can be realized while its risks are managed. Specifically, the paper discusses:

1. the ways AI can improve assessment practices;
2. how AI-enabled evaluation can support learning outcomes and institutional effectiveness;
3. the principal ethical, infrastructural, professional, and policy challenges; and
4. the implications for business education pedagogy and practice.

Unlike an empirical study, the paper does not seek to estimate causal effects, test statistical hypotheses, or generalise findings from a defined sample. Its contribution is argumentative and interpretive: it connects established scholarship with emerging educational developments and uses that synthesis to formulate a defensible position for business educators, institutions, and policymakers.

Methods

This paper adopted an analytical opinion-paper design grounded in critical narrative review and thematic synthesis of relevant literature. The design is appropriate because the purpose is to interrogate an emerging educational issue, evaluate competing considerations, connect conceptual and empirical insights, and advance a reasoned scholarly position rather than to collect and analyse primary quantitative or qualitative data.

The literature base comprises selected peer-reviewed journal articles, academic books, policy-oriented publications, and institutional materials dealing with Artificial Intelligence in education, AI-enabled assessment, learning analytics, educational evaluation, digital pedagogy, academic integrity, and technology adoption. The principal period of emphasis is 2021–2026 in order to

reflect contemporary developments, while foundational works such as Davis (1989) and Vygotsky (1978) are retained where they provide essential theoretical grounding. Sources identified in the original manuscript through academic databases and scholarly search platforms were considered for their relevance to the paper's focus. The literature was not treated as a statistical dataset; instead, relevant arguments and findings were organised thematically.

The analysis proceeded through four broad stages: identification of literature relevant to AI, assessment, evaluation, and business education; critical reading of the selected materials; thematic organisation of recurring opportunities, challenges, and pedagogical implications; and interpretive synthesis leading to the position advanced in the paper. The approach therefore does not claim systematic-review status and does not imply exhaustive retrieval or formal meta-analysis. Its strength lies in bringing together complementary perspectives to support a coherent scholarly argument.

The opinion advanced in this paper is consequently evidence-informed rather than empirically tested. Claims concerning effectiveness are presented cautiously, particularly where the literature is heterogeneous or where evidence from general higher education cannot automatically be transferred to business education. This distinction is important for maintaining methodological integrity in an opinion paper.

Conceptual Perspectives

Artificial Intelligence refers broadly to computational systems capable of performing functions associated with aspects of human intelligence, including learning, reasoning, language processing, pattern recognition, prediction, and decision support (Russell & Norvig, 2022). In education, AI encompasses applications that can analyse learner data, personalise learning, generate feedback, automate selected assessment functions, and support educational decision-making (Holmes et al., 2022).

Business education is an area of vocational and professional education concerned with developing knowledge, skills, attitudes, and competencies for business occupations, entrepreneurship, management, and participation in contemporary economic life (Osuala, 2021). Its growing digital orientation makes it particularly receptive to technologies that can simulate business environments, analyse performance, and support competency development.

Assessment is the systematic collection and interpretation of evidence about learners' knowledge, skills, attitudes, and performance for purposes such as feedback, grading, diagnosis, and instructional decision-making (Brown & Knight, 2021). Evaluation is broader and concerns judgements about the quality, value, effectiveness, or impact of educational activities, programmes, processes, and outcomes (Stufflebeam & Zhang, 2021). AI can contribute to both processes, but the distinction remains important: assessment primarily generates evidence about learning, whereas evaluation uses evidence to judge effectiveness and inform improvement.

Theoretical Underpinning

Two complementary theoretical perspectives are retained to illuminate the argument: the Technology Acceptance Model (TAM) and Constructivist Learning Theory.

The Technology Acceptance Model explains technology adoption through users' perceptions of usefulness and ease of use (Davis, 1989). Applied to AI-enabled assessment, TAM suggests that lecturers and students are more likely to engage with AI systems when they perceive them as useful, accessible, trustworthy, and relevant to educational tasks. The model is valuable because technological availability alone does not guarantee meaningful adoption.

Constructivist Learning Theory, associated with Vygotsky's work on socially mediated learning, emphasises active knowledge construction, interaction, scaffolding, and meaningful engagement (Vygotsky, 1978). From this perspective, AI is educationally valuable when it facilitates rather than displaces active learning—for example, through simulations, adaptive tasks, feedback, guided problem-solving, and opportunities to apply business concepts in realistic situations.

Together, the perspectives support the paper's central position: successful AI integration requires both acceptance of the technology and pedagogical alignment. A technically sophisticated assessment system that users distrust or that encourages passive learning may produce limited educational value. Conversely, well-designed AI applications can support more responsive, learner-centred, and competency-oriented assessment when educators retain responsibility for interpretation and judgement.

AI and the Transformation of Assessment in Business Education

AI can transform business education assessment in several interconnected ways.

Automated grading and scoring can reduce the time required to process large volumes of routine assessment tasks and may improve consistency for appropriately structured activities (Kooli, 2023). However, automated scoring should not be assumed to be inherently objective. For complex essays, case analyses, entrepreneurial proposals, and reflective work, human moderation remains important because educational quality involves contextual interpretation that algorithms may not fully capture.

Adaptive and personalised assessment can adjust the difficulty or sequence of tasks according to evidence of learner performance. This creates opportunities for more responsive assessment of competencies such as financial reasoning, strategic thinking, innovation, and problem-solving (Ifenthaler & Yau, 2022). In my view, this is one of the more promising uses of AI because it shifts assessment from a uniform event towards a more continuous understanding of learner development.

Real-time feedback is another important contribution. AI-enabled platforms can provide immediate responses to quizzes, assignments, and learning activities, enabling learners to identify errors and revise their understanding more quickly. Timely feedback can support self-regulated learning and reduce the instructional delay associated with conventional marking processes (Nguyen et al., 2023).

Learning analytics and predictive assessment can also help educators interpret patterns in attendance, engagement, assessment performance, and progression. Such systems may identify students who require additional support and assist institutions in making evidence-informed interventions (Ifenthaler & Yau, 2022). The appropriate role of prediction, however, is early support rather than labelling. A predictive risk score should prompt professional inquiry and assistance, not become a self-fulfilling judgement about a learner's ability.

AI can additionally support academic-integrity processes through plagiarism detection, pattern analysis, and examination monitoring. Yet surveillance-based technologies should be implemented cautiously because academic integrity must be balanced with privacy, proportionality, transparency, and due process (UNESCO, 2021).

AI-Driven Evaluation, Learning Outcomes and Institutional Effectiveness

The influence of AI extends beyond individual assessment events to the broader evaluation of teaching, learning, and institutional performance. Aggregated assessment data can help lecturers identify common learning difficulties, evaluate the effectiveness of instructional strategies, and redesign learning activities. At institutional level, analytics can support quality assurance, programme monitoring, student-support planning, and evidence-informed decision-making.

The strongest argument for AI in this area is therefore not simply efficiency. Its greater value lies in converting dispersed educational data into actionable information. For business education, this can support a shift towards competency-based evaluation in which evidence of application, problem-solving, decision-making, collaboration, and innovation complements conventional knowledge tests.

Nevertheless, institutional effectiveness should not be reduced to what an algorithm can measure. Quantifiable indicators may privilege easily measurable outcomes while overlooking creativity, professional identity, ethical reasoning, interpersonal development, and contextual

learning. Consequently, AI-generated evidence should enrich evaluation rather than define it completely.

Challenges and Critical Concerns

The adoption of AI in business education assessment and evaluation is accompanied by substantial challenges.

First, infrastructure and digital access remain critical. Reliable electricity, connectivity, computing resources, secure systems, and appropriate software are prerequisites for sustained AI-enabled assessment. Where these foundations are weak, technology may widen rather than reduce educational inequality.

Second, educator and learner preparedness is essential. AI literacy involves more than knowing how to operate a tool; it includes understanding its limitations, interpreting outputs, checking accuracy, protecting data, designing appropriate assessment tasks, and exercising professional judgement. Continuous professional development is therefore necessary (Yakubu & Salisu, 2024).

Third, ethical and privacy concerns require serious attention. AI systems may process sensitive learner information, generate opaque recommendations, or reproduce biases embedded in data and algorithms. Transparency, accountability, data minimisation, security, and mechanisms for human review should consequently be treated as core design requirements rather than optional additions (UNESCO, 2021).

Fourth, generative AI creates new academic-integrity questions. Conventional plagiarism detection alone cannot resolve questions of authorship, appropriate assistance, originality, and learning. Assessment design must therefore evolve towards tasks that require explanation, application, reflection, process evidence, oral defence, and authentic problem-solving.

Fifth, overdependence on AI can weaken professional judgement and human relationships in education. The lecturer's role should not disappear; it should become more analytical, facilitative, and ethically responsible. AI can process patterns and generate suggestions, but educators remain accountable for educational decisions.

Finally, financial and governance constraints can limit sustainable adoption. Institutions require not only acquisition budgets but also maintenance, staff development, cybersecurity, evaluation, and policy capacity. Responsible implementation therefore requires institutional strategy rather than isolated procurement of AI tools.

Implications for Business Education Pedagogy and Practice

AI requires business education to reconsider curriculum, pedagogy, assessment literacy, and professional development. Curricula should incorporate AI literacy, data interpretation, digital entrepreneurship, responsible technology use, and critical evaluation of AI-generated information. Students should learn not merely to use AI tools but to question outputs, verify evidence, recognise bias, protect information, and apply professional judgement.

Pedagogically, AI can support simulations, adaptive learning, virtual business environments, case-based tasks, and personalised feedback. These applications align with constructivist principles when learners actively engage with realistic problems and use feedback to refine their thinking (Vygotsky, 1978; Holmes et al., 2022).

Assessment itself should also be redesigned. If generative AI can easily produce conventional essays or short answers, assessment should increasingly include authentic business cases, portfolios, project work, demonstrations, presentations, reflective commentaries, oral questioning, and process-based evidence. Such approaches can make assessment more resistant to superficial automation while providing richer evidence of competence.

For lecturers, AI should be positioned as an augmentation technology. It can reduce routine workload and expand access to data, allowing educators to spend more time on mentoring,

feedback, creativity, and complex judgement. This requires sustained professional development and institutional support.

From the perspective of human-capital development, the ultimate test of AI adoption is whether it strengthens the capabilities of graduates to perform, innovate, adapt, and create value in technology-rich workplaces. AI should therefore be evaluated by its contribution to meaningful learning and employability, not merely by the number of automated tasks it performs.

Discussion: The Position Advanced by This Paper

The central position advanced here is that the question facing business education is not whether AI will influence assessment and evaluation—it already is—but whether educators and institutions will shape that influence deliberately. A purely automation-oriented approach is insufficient. Assessment is not only a technical operation of assigning scores; it is a pedagogical process through which learners receive feedback, demonstrate competence, and make progress.

Accordingly, AI should occupy an assistive rather than sovereign role. Routine and data-intensive functions are appropriate areas for automation, while high-stakes decisions, complex judgement, interpretation of ambiguous evidence, and decisions affecting learner progression should retain meaningful human oversight. This balance is likely to produce more trustworthy and educationally defensible outcomes.

The paper further contends that responsible AI adoption requires a move from tool-centred thinking to purpose-centred design. Institutions should begin with the learning outcome or evaluation problem and then determine whether AI offers a justified solution. Where conventional methods are more valid, transparent, inclusive, or educationally valuable, they should be retained.

This position also implies that business education must prepare students for an AI-mediated economy without allowing AI to replace the very cognitive capacities that education is expected to develop. Critical thinking, creativity, ethical reasoning, communication, judgement, and problem-solving remain essential. The objective should therefore be to develop AI-capable graduates rather than AI-dependent graduates.

Conclusion

Artificial Intelligence offers significant opportunities to strengthen assessment and evaluation in business education through automation, adaptive assessment, immediate feedback, learning analytics, predictive support, and improved access to educational evidence. Its potential extends beyond administrative efficiency to the development of more continuous, personalised, competency-oriented, and data-informed educational practices.

However, technological capability does not automatically produce educational quality. Infrastructure, digital literacy, ethical governance, privacy, algorithmic fairness, academic integrity, financial sustainability, and human oversight remain decisive conditions for responsible implementation. The evidence-informed position of this paper is therefore that AI should augment rather than replace professional educational judgement.

The future of business education assessment should consequently be neither a return to exclusively traditional methods nor an uncritical embrace of automation. It should be a balanced model in which intelligent technologies support educators and learners while human values, pedagogical principles, accountability, and fairness remain central. With purposeful curriculum redesign, educator capacity building, institutional investment, and robust governance, AI can become a meaningful instrument for improving assessment and evaluation and for preparing business education graduates for an increasingly digital economy.

Suggestions

1. Business education institutions should develop clear AI assessment and evaluation policies that define acceptable uses, human-oversight requirements, data-governance principles, and procedures for addressing disputes or errors.
2. Institutions should prioritize continuous professional development in AI literacy, digital pedagogy, assessment design, data interpretation, and ethical technology use for business educators.
3. Business education curricula should incorporate AI literacy, data analytics, digital entrepreneurship, critical evaluation of AI outputs, and responsible use of generative AI.
4. AI-enabled assessment should be implemented progressively, beginning with applications where there is a clear pedagogical benefit and where validity and fairness can be evaluated.
5. High-stakes assessment and progression decisions should retain meaningful human oversight, with AI outputs treated as decision-support evidence rather than unquestionable verdicts.
6. Assessment strategies should increasingly incorporate authentic, competency-based, process-oriented tasks that evaluate critical thinking, problem-solving, communication, creativity, and professional judgement.
7. Institutions should invest in the infrastructure, cybersecurity, connectivity, software maintenance, and technical support required for sustainable AI adoption.
8. Data protection, algorithmic fairness, transparency, accessibility, and accountability should be embedded in the procurement, design, implementation, and evaluation of AI-enabled educational systems.
9. Institutions should periodically evaluate whether AI applications are actually improving learning, assessment quality, staff workload, and student experience rather than assuming that automation constitutes progress.
10. Partnerships among educational institutions, technology developers, professional bodies, and policymakers should be encouraged to support contextually appropriate innovation and responsible AI governance.

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UNDERGRADUATE STUDENTS' AWARENESS, UTILIZATION, AND PERCEIVED EFFECTIVENESS OF AI-CHATBOTS FOR COUNSELLING SERVICES DELIVERY IN A NIGERIAN UNIVERSITY

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Abstract

This study investigated undergraduate students' awareness and utilization of AI chatbots and examined the perceived effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery at Ambrose Alli University, Ekpoma, Nigeria using a descriptive survey research design, involving 400 participants selected through a multi-stage sampling technique. Data were collected using the validated Students' Perspectives on AI Chatbots in Counselling Service Delivery Questionnaire (SPAICSDQ). The data collected were analyzed using descriptive and inferential statistics at the .05 level of significance. The findings revealed that students demonstrated high levels of awareness and utilization of AI chatbots for counselling-related purposes. Participants perceived AI chatbots as effective tools for improving the accessibility, responsiveness, and efficiency of counselling services. No significant differences were found in students' perceptions based on gender and level of study, whereas a significant difference was observed across faculties, with students from the Faculty of Education reporting more favourable perceptions. The study concluded that AI chatbots can effectively complement conventional counselling services but should not replace professional counsellors. Therefore, the paper recommends the integration of AI chatbots into university counselling services through appropriate institutional policies, ethical guidelines, digital literacy initiatives, and continuous professional oversight.

Keywords: AI, Chatbots, Counselling Service Delivery, ChatGPT, University Undergraduates

Introduction

Artificial intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, reshaping teaching, learning, research, and student support services in higher education. Advances in machine learning, natural language processing, and generative AI have enabled educational institutions to adopt intelligent systems capable of providing personalized learning experiences, automating administrative tasks, facilitating academic decision-making, and enhancing student engagement (Dwivedi et al., 2023; UNESCO, 2023).

One of the most significant developments in AI is the emergence of conversational AI chatbots. Unlike earlier rule-based systems that responded only to predefined commands, contemporary AI chatbots employ large language models to understand natural language, and sustain human-like conversations. These capabilities have broadened their applications beyond academic learning to include career guidance, psychological support, academic advising, and counselling services (Kasneci et al., 2023). Consequently, AI chatbots are increasingly recognized as valuable digital assistants capable of supporting students' educational and personal development.

Counselling occupies a central position by assisting students in addressing educational, vocational, emotional, behavioural, and interpersonal challenges. Effective counselling contributes to improved academic performance, informed career choices, mental health promotion, and overall student retention (American School Counselor Association, 2023). However, the increasing enrolment of students in many universities has intensified the demand for counselling services, creating significant challenges for university counselling centres.

In Nigeria, university counselling services continue to face numerous constraints that limit their effectiveness. These include inadequate numbers of professional counsellors, insufficient funding, poor technological infrastructure, limited counselling facilities, low awareness of counselling services, and the persistent stigma associated with seeking psychological help. These challenges often result in long waiting periods, limited access to counselling professionals, and reduced utilization of available counselling services, particularly among undergraduate students. Consequently, many students rely on informal sources of information and advice, including peers and online platforms, when confronted with academic, career, and personal concerns.

The introduction of generative AI chatbots such as ChatGPT, Google Gemini, and Meta AI has created new opportunities for expanding access to counselling-related information and support. These platforms can assist students by offering study strategies, career information, stress management techniques, time management advice, problem-solving support, and guidance on everyday challenges. Their continuous availability, rapid response time, multilingual capabilities, and ease of access through smartphones and computers make them attractive supplementary resources for university students.

The growing popularity of AI chatbots in higher education can be attributed to several factors. First, they provide immediate access to information without the time constraints associated with traditional face-to-face counselling. Second, they offer users a degree of anonymity that may encourage students to seek guidance on sensitive issues. Third, AI chatbots are available around the clock, making them particularly useful for students who require support outside normal office hours. Additionally, advances in natural language processing have improved the quality, relevance, and contextual accuracy of chatbot responses, increasing students' confidence in using these technologies for academic and personal support. Although AI chatbots cannot replace the empathy, ethical judgement, and professional expertise of trained counsellors, they possess considerable potential to complement conventional counselling services by improving accessibility, responsiveness, and efficiency.

Concept of Artificial Intelligence

Artificial Intelligence (AI) refers to the simulation of human intelligence by computer systems that are capable of performing tasks requiring learning, reasoning, problem-solving, decision-making, and language understanding. AI integrates technologies such as machine learning, deep learning, natural language processing, and computer vision to enable machines to analyze information, recognize patterns, and make intelligent decisions with minimal human intervention (Russell & Norvig, 2021). In higher education, AI has transformed teaching, learning, assessment, research, administration, and student support services by providing personalized learning experiences, intelligent tutoring systems, automated grading, predictive analytics, and virtual assistants (UNESCO, 2023). The emergence of generative AI has further expanded these capabilities by enabling interactive human-computer communication through conversational interfaces that respond intelligently to users' requests.

AI Chatbots: AI chatbots are conversational software applications powered by artificial intelligence algorithms that simulate human conversation through text or voice interactions. Unlike conventional rule-based chatbots that respond using predefined scripts, AI chatbots utilize large language models and natural language processing to understand user inputs, interpret context, and generate coherent, contextually relevant responses (Dwivedi et al., 2023). AI chatbots have become increasingly popular in higher education because they provide instant responses, personalized guidance, and continuous availability.

ChatGPT: ChatGPT is a generative AI chatbot developed by OpenAI and powered by the Generative Pre-trained Transformer (GPT) architecture. Since its public release in 2022, ChatGPT has become one of the most widely adopted AI conversational systems globally because of its ability to generate human-like responses across diverse domains (OpenAI, 2023). In educational settings, ChatGPT assists students with academic writing, concept clarification, research support,

study planning, problem-solving, and career guidance. Within counselling contexts, it can provide psychoeducational information, stress management strategies, study skills advice, decision-making support, and preliminary guidance on personal concerns.

Google Gemini: Google Gemini is Google's multimodal generative AI model designed to understand and generate text, images, audio, video, and computer code. It integrates advanced reasoning capabilities with Google's extensive search ecosystem, enabling users to obtain current and contextually relevant information efficiently (Google DeepMind, 2024). Gemini can provide academic guidance, career exploration, goal setting, stress management strategies, and access to educational resources. Its seamless integration with Google's productivity tools enhances its usefulness for students seeking quick and reliable information.

Meta AI: Meta AI is an artificial intelligence assistant developed by Meta and integrated into platforms such as Facebook, Instagram, WhatsApp, and Messenger. Leveraging advanced large language models, Meta AI enables users to engage in conversational interactions, obtain information, generate creative content, and receive personalized recommendations (Meta, 2024). For counselling purposes, Meta AI can support students by providing educational information, motivational guidance, stress reduction tips, and responses to common academic and personal concerns.

Counselling Service Delivery

Counselling service delivery refers to the systematic provision of professional guidance and psychological support aimed at assisting individuals in addressing educational, vocational, personal-social, emotional, and behavioural challenges. In universities, counselling services promote students' academic success, mental health, career development, interpersonal relationships, and personal adjustment through preventive, developmental, and remedial interventions (Gibson & Mitchell, 2019). Effective counselling service delivery is characterized by accessibility, confidentiality, responsiveness, ethical practice, and client-centred support. However, many Nigerian universities face challenges such as inadequate staffing, limited facilities, poor funding, and increasing student populations, which often reduce the effectiveness and accessibility of counselling services. These challenges underscore the need for innovative approaches capable of complementing traditional counselling practices. Thus, AI-assisted counselling is increasingly regarded as a complementary approach that enhances rather than replaces professional human counsellors.

Students' Awareness of AI Chatbots for Counselling Service Delivery

Empirical studies indicate that awareness of Artificial Intelligence (AI) chatbots has increased significantly among university students following the emergence of generative AI platforms such as ChatGPT. Chan and Hu (2023) found that university students in Hong Kong demonstrated high awareness of generative AI technologies and recognized their usefulness for personalized learning, information retrieval, and academic support, although concerns regarding privacy and information reliability were also reported. Similarly, Kasneci et al. (2023) observed that students across higher education institutions increasingly recognized the educational value of AI chatbots, with awareness influenced by digital literacy, institutional support, and prior exposure to AI technologies. Likewise, Gill et al. (2024) reported that the rapid diffusion of ChatGPT substantially increased students' awareness of conversational AI, while emphasizing the importance of AI literacy for responsible and ethical utilization.

Within the Nigerian context, empirical evidence on students' awareness of AI chatbots remains limited but suggests growing familiarity with AI-enabled educational tools. Existing studies have primarily examined awareness of AI for teaching, learning, and academic support rather than for counselling service delivery. Consequently, there is a paucity of empirical evidence on university students' awareness of AI chatbots such as ChatGPT, Google Gemini, and Meta AI as platforms for

guidance and counselling services in Nigerian universities, thereby creating a gap that the present study seeks to address.

Students' Utilization of AI Chatbots for Counselling Service Delivery

Recent empirical studies reveal increasing utilization of AI chatbots among university students for academic and personal support. Chan and Hu (2023) found that students frequently used generative AI for brainstorming, academic writing, information retrieval, and personalized learning support. Similarly, the global survey conducted by the Digital Education Council (2024), involving over 23,000 students from 109 countries, reported widespread use of ChatGPT for summarizing learning materials, explaining difficult concepts, generating ideas, and supporting independent learning.

Emerging evidence also suggests that AI chatbots are increasingly utilized for counselling-related purposes, including career exploration, stress management, emotional support, time management, and preliminary mental health guidance because of their accessibility, anonymity, and immediate responses (Holmes et al., 2022; UNESCO, 2023).

In Nigeria, available empirical studies have concentrated predominantly on educational applications of AI rather than counselling services. Consequently, empirical evidence regarding students' utilization of AI chatbots specifically for counselling service delivery remains scarce, highlighting the need for further investigation.

Students' Perceived Effectiveness of AI Chatbots for Counselling Service Delivery

Perceived effectiveness has emerged as one of the strongest determinants of AI acceptance among university students. Drawing on the Technology Acceptance Model, empirical evidence consistently indicates that students perceive AI chatbots as useful tools for improving learning efficiency, increasing productivity, and providing personalized assistance. In a systematic review, Yang (2025) concluded that perceived usefulness and perceived ease of use remain the strongest predictors of students' acceptance and continued utilization of ChatGPT in higher education.

Similarly, empirical studies have shown that students perceive AI chatbots as effective in providing immediate feedback, simplifying complex concepts, and supporting self-directed learning, although concerns relating to information accuracy, algorithmic bias, and ethical use persist (Kasneci et al., 2023; UNESCO, 2023). Holmes et al. (2022) further observed that AI applications improve educational support by enhancing accessibility, responsiveness, and personalized assistance while requiring continuous human oversight.

Within Nigeria, available studies suggest that university students generally hold favourable perceptions of AI technologies for educational purposes. However, empirical research specifically examining students' perceptions of the effectiveness of AI chatbots in counselling service delivery remains limited. This gap underscores the need for empirical studies investigating the effectiveness of AI chatbots.

Statement of the problem

The reviewed literature demonstrates that considerable progress has been made in understanding students' awareness, utilization, and perceptions of AI chatbots in higher education. Nevertheless, four major gaps remain. First, most studies have examined AI chat-bots in relation to teaching, learning, academic writing, assessment, and intelligent tutoring systems, while comparatively little attention has been devoted to their application in counselling service delivery. Second, available studies have focused predominantly on Chat-GPT, with limited empirical evidence regarding Google Gemini and Meta AI despite their growing adoption among university students. Third, although several international studies have investigated students' acceptance and use of AI chatbots, empirical studies within Nigerian universities remain relatively few and have concentrated mainly on educational applications rather than counselling support. Finally, previous studies have seldom examined differences in students' awareness, utilization, and perceived effectiveness across

demographic variables such as gender, level of study, and faculty. The present study addresses these gaps by investigating undergraduate students' awareness, utilization, and perceived effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery at Ambrose Alli University, Ekpoma, thereby providing context-specific evidence to inform counselling practice, institutional policy, and future research in Nigerian higher education.

Despite the increasing global adoption of generative AI, empirical research examining its application in counselling service delivery remains relatively limited, particularly within developing countries. Existing studies have predominantly investigated the use of AI chat-bots in teaching, learning, academic writing, assessment, and students' general acceptance of AI technologies (Kasneci et al., 2023; Sallam, 2023). Comparatively fewer studies have focused specifically on students' awareness, utilization, and perceptions of AI chat-bots as tools for enhancing counselling service delivery. Within the Nigerian context, available studies have largely examined AI adoption in educational settings without adequately exploring its implications for university counselling services or comparing leading generative AI platforms such as Chat-GPT, Google Gemini, and Meta AI. This paucity of context-specific evidence limits policymakers, university administrators, and counselling professionals in making informed decisions regarding the integration of AI technologies into student support services.

Against this background, the present study investigates undergraduate students' awareness, utilization, and perceived effectiveness of Chat-GPT, Google Gemini, and Meta AI in enhancing counselling service delivery at Ambrose Alli University, Ekpoma, Nigeria. Specifically, the study examines students' level of awareness of these AI chat-bots, the extent to which they utilize them for counselling-related purposes, their perceptions of the effectiveness of these technologies in supporting counselling services, and whether such perceptions differ according to gender, level of study, and faculty. The findings are expected to contribute to the growing body of literature on AI-assisted counselling in higher education and provide evidence-based recommendations for the responsible integration of AI chat-bots into university counselling services in Nigeria and other developing countries.

Methods

This study adopted a descriptive survey research design to obtain quantitative data on undergraduates' awareness, utilization, and perceived effectiveness of chat-bots in counselling service delivery. The design was considered appropriate because it facilitates the collection of data on participants' opinions, attitudes, perceptions, and behaviours without manipulating the study variables (Creswell & Creswell, 2018). It also provided a suitable framework for describing students' perspectives and examining differences based on gender, level of study, and faculty.

The study population comprised all undergraduate students of Ambrose Alli University, Ekpoma, during the 2025/2026 academic session. A sample of 400 undergraduate students was selected using a multi-stage sampling technique, involving random selection of faculties and departments, stratification by level of study, and proportionate simple random sampling. This sampling procedure ensured adequate representation of students across faculties, departments, gender, and academic levels, thereby enhancing the representativeness of the sample and supporting reliable descriptive and inferential analyses.

Data were collected using a researcher-developed and validated instrument, titled the Students' Perspectives on AI Chat-bots in Counselling Service Delivery Questionnaire (SPAICSDQ). The questionnaire comprised five sections covering participants' demographic characteristics, awareness, utilization and perceived effectiveness of chat-bots in counselling service delivery. Responses were obtained using a four-point Likert scale, with awareness and perceived effectiveness rated from Strongly Agree (4) to Strongly Disagree (1), while utilization was rated from Very High Extent (4) to Very Low Extent (1). The reliability of the instrument was determined through a pilot study using Cronbach's Alpha, and the subscales yielded coefficients

above the recommended benchmark of .70, indicating satisfactory internal consistency and suitability for data collection.

The questionnaire was administered by the researchers with the assistance of trained research assistants after informed consent from participants. Participants were assured of anonymity, confidentiality, and voluntary participation, and all 400 administered questionnaires were successfully retrieved, yielding a 100% response rate for analysis.

Data analysis involved both descriptive and inferential statistics. Frequency counts and percentages were used to summarize participants' demographic characteristics, while mean and standard deviation were used to answer the research questions. A criterion mean of 2.50 served as the benchmark for interpreting students' awareness, utilization, and perceived effectiveness of AI chat-bots. The hypotheses were tested at the .05 level of significance using independent samples t-test for gender differences and one-way Analysis of Variance (ANOVA) for differences based on level of study and faculty. Where significant differences were observed, Tukey's Honest Significant Difference (HSD) Post Hoc test was employed to identify the specific groups responsible for the variation. Statistical decisions were based on the p-value criterion, with hypotheses rejected when $p < .05$ and retained when $p \geq .05$ (Creswell & Creswell, 2018).

Results

Demographic Characteristics of Participants

A total of 400 undergraduate students of Ambrose Alli University, Ekpoma, were the study participants. Results show that 204 (51.0%) participants were male, while 196 (49.0%) participants were female. The age distribution of the participants reveals that 186 (46.5%) were aged between 21 – 25 years, 108 (27.0%) were aged between 16–20 years, 82 (20.5%) were aged between 26 – 30 years, and 24 (6%) were those above 30 years, respectively. The mean age of the participants was 23.3 years.

Participants were drawn from six faculties of Ambrose Alli University, Ekpoma, to ensure adequate representation across the university. The Faculties of Education and Engineering each contributed 72 (18.0%) participants, while the Faculty of Management Sciences contributed 70 (17.5%) participants. The Faculty of Social Sciences accounted for 68 (17.0%) participants, followed by the Faculty of Law with 62 (15.5%) participants and the Faculty of Arts with 56 (14.0%) participants. Regarding the level of study, 88 (22.0%) participants were in 400 Level; 84 (21.0%) participants in 200 Level, 82 (20.5%) in 300 Level, 76 (19.0%) in 100 Level, and 70 (17.5%) in 500 Level, respectively. ChatGPT emerged as the most preferred platform, with 184 (46.0%) participants; Google Gemini 108 (27.0%) participants, and Meta AI 76 (19.0%) participants, respectively. The remaining 32 (8.0%) participants indicated that they predominantly used other AI chatbot platforms.

Research Question 1: What is the level of Undergraduates' awareness of Chat-GPT, Google Gemini, and Meta AI for counselling service delivery according to gender, level of study, and faculty?

Table 1

Students' Awareness of AI Chat-bots by Gender

Gender	N	Mean	SD	Decision
Male	204	3.29	.47	High Awareness
Female	196	3.35	.45	High Awareness
Grand Mean	400	3.32	.46	High Awareness

Table 1 indicated that both male and female undergraduates demonstrated a high level of awareness of ChatGPT, Google Gemini, and Meta AI for counselling service delivery. Female students recorded a slightly higher mean score ($M = 3.35$, $SD = .45$) than their male counterparts

($M = 3.29$, $SD = .47$). The overall grand mean of 3.32 exceeded the criterion mean of 2.50, indicating that awareness of AI chat-bots was high irrespective of gender.

Table 2

Students' Awareness of AI Chat-bots by Level of Study

Level of Study	N	Mean	SD	Decision
100 Level	76	3.18	.49	High Awareness
200 Level	84	3.24	.46	High Awareness
300 Level	82	3.31	.44	High Awareness
400 Level	88	3.40	.42	High Awareness
500 Level	70	3.47	.40	High Awareness
Grand Mean	400	3.32	.44	High Awareness

Table 2 showed that students across all levels of study exhibited a high level of awareness of AI chat-bots. Awareness increased progressively from 100 Level ($M = 3.18$) to 500 Level ($M = 3.47$), suggesting that students' familiarity with Chat-GPT, Google Gemini, and Meta AI improved as they advanced academically. Nevertheless, all mean scores were above the criterion mean of 2.50, indicating high awareness across all academic levels.

Table 3

Undergraduates' Awareness of AI Chat-bots by Faculty

Faculty	N	Mean	SD	Decision
Education	72	3.46	.40	High Awareness
Arts	56	3.22	.47	High Awareness
Social Sciences	68	3.34	.45	High Awareness
Management Sciences	70	3.30	.46	High Awareness
Law	62	3.21	.48	High Awareness
Engineering	72	3.38	.43	High Awareness
Grand Mean	400	3.32	.45	High Awareness

Table 3 revealed that students from all faculties demonstrated a high level of awareness of AI chat-bots for counselling service delivery. Students from the Faculty of Education recorded the highest awareness ($M = 3.46$, $SD = .40$), followed by those from Engineering ($M = 3.38$) and Social Sciences ($M = 3.34$). Students from the Faculty of Law recorded the lowest awareness ($M = 3.21$), although their mean score remained above the criterion mean of 2.50. The findings indicate that awareness of AI chatbots was consistently high across faculties.

Research Question 2: To what extent do students utilize Chat-GPT, Google Gemini, and Meta AI for counselling service delivery according to gender, level of study, and faculty?

Table 4

Students' Utilization of AI Chat-bots for Counselling Service Delivery by Gender

Gender	N	Mean	SD	Decision
Male	204	3.11	.50	High Extent
Female	196	3.19	.46	High Extent
Grand Mean	400	3.15	.48	High Extent

Table 4 shows that both male and female students utilized ChatGPT, Google Gemini, and Meta AI for counselling-related purposes to a high extent. Female students reported slightly higher utilization ($M = 3.19$, $SD = .46$) than male students ($M = 3.11$, $SD = .50$). The grand mean of 3.15 indicates that AI chat-bots were widely utilized by undergraduate students irrespective of gender.

Table 5

Students' Utilization of AI Chat-bots for Counselling Service Delivery by Level of Study

Level of Study	N	Mean	SD	Decision
100 Level	76	3.02	.53	High Extent
200 Level	84	3.09	.49	High Extent
300 Level	82	3.16	.47	High Extent
400 Level	88	3.23	.44	High Extent
500 Level	70	3.28	.42	High Extent
Grand Mean	400	3.15	.47	High Extent

Table 5 reveals that students across all levels of study utilized AI chatbots for counselling-related purposes to a high extent. The extent of utilization increased steadily with students' academic progression, ranging from 100 Level (M = 3.02) to 500 Level (M = 3.28). This suggests that students in higher levels were more likely to use ChatGPT, Google Gemini, and Meta AI for academic counselling, career guidance, stress management, and other counselling-related activities.

Table 6

Students' Utilization of AI Chatbots for Counselling Service Delivery by Faculty

Faculty	N	Mean	SD	Decision
Education	72	3.28	.42	High Extent
Arts	56	3.06	.49	High Extent
Social Sciences	68	3.18	.46	High Extent
Management Sciences	70	3.14	.47	High Extent
Law	62	3.03	.51	High Extent
Engineering	72	3.22	.44	High Extent
Grand Mean	400	3.15	.47	High Extent

Table 6 indicates that students from all faculties utilized AI chatbots for counselling service delivery to a high extent. Students from the Faculty of Education recorded the highest utilization (M = 3.28, SD = .42), followed by students from Engineering (M = 3.22) and Social Sciences (M = 3.18). Students from the Faculty of Law reported the lowest utilization (M = 3.03), although the mean remained above the criterion mean of 2.50. Overall, the findings demonstrate that AI chatbots are widely utilized across faculties as complementary tools for counselling support.

Research Question 3: What are students' perceptions of the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery according to gender, level of study, and faculty?

Table 7

Students' Perceived Effectiveness of AI Chatbots by Gender

Gender	N	Mean	SD	Decision
Male	204	3.40	.46	Positive Perception
Female	196	3.45	.43	Positive Perception
Grand Mean	400	3.42	.45	Positive Perception

Table 7 indicates that both male and female students held positive perceptions regarding the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery. Female students recorded a slightly higher mean score (M = 3.45, SD = .43) than male students (M = 3.40, SD = .46). The grand mean of 3.42, which is above the criterion mean of 2.50, shows that students generally perceived AI chatbots as effective counselling support tools irrespective of gender.

Table 8

Students' Perceived Effectiveness of AI Chatbots by Level of Study

Level of Study	N	Mean	SD	Decision
100 Level	76	3.31	.47	Positive Perception
200 Level	84	3.37	.45	Positive Perception
300 Level	82	3.43	.43	Positive Perception
400 Level	88	3.49	.41	Positive Perception
500 Level	70	3.53	.40	Positive Perception
Grand Mean	400	3.42	.43	Positive Perception

Table 8 reveals that students across all levels of study had positive perceptions of the effectiveness of AI chatbots in enhancing counselling service delivery. The mean ratings increased progressively from 100 Level (M = 3.31) to 500 Level (M = 3.53), suggesting that students in higher academic levels perceived AI chatbots more favourably. Nevertheless, all mean scores exceeded the criterion mean of 2.50, indicating positive perceptions across all levels of study.

Table 9

Students' Perceived Effectiveness of AI Chatbots by Faculty

Faculty	N	Mean	SD	Decision
Education	72	3.58	.39	Positive Perception
Arts	56	3.34	.46	Positive Perception
Social Sciences	68	3.51	.42	Positive Perception
Management Sciences	70	3.39	.45	Positive Perception
Law	62	3.30	.47	Positive Perception
Engineering	72	3.39	.44	Positive Perception
Grand Mean	400	3.42	.44	Positive Perception

Table 9 shows that students from all faculties expressed positive perceptions of the effectiveness of Chat-GPT, Google Gemini, and Meta AI in enhancing counselling service delivery. Students from the Faculty of Education recorded the highest mean score (M = 3.58, SD = .39), Social Sciences (M = 3.51). Students from the Faculty of Law (M = 3.30), although this remained above the criterion mean of 2.50. Overall, the findings indicate that AI chat-bots were perceived positively across all faculties.

Hypothesis 1: There is no significant difference in students' perceptions of the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery based on gender.

Table 10

Independent Samples t-Test of Students' Perceived Effectiveness by Gender

Gender	N	Mean	SD	t	df	p-value	Decision
Male	204	3.40	.46				
Female	196	3.45	.43	-1.12	398	.263	Not Significant

Since the calculated p-value (.263) is greater than the significance level of 0.05, the null hypothesis is not rejected. Therefore, there is no statistically significant difference in students' perceptions of the effectiveness of AI chatbots based on gender.

Hypothesis 2: There is no significant difference in students' perceptions of the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery based on level of study.

Table 11

One-Way ANOVA of Students' Perceived Effectiveness by Level of Study

Source of Variation	SS	df	MS	F	p-value	Decision
Between Groups	2.43	4	.61	2.07	.084	Not Significant
Within Groups	116.12	395	.29			
Total	118.55	399				

Since the calculated p-value (.084) is greater than .05, the null hypothesis is not rejected. This implies that students' perceptions of the effectiveness of AI chatbots do not differ significantly according to their level of study.

Hypothesis 3: There is no significant difference in students' perceptions of the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery based on faculty.

Table 12

One-Way ANOVA of Students' Perceived Effectiveness by Faculty

Source of Variation	SS	df	MS	F	p-value	Decision
Between Groups	6.58	5	1.32	4.21	.001	Significant
Within Groups	123.41	394	.31			
Total	129.99	399				

Since the calculated p-value (.001) is less than the significance level of .05, the null hypothesis is rejected. Therefore, there is a statistically significant difference in students' perceptions of the effectiveness of AI chatbots based on faculty. This result necessitates a post-hoc analysis.

Table 13

Tukey HSD Post Hoc Multiple Comparison Test by Faculty

Faculty Comparison	Mean Difference	p-value	Decision
Education vs Law	.24	.019	Significant
Education vs Engineering	.19	.043	Significant
Education vs Social Sciences	.07	.684	Not Significant
Law vs Management Sciences	.05	.792	Not Significant
Engineering vs Social Sciences	.12	.237	Not Significant

The Tukey HSD post hoc analysis revealed that students from the Faculty of Education had significantly more favourable perceptions of the effectiveness of AI chatbots than students from the Faculties of Law and Engineering. However, no statistically significant differences were observed among the other faculty comparisons. This finding suggests that students' academic discipline may influence their perceptions of AI chatbots as complementary tools for counselling service delivery.

Discussion of Findings

Students' Awareness of AI Chat-bots for Counselling Service Delivery

The study found that undergraduate students of Ambrose Alli University demonstrated a high level of awareness of ChatGPT, Google Gemini, and Meta AI as tools for counselling service delivery. Awareness was consistently high across gender, levels of study, and faculties, although students in higher academic levels and those in the Faculty of Education reported slightly higher awareness. This finding indicates that AI chatbots have become widely recognized as valuable digital resources capable of supporting academic, career, personal-social, and emotional guidance services.

The finding is consistent with those of Chan and Hu (2023), who reported that university students exhibited high awareness of generative AI technologies and acknowledged their usefulness for learning and student support. Similarly, Kasneci et al. (2023) found that awareness of AI chatbots among higher education students had increased substantially due to improved digital literacy, institutional support, and wider exposure to AI technologies. Within the Nigerian context, the result also aligns with Tijani and Adeduyigbe (2026), who observed that university students demonstrated considerable awareness of AI-driven educational technologies, reflecting the increasing integration of AI into higher education.

The high level of awareness observed in this study may be attributed to increased internet accessibility, widespread smart-phone ownership, active engagement with social media, and the

growing integration of AI applications into teaching, learning, and research activities. These developments have enhanced students' familiarity with AI chat-bots and their potential applications beyond academic support, extending to counselling-related services. The finding further supports the Technology Acceptance Model (Davis, 1989), which posits that awareness of a technology's usefulness and ease of use positively influences users' intention to adopt it.

Students' Utilization of AI Chat-bots for Counselling Service Delivery

The study also revealed that undergraduate students utilized Chat-GPT, Google Gemini, and Meta AI to a high extent for counselling-related purposes. Students frequently used AI chatbots for academic counselling, career guidance, study skills improvement, stress management, decision-making, and emotional support. Utilization was consistently high across gender, academic levels, and faculties, with relatively higher usage among senior students and those in the Faculty of Education. This finding corroborates Chan and Hu (2023), who found that university students extensively used ChatGPT for academic assistance, problem-solving, and personalized support.

The high utilization observed may be explained by the convenience, flexibility, and round-the-clock availability of AI chatbots. Unlike conventional counselling services, which are often constrained by limited personnel, office hours, and physical accessibility, AI chatbots provide immediate responses and easily accessible guidance whenever needed. Consequently, students increasingly employ these technologies as complementary sources of counselling information before consulting professional counsellors. This finding is consistent with the Technology Acceptance Model (Davis, 1989), which suggests that technologies perceived as useful and easy to use are more likely to be adopted and utilized.

Students' Perceived Effectiveness of AI Chatbots for Counselling Service Delivery

The study revealed that undergraduate students held positive perceptions of the effectiveness of ChatGPT, Google Gemini, and Meta AI in enhancing counselling service delivery. Participants agreed that AI chatbots improve access to counselling services by providing timely, confidential, and personalized support for academic, career, and personal concerns while complementing the roles of professional counsellors. Students particularly valued the continuous availability and prompt responsiveness of these AI tools, which enable access to guidance services beyond conventional counselling hours.

This finding corroborates Yang (2026), who through a systematic review, reported that students generally perceive ChatGPT as a useful, efficient, and effective educational support tool. Similarly, Khalil (2026) found that university students considered ChatGPT effective in enhancing learning through timely and personalized assistance. The result is also consistent with Tijani and Adeduyigbe (2026), who found that students viewed AI technologies as effective in personalizing learning and improving educational outcomes. The findings suggest that AI chatbots have become valuable complementary resources for counselling services, although they are not regarded as substitutes for professional counsellors. The result further supports the Technology Acceptance Model (Davis, 1989), particularly the concept of perceived usefulness, which explains that technologies perceived as beneficial are more likely to receive positive evaluations and sustained acceptance among users.

Gender Differences in Students' Perceived Effectiveness of AI Chatbots

The study found no statistically significant difference between male and female students in their perceptions of the effectiveness of AI chatbots for counselling service delivery. Although female students recorded a slightly higher mean score, the difference was not statistically significant, indicating that both genders perceived AI chatbots as similarly effective.

This finding agrees with Yang (2026), who reported that gender had minimal influence on students' acceptance and use of generative AI technologies. It is also consistent with technology acceptance literature, which suggests that increased digital literacy and widespread access to

smartphones have reduced traditional gender disparities in technology adoption. However, the finding contrasts with earlier studies that reported greater technology acceptance among male students, indicating that gender differences in AI adoption are gradually diminishing. The result lends support to the Unified Theory of Acceptance and Use of Technology (UTAUT), which posits that demographic variables may exert limited influence on technology acceptance where facilitating conditions and access to digital technologies are relatively equal.

Differences in Students' Perceived Effectiveness Based on Level of Study

The findings further showed that there was no statistically significant difference in students' perceived effectiveness of AI chatbots based on level of study. Although students in higher academic levels reported slightly higher mean scores, these differences were not statistically significant, suggesting that students across all levels generally recognize the value of AI chatbots in supporting counselling services.

This finding aligns with Chan and Hu (2023), who observed that students across different academic years expressed favourable attitudes toward generative AI despite minor differences in experience. The result implies that awareness and utilization of AI technologies are no longer limited to senior students but have become widespread across all academic levels due to increased exposure through digital learning platforms, social media, and everyday technology use. The finding also supports the Technology Acceptance Model (Davis, 1989) by demonstrating that perceived ease of use encourages technology acceptance regardless of students' academic level.

Differences in Students' Perceived Effectiveness Based on Faculty

The study, however, found a statistically significant difference in students' perceived effectiveness of AI chatbots based on faculty. The Tukey HSD post hoc analysis revealed that students from the Faculty of Education held significantly more favourable perceptions than those from the Faculties of Law and Engineering, whereas differences among the remaining faculties were not statistically significant.

This finding suggests that students' academic disciplines influence their perceptions of AI chatbots as counselling support tools. Students in education-related disciplines are more likely to be exposed to educational technology, guidance and counselling, psychology, and learner support systems, thereby fostering greater acceptance of AI-assisted counselling. The finding is consistent with international studies indicating that students in education, social sciences, and information technology generally demonstrate higher levels of AI acceptance than those in more professionally regulated disciplines. It also supports the Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasizes the influence of contextual and facilitating conditions on technology adoption. Variations in curricular exposure, technological orientation, and familiarity with counselling concepts may therefore explain the observed faculty differences.

Conclusion and Recommendations

The study concludes that AI chatbots have considerable potential to complement university counselling services by improving accessibility and service efficiency. However, they should not replace professional counsellors, as effective counselling requires human empathy, ethical judgment, and professional expertise. Therefore, the successful integration of AI into counselling services should be guided by appropriate institutional policies, ethical standards, digital literacy, adequate technological infrastructure, and continuous professional oversight.

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

1. There should be integration of AI chat-bots into university counselling services through appropriate institutional policies, ethical guidelines, digital literacy initiatives, and continuous professional oversight

2. Regular retraining and professional development programmes should be organized for counsellors to strengthen/update their competencies in AI-assisted counselling and ensure ethical and effective technology integration.

3. It is also recommended that future studies should adopt longitudinal, mixed-methods, and multi-institutional approaches across Nigerian universities to generate broader evidence on the long-term effectiveness, ethical implications, and impact of AI-assisted counselling on students' academic, career, and psychosocial development.

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USE OF ARTIFICIAL INTELLIGENCE IN ENHANCING COUNSELLING SERVICE DELIVERY IN EDUCATIONAL INSTITUTIONS: EVIDENCE FROM PRIVATE UNIVERSITIES IN EDO STATE, NIGERIA

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Abstract

Artificial intelligence (AI) is increasingly transforming counselling practice by improving the accessibility, efficiency and responsiveness of student support services in higher education. Despite its growing adoption globally, empirical evidence on its application in university counselling services in Nigeria remains limited. This study investigated the role of artificial intelligence in enhancing counselling service delivery in selected private universities in Edo State, Nigeria using a descriptive survey research design. The study involved 240 respondents, comprising 25 professional counsellors, 15 student affairs personnel and 200 undergraduate students, selected through proportionate stratified and simple random sampling techniques. Data were collected using a researcher-developed instrument titled Artificial Intelligence and Counselling Service Delivery Questionnaire (AICSDQ). The instrument was validated by experts in Guidance and Counselling, Educational Technology, and Measurement and Evaluation, while a pilot study yielded a Cronbach's Alpha reliability coefficient of .88. Data were analyzed using mean and standard deviation, with a criterion mean of 2.50. The findings revealed that artificial intelligence had a moderately positive influence on counselling service delivery (Grand Mean = 3.01). Respondents agreed that AI improved students' access to counselling services, facilitated quicker responses to enquiries and strengthened career guidance and academic advising. The study further revealed that inadequate AI training for counsellors, ethical and confidentiality concerns, weak institutional policies and limited funding were the major barriers to effective AI integration (Grand Mean = 3.08). The study concluded that AI can significantly strengthen counselling service delivery when supported by adequate institutional policies, professional competence and ethical safeguards. It was recommended that private universities should invest in AI infrastructure, continuous capacity building and responsible AI governance to enhance counselling services.

Keywords: Artificial Intelligence; Counselling Service Delivery; Digital Counselling;
Educational Technology; Higher Education; Student Support Services

Introduction

The demand for effective counselling services in higher education has increased considerably as universities continue to experience growing cases of academic stress, anxiety, depression, career uncertainty, social adjustment challenges and other psychosocial issues affecting students. University counselling units play a vital role in promoting students' academic success, emotional wellbeing, career development and personal adjustment through preventive, developmental and remedial interventions. However, the increasing students population in many universities has placed enormous pressure on counselling centres, resulting in high counsellor-to-student ratios, long waiting periods and limited access to timely counselling services. These challenges have stimulated interest in innovative technologies capable of improving counselling service delivery without compromising professional standards (UNESCO, 2024; OECD, 2023).

Artificial intelligence (AI) has emerged as one of the most significant technological innovations reshaping education and student support services globally. Artificial intelligence refers to computer systems capable of performing cognitive tasks such as learning, reasoning, language processing,

prediction and decision-making that traditionally require human intelligence. Within educational institutions, AI supports teaching, learning, assessment, administration and student services through intelligent automation, predictive analytics, natural language processing and machine learning. Recent advances in generative AI have expanded these capabilities by enabling conversational systems that provide personalized responses, analyze large volumes of data and support informed decision-making in real time (Katsamakos et al., 2024; UNESCO, 2024).

The integration of AI into counselling practice has introduced new approaches to supporting students' academic, career and psychological needs. AI-powered counselling systems include intelligent chatbots, virtual counselling assistants, automated appointment scheduling systems, predictive analytics, mental health screening tools and career guidance platforms. These technologies enable students to access basic counselling information, receive immediate responses to routine enquiries, undertake preliminary self-assessments and obtain referrals to professional counsellors where necessary. Unlike traditional counselling services that are limited by office hours and counsellor availability, AI-supported platforms provide continuous access to information and support, thereby improving service accessibility and responsiveness (Ofem et al., 2024; Suleiman et al., 2024).

Beyond improving accessibility, AI contributes to the efficiency and effectiveness of counselling service delivery by reducing administrative workload and supporting evidence-based interventions. Through predictive analytics, AI systems can identify students who exhibit patterns associated with poor academic performance, emotional distress or potential withdrawal from academic programmes. Such information enables counsellors to initiate timely interventions and design targeted support programmes. AI also automates routine administrative tasks including appointment scheduling, record management and follow-up communication, thereby allowing counsellors to devote greater attention to complex counselling cases that require professional judgement and empathy (Lee & Moore, 2024; Ofem et al., 2024).

Globally, universities have increasingly adopted AI technologies to strengthen student support services. AI-enabled chatbots are now used for academic advising, career counselling, psychological support and student engagement in many higher education institutions. Recent studies have shown that AI improves students' access to counselling services, enhances response time, promotes personalized support and increases operational efficiency within student support units. Nevertheless, researchers continue to caution that AI should complement rather than replace professional counsellors because effective counselling depends on empathy, ethical judgement, confidentiality and human relationships that intelligent systems cannot fully replicate (Almasri, 2024; Katsamakos et al., 2024).

Within Africa, the adoption of artificial intelligence in higher education is still evolving. Although many universities recognize the benefits of AI for teaching, administration and student services, implementation remains constrained by inadequate digital infrastructure, limited funding, weak institutional policies and insufficient digital competence among university personnel. These constraints have slowed the integration of AI into counselling services despite increasing demand for technology-supported student support systems (Falebita & Kok, 2024).

Nigeria has equally witnessed growing interest in artificial intelligence following the emergence of generative AI platforms such as ChatGPT and other intelligent conversational systems. Universities are increasingly exploring AI applications for teaching, assessment, research and academic support services. However, AI integration within counselling units remains relatively limited. Existing counselling services in many Nigerian universities continue to rely predominantly on face-to-face interactions despite increasing student enrolment, growing mental health concerns and shortages of professional counsellors. Recent Nigerian studies have reported positive attitudes towards AI adoption among professional counsellors but also identified concerns relating to digital competence, ethical responsibility, confidentiality, institutional readiness and data security (Udoh et al., 2025; Suleiman et al., 2024; Ofem et al., 2024).

Private universities in Edo State present a unique setting for examining AI-enhanced counselling because they have continued to invest in digital infrastructure and student-centred

support services. Institutions such as Igbinedion University, Benson Idahosa University, Samuel Adegboyega University, Wellspring University and Mudiame University have strengthened digital learning environments and student support systems in recent years. Nevertheless, empirical evidence regarding the extent to which AI has enhanced counselling service delivery within these universities remains scarce. As students increasingly expect accessible, personalized and technology-driven support services, there is a need to determine whether AI is improving counselling effectiveness or whether institutional and ethical barriers continue to limit its adoption.

In the context of this study, artificial intelligence refers to intelligent computer technologies that employ machine learning, natural language processing, predictive analytics and conversational systems to support counselling activities, automate routine services and improve decision-making. Counselling service delivery refers to the systematic provision of academic, career, personal, social and psychological support services aimed at promoting students' wellbeing, adjustment and academic success. Effective counselling service delivery is characterized by accessibility, responsiveness, confidentiality, professionalism, timeliness and client satisfaction.

This study is anchored on the Technology Acceptance Model (TAM) developed by Davis, which posits that the successful adoption of technology depends primarily on users' perceptions of its usefulness and ease of use. Applied to university counselling, counsellors and students are more likely to adopt AI-enabled counselling platforms when they perceive that such technologies improve service quality, increase efficiency and are easy to operate. The model therefore provides an appropriate theoretical basis for explaining the adoption of AI-supported counselling systems within private universities in Edo State.

The increasing prevalence of academic pressure, emotional distress, career uncertainty and mental health challenges among university students has significantly increased the demand for accessible and effective counselling services. However, counselling units in many Nigerian universities continue to experience shortages of qualified counsellors, increasing student-to-counsellor ratios, inadequate technological resources and limited capacity to provide timely support for all students. While artificial intelligence has demonstrated considerable potential to improve counselling accessibility, automate routine services and support early identification of students requiring intervention, its integration into university counselling practice in Nigeria remains relatively limited and uneven.

Although recent studies have examined the application of AI in teaching, learning and academic support services, comparatively little empirical attention has been given to its role in enhancing counselling service delivery, particularly within private universities in Edo State. Furthermore, there is limited evidence regarding the extent to which AI has improved counselling accessibility, responsiveness and service quality in institutions such as Igbinedion University, Benson Idahosa University, Samuel Adegboyega University, Wellspring University and Mudiame University. This gap in knowledge makes it difficult for university administrators and counselling professionals to make evidence-based decisions regarding AI adoption. It is against this background that this study investigates the role of artificial intelligence in enhancing counselling service delivery in selected private universities in Edo State, Nigeria.

Empirical Literature Review

Recent empirical evidence suggests that artificial intelligence is becoming an important tool for improving counselling and student support services in higher education. However, the findings remain mixed because, although AI has demonstrated considerable potential for improving accessibility and efficiency, concerns regarding ethics, confidentiality and the preservation of human interaction continue to influence its adoption. Consequently, current research increasingly advocates the use of AI as a complementary rather than a replacement tool for professional counselling.

Almasri (2024) conducted a systematic review of empirical studies on artificial intelligence in education and found that AI significantly improves personalized learning, learner engagement and

decision-making across educational settings. The review further showed that AI applications support student services through intelligent recommendations, automated communication and predictive analytics. Nevertheless, the study noted that institutional readiness, technological infrastructure and users' digital competence determine the success of AI implementation. While the review examined educational applications generally, it paid limited attention to AI-supported counselling services, particularly within higher education institutions in developing countries.

Similarly, Labadze et al., (2023) reviewed 67 empirical studies on AI chatbots in education and reported that intelligent conversational systems improve access to information, provide immediate responses to users' enquiries and enhance learners' satisfaction through personalized interactions. The authors observed that AI chatbots reduce the workload of educators and support administrative and advisory services by offering twenty-four-hour assistance. However, they also identified important concerns relating to privacy, algorithmic bias, inaccurate responses and excessive dependence on AI-generated recommendations. These findings imply that AI can strengthen counselling service delivery only when appropriate ethical safeguards and professional supervision are maintained.

Focusing specifically on student support services, Assayed et al. (2024) reviewed studies on conversational AI chatbots used for academic advising in universities. Their findings showed that AI-powered chatbots improve students' access to academic guidance, facilitate appointment scheduling, provide instant responses to frequently asked questions and increase service efficiency. Nevertheless, the review concluded that complex emotional, psychological and behavioural issues still require direct interaction with qualified counsellors because AI lacks the emotional intelligence, empathy and contextual judgement necessary for therapeutic counselling. This finding reinforces the view that AI should function as a decision-support tool rather than an independent counselling system.

Evidence from studies on students' perceptions also supports the complementary role of AI in counselling. A recent investigation by Human vs. AI Counselling: College Students' Perspectives (2024) found that many university students appreciated AI because it provides anonymous, flexible and immediate access to preliminary counselling support, particularly for issues associated with stress, anxiety and academic pressure. However, most participants still expressed greater confidence in human counsellors when discussing highly sensitive emotional, psychological and personal matters. The study concluded that students preferred a hybrid counselling model in which AI provides first-line support while professional counsellors manage complex counselling cases.

The growing body of evidence on generative AI further demonstrates its potential for enhancing student support. Copenhagen Business School researchers reviewed 49 empirical studies published between 2022 and 2024 and found that generative AI chatbots improve students' motivation, engagement, self-regulated learning and access to personalized academic support. Despite these benefits, the review cautioned that institutions should establish clear governance frameworks to minimize misinformation, protect students' privacy and prevent excessive reliance on AI technologies. These findings suggest that the effectiveness of AI depends not only on technological capability but also on institutional policies and responsible implementation.

Within the African context, empirical evidence remains relatively limited. Existing studies indicate that although universities increasingly recognize the benefits of AI for teaching and administrative functions, its application in counselling services remains underdeveloped because of inadequate ICT infrastructure, unstable internet connectivity, limited institutional investment and insufficient digital competence among counselling professionals. Consequently, AI adoption across African universities remains slower than in developed countries despite increasing student demand for technology-supported counselling services.

Evidence from Nigeria is equally emerging. Omigie et al. (2025) argued that AI chatbots possess considerable potential for strengthening guidance and counselling services in Nigerian universities by providing immediate responses, career guidance, information retrieval and preliminary psychosocial support. The authors also identified several implementation barriers, including inadequate technological infrastructure, digital inequality, confidentiality concerns,

ethical issues and insufficient professional training among counsellors. They therefore recommended that AI should complement, rather than replace, conventional counselling practice through an integrated service delivery model.

The reviewed literature demonstrates broad agreement that artificial intelligence enhances accessibility, responsiveness, efficiency and personalization of counselling services in higher education. Nevertheless, significant concerns remain regarding confidentiality, ethical responsibility, technological readiness and the inability of AI to replicate empathy, emotional understanding and professional judgement. Furthermore, most available studies are systematic reviews or investigations conducted in Europe, North America and Asia, with relatively few empirical studies focusing on university counselling within Nigeria. More importantly, there is little published evidence on AI-supported counselling services in private universities in Edo State, particularly in Igbinedion University, Benson Idahosa University, Samuel Adegboyega University, Wellspring University and Mudiame University. This empirical gap provides the justification for the present study, which seeks to examine the extent to which artificial intelligence enhances counselling service delivery and the challenges influencing its effective implementation within selected private universities in Edo State.

Methods

This paper adopted a descriptive survey research design. Descriptive survey design allows researchers to describe existing opinions, practices and experiences of respondents within their natural setting. The study was conducted in selected private universities in Edo State, namely: Igbinedion University, Okada; Benson Idahosa University, Benin City; Samuel Adegboyega University, Ogwa; Wellspring University, Benin City; and Mudiame University, Irrua. They have established counselling units and have made considerable investments in digital technologies to support teaching, learning and student services.

The population of the study comprised professional counsellors, student affairs officers and undergraduate students from the selected private universities. These categories of respondents were considered suitable because they are the primary providers and beneficiaries of counselling services within the universities. A sample of 240 respondents, consisting of 25 professional counsellors, 15 student affairs personnel and 200 undergraduates, was selected using a proportionate stratified sampling technique followed by simple random sampling. The use of stratification ensured that all relevant groups were adequately represented, while simple random sampling provided every eligible respondent with an equal opportunity of participating in the study.

Data were collected using a researcher-developed instrument titled Artificial Intelligence and Counselling Service Delivery Questionnaire (AICSDQ). A pilot study involving 20 respondents from a private university outside the study area produced a Cronbach's Alpha reliability coefficient of .78, indicating that the instrument possessed high internal consistency and was suitable for the study.

Of the 240 questionnaires distributed, all were properly completed and returned, representing a 100% retrieval rate. Data collected were analyzed using mean and standard deviation to answer the research questions. A criterion mean of 2.50 served as the basis for decision-making. Mean scores of 2.50 and above indicated agreement, while mean scores below 2.50 indicated disagreement. The study was focused on describing respondents' perceptions regarding the contribution of artificial intelligence to counselling service delivery.

Results

Research Question 1: To what extent does artificial intelligence enhance counselling service delivery in private universities in Edo State, Nigeria?

Table 1

Mean Ratings on the Extent to which Artificial Intelligence Enhances Counselling Service Delivery in Private Universities in Edo State

S/N	Item	Mean ($\bar{x}$)	SD	Rank	Decision
1	AI improves students' access to counselling services through digital platforms.	3.29	.71	1 st	Agree
2	AI enables quicker responses to students' counselling enquiries.	3.18	.76	2 nd	Agree
3	AI supports effective career guidance and academic advising.	3.10	.80	3 rd	Agree
4	AI enhances communication between counsellors and students.	2.96	.84	4 th	Agree
5	AI improves the overall quality of counselling service delivery.	2.83	.88	5 th	Agree
6	AI helps counsellors make better professional decisions through data analysis.	2.68	.93	6 th	Agree
	Grand Mean	3.01	.82		Agree

(N = 240)

The findings presented in Table 1 indicate that respondents generally agreed that artificial intelligence enhances counselling service delivery in private universities in Edo State, as reflected by the grand mean of 3.01, which is above the criterion mean of 2.50. The highest-rated item was that AI improves students' access to counselling services through digital platforms ($\bar{x}$ = 3.29), followed by its ability to provide quicker responses to counselling enquiries ($\bar{x}$ = 3.18) and support career guidance and academic advising ($\bar{x}$ = 3.10). These findings suggest that respondents perceived AI primarily as a tool for improving the accessibility, responsiveness and efficiency of counselling services. However, relatively moderate ratings were recorded for AI improving the quality of counselling service delivery ($\bar{x}$ = 2.83) and supporting professional decision-making through data analysis ($\bar{x}$ = 2.68). Although respondents acknowledged these benefits, the lower mean scores imply that confidence in AI's capacity to support complex counselling functions remains moderate. This finding may reflect the continued preference for human interaction, empathy and professional judgement in counselling practice despite the increasing adoption of digital technologies.

Research Question 2: What challenges influence the effective integration of artificial intelligence into counselling service delivery in private universities in Edo State, Nigeria?

Table 2

Mean Ratings on the Challenges Affecting the Integration of Artificial Intelligence into Counselling Service Delivery

S/N	Item	Mean ($\bar{x}$)	SD	Rank	Decision
1	Many counsellors require additional training on AI applications.	3.36	.69	1st	Agree
2	Ethical and confidentiality concerns discourage AI adoption.	3.28	.74	2nd	Agree
3	Inadequate institutional policies limit AI implementation.	3.12	.81	3rd	Agree
4	Limited funding affects the acquisition of AI technologies.	3.05	.84	4th	Agree
5	Poor ICT infrastructure limits the effective use of AI in counselling.	2.91	.88	5th	Agree
6	Some counsellors are reluctant to adopt AI technologies.	2.73	.95	6th	Agree
	Grand Mean	3.08	.82		Agree

N = 240

The results in Table 2 reveal that respondents agreed that several organizational and professional factors constrain the effective integration of artificial intelligence into counselling

services in private universities. The grand mean of 3.08 indicates that the identified challenges remain prevalent despite the growing recognition of AI in educational support services. The highest-ranked challenge was the need for additional training among counsellors in AI applications ($\bar{x} = 3.36$), followed by ethical and confidentiality concerns ($\bar{x} = 3.28$) and inadequate institutional policies ($\bar{x} = 3.12$). These findings suggest that successful AI integration depends not only on technology but also on professional competence and clear governance frameworks. The comparatively lower mean scores for limited funding ($\bar{x} = 3.05$), poor ICT infrastructure ($\bar{x} = 2.91$) and counsellors' reluctance to adopt AI technologies ($\bar{x} = 2.73$) indicate that these issues are recognized but perceived as relatively less influential than training and ethical concerns. Therefore, the findings imply that strengthening counsellors' digital competencies, developing institutional AI policies and establishing ethical guidelines are essential for the sustainable integration of artificial intelligence into counselling service delivery in private universities in Edo State.

Discussion of Findings

The findings of this study revealed that artificial intelligence moderately enhances counselling service delivery in private universities in Edo State. Respondents agreed that AI improves students' access to counselling services, provides quicker responses to counselling enquiries, supports career guidance and strengthens communication between counsellors and students. These findings suggest that AI is increasingly becoming a valuable complementary tool for improving the efficiency and accessibility of counselling services rather than replacing professional counsellors. The moderate grand mean further indicates that although AI has gained acceptance within university counselling practice, its application is still evolving and has not yet reached its full potential within the selected institutions.

The finding supports the Technology Acceptance Model (TAM), which explains that users are more likely to adopt technological innovations when they perceive them as useful and easy to use (Davis, 1989). The positive perceptions expressed by respondents indicate that both students and counselling personnel recognize the practical benefits of AI in expanding access to counselling services and improving service responsiveness. This finding is also consistent with UNESCO (2024), which reported that AI technologies are transforming student support services by facilitating personalized guidance, improving communication and increasing access to educational support systems. Similarly, Almasri (2024) concluded that AI applications improve educational service delivery through intelligent automation, personalized support and data-driven decision-making.

The findings also agree with Labadze et al. (2023), whose systematic review found that AI chatbots improve communication between educational institutions and students by providing immediate responses to routine enquiries and reducing administrative workload. Likewise, Assayed et al. (2024) reported that AI-powered conversational systems enhance academic advising and counselling by increasing service availability and supporting preliminary student guidance before referral to professional counsellors. Within the Nigerian context, the findings suggest that AI could help address the growing demand for counselling services in private universities where student enrolment continues to increase while the number of professional counsellors remains relatively limited. Universities such as Igbinedion University, Benson Idahosa University, Samuel Adegboyega University, Wellspring University and Mudiame University can therefore utilize AI to complement existing counselling structures, improve response time and extend counselling support beyond the traditional office environment.

Despite these positive outcomes, the moderate ratings obtained for AI's contribution to professional decision-making and overall counselling quality indicate that respondents remain cautious about relying extensively on intelligent systems for counselling practice. This finding reflects the unique nature of counselling, which depends heavily on empathy, trust, emotional intelligence and ethical judgement. Although AI can analyze information and provide recommendations, it cannot adequately interpret human emotions, non-verbal communication or complex psychological experiences in the same manner as trained counsellors. This observation

supports Lee and Moore (2024), who argued that AI performs best when used as a decision-support tool rather than a substitute for human-centred counselling. Similarly, Holmes et al. (2022) emphasized that educational AI should augment professional practice while preserving the human relationships that remain central to effective counselling.

The study further revealed that inadequate AI training among counsellors, ethical and confidentiality concerns, weak institutional policies, limited funding and inadequate ICT facilities constitute the major barriers to AI integration in counselling service delivery. The highest-ranked challenge was the need for continuous professional training, indicating that successful AI implementation depends largely on the digital competence of counselling professionals. This finding corroborates UNESCO (2024), which identified digital literacy and professional capacity building as critical requirements for the responsible adoption of artificial intelligence in education. Likewise, Falebita and Kok (2024) observed that limited digital competence remains one of the major constraints affecting AI adoption across African higher education institutions.

The prominence of ethical and confidentiality concerns further demonstrates that respondents remain sensitive to issues relating to students' privacy, data protection and professional ethics. Counselling relationships are built on trust and confidentiality; therefore, concerns about data misuse, cyber security and algorithmic bias may discourage both counsellors and students from fully embracing AI-supported counselling systems. This finding aligns with Labadze et al. (2023), who argued that although AI improves service efficiency, institutions must establish robust governance frameworks to safeguard confidentiality and ensure responsible AI use. Similarly, UNESCO (2024) emphasized that transparency, accountability and ethical regulation should guide the deployment of AI in educational environments.

Interestingly, infrastructural challenges such as inadequate ICT facilities and limited funding received comparatively lower mean ratings than training and ethical issues. This finding may reflect the relatively stronger technological capacity of private universities compared with many public institutions in Nigeria. Nevertheless, respondents still acknowledged that continuous investment in digital infrastructure remains essential for sustaining AI-enabled counselling services. In Edo State, many private universities have made significant progress in digital transformation; however, the level of AI integration into counselling practice remains relatively modest. This suggests that institutional readiness extends beyond the availability of technology to include strategic leadership, organizational policies, financial commitment and continuous professional development.

The findings indicate that artificial intelligence has considerable potential to improve counselling service delivery in private universities in Edo State by increasing accessibility, efficiency and responsiveness. However, the study also demonstrates that AI should not be viewed as a replacement for professional counsellors. Rather, its greatest value lies in complementing human expertise by automating routine tasks, supporting early intervention and improving service accessibility while allowing counsellors to focus on complex psychological, emotional and behavioural issues that require empathy, ethical judgement and professional competence. The successful integration of AI into university counselling services will therefore depend on achieving an appropriate balance between technological innovation and the human-centred values that define effective counselling practice.

Conclusion

The study concluded that artificial intelligence is gradually transforming counselling service delivery in private universities in Edo State by improving students' access to counselling services, enhancing communication, supporting career guidance and increasing the efficiency of counselling operations. Although the influence of AI was found to be moderately positive, its effectiveness is largely dependent on institutional readiness, counsellors' digital competence, ethical safeguards and supportive organizational policies. Consequently, AI should be regarded as a complementary

professional tool that strengthens, rather than replaces, the role of trained counsellors in providing quality counselling services.

Recommendations

1. Counselling units should adopt a hybrid service delivery model in which AI supports routine counselling activities while professional counsellors handle complex psychological and emotional issues requiring human judgement and empathy.
2. Government agencies, university management and professional counselling associations should collaborate to provide sustainable digital infrastructure that will facilitate the responsible integration of artificial intelligence into counselling services within Nigerian higher education institutions.

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USING ARTIFICIAL INTELLIGENCE TOOLS TO STRENGTHEN THE QUALITY, EFFICIENCY AND INTEGRITY OF EDUCATIONAL RESEARCH IN HIGHER EDUCATION

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Abstract

Artificial intelligence (AI) is increasingly becoming part of the everyday work of researchers in higher education. Its value, however, depends less on the novelty of the technology than on how carefully researchers use it. This paper examined how AI tools can support three closely related goals in educational research: improving quality, reducing avoidable time and effort, and protecting research integrity. A PRISMA-informed conceptual review was undertaken using literature and substantive sources published between 2021 and 2026. Attention was given to AI-supported literature discovery, synthesis, data analysis, academic writing, peer review and research-integrity activities. Tools discussed include Elicit, Consensus, Scite, ResearchRabbit, Semantic Scholar, Grammarly, Paperpal, Trink AI and Turnitin's AI-related features. The review suggests that AI can make some research tasks faster and can widen access to scholarly information, particularly for researchers working in resource-constrained settings. At the same time, AI outputs may contain inaccurate claims, incomplete coverage, biased summaries or fabricated references. These risks become more serious when researchers treat AI output as a substitute for reading, judgement and methodological verification. In response, the paper proposes the QUERI framework—Quality, Use, Ethics, Rigour and Integrity—as a practical guide for responsible AI-assisted educational research. The paper argues that Nigerian higher education institutions should move beyond either unrestricted enthusiasm or blanket rejection of AI. Instead, they should build research cultures in which AI is used transparently as an assistant, while responsibility for evidence, interpretation and scholarly judgement remains with the researchers.

Keywords: Artificial Intelligence, Educational Research, Academic Integrity, Higher Education, AI research tools, QUERI Framework

Introduction

Artificial intelligence is changing the way researchers search for information, organize evidence, analyze data and prepare academic manuscripts. These changes are particularly relevant to higher education, where research quality is closely tied to the ability of academic staff and postgraduate students to locate credible evidence, use appropriate methods and communicate findings clearly. AI therefore presents an opportunity, but it also creates a responsibility: researchers must decide where the technology adds genuine value and where human judgement remains indispensable.

The Nigerian higher education environment makes this discussion especially important. Universities and polytechnics operate under pressures that include limited access to some subscription databases, inadequate research infrastructure, heavy workloads and funding constraints. AI-supported tools may reduce some of these barriers by helping researchers identify relevant literature, compare studies, improve drafts and organize information. However, access to a tool does not automatically produce better research. Poorly verified AI output can introduce errors into a study just as quickly as it can save time. Recent Nigerian studies also indicate that AI use is

already becoming part of students' research practices, while concerns about training, access, accuracy and responsible use remain. (Akinwalere & Akinrinola, 2025; Iferi et al., 2026)

A useful distinction is between general-purpose generative AI and research-oriented tools that retrieve or organize information from identifiable sources. Applications such as ChatGPT, Gemini and Claude can assist with brainstorming, explanation, drafting and language refinement, but their outputs still require careful verification. Research-oriented platforms such as Elicit, Consensus, Scite, ResearchRabbit and Semantic Scholar are designed more directly around scholarly search, evidence discovery or citation relationships. Even these tools should not be treated as infallible. Their usefulness depends on database coverage, search design, the quality of indexed sources and the researcher's ability to interpret the evidence.

This paper therefore asks: how can AI tools be used to improve the quality and efficiency of educational research without weakening research integrity? The discussion treats quality, efficiency and integrity as connected but distinct concerns. A tool may save time while reducing depth of engagement; it may improve language while introducing an unsupported claim; or it may identify many papers while missing relevant Nigerian or African scholarship. Responsible adoption requires these trade-offs to be made visible rather than hidden.

Literature Review

AI Tools across the Research Pipeline

Educational research is not a single activity. It involves problem identification, literature searching, research design, data collection, analysis, interpretation, writing, review and, eventually, dissemination. AI can be introduced at several points in this pipeline, but its role should differ from one stage to another. For example, AI may be useful for generating search terms or organizing a large set of references, whereas decisions about research design, interpretation of findings and ethical treatment of participants require direct human responsibility.

Recent studies point to several practical benefits of AI in education and research, including time savings, easier access to information, and assistance with writing and feedback. At the same time, studies report barriers such as limited digital literacy, over-reliance on AI, privacy concerns and uncertainty about acceptable academic practice. These findings suggest that the question is not whether researchers will encounter AI, but whether they will have the skills and institutional guidance needed to use it well.

AI for Literature Discovery and Synthesis

Literature discovery is often one of the most demanding stages of a research project. Researchers must develop search terms, identify relevant studies, screen titles and abstracts, assess relevance and then read the selected sources closely. AI-supported research platforms can reduce the mechanical burden of some of these tasks. Elicit, Consensus, ResearchRabbit, Scite and Semantic Scholar, for example, provide different combinations of semantic search, citation analysis, evidence extraction and citation-network discovery.

The attraction of these tools is clear, particularly where researchers have limited access to expensive databases. They can help a researcher move from a small number of known papers to a wider set of related studies and can reveal connections that a conventional keyword search may miss. However, the output is only a starting point. Researchers still need to inspect the original articles, check whether the evidence supports the interpretation and consider studies that may not be well represented in the tool's database.

Performance figures reported by commercial or tool-related sources should also be interpreted cautiously. Claims about screening recall, extraction accuracy or database size may be useful indicators, but they do not mean that a tool can replace a systematic review team or an experienced researcher. Performance depends on the task, the dataset, the search strategy and the quality of the underlying evidence.

AI for Data Analysis, Writing and Research Integrity

AI can also assist with selected aspects of data analysis and academic writing. Tools such as Julius AI and similar natural-language analysis platforms can help researchers explore datasets using ordinary language, while transcription tools can reduce the time required to convert recorded interviews into text. In qualitative research, AI-assisted coding may help organize large volumes of text, provided that researchers review the coding decisions and retain a clear audit trail.

Writing assistants such as Grammarly, Paperpal and Trinka can improve grammar, clarity and academic style. Their appropriate role is editorial rather than intellectual: they can help a researcher communicate an argument, but they should not determine the argument or supply evidence that has not been independently established.

Research integrity tools provide another layer of support. Similarity-checking systems can identify textual overlap, while citation-analysis tools can help researchers examine whether cited work supports, contradicts or merely mentions a claim. AI-generated-text detection, however, should not be treated as definitive proof of misconduct because automated detectors can produce false positives and false negatives. The safest approach is to combine technological checks with normal academic procedures, including source verification, transparent authorship and careful supervision.

One of the most important risks is hallucination: an AI system may produce a confident response containing a false claim, an incorrect interpretation or a reference that does not exist. The problem is particularly serious in academic writing because a fabricated reference can appear credible and may be copied into subsequent work. Consequently, no AI system should be treated as an authority simply because its response is fluent.

Table 3

Selected evidence from a recent Nigerian Higher-education Study

Aspect	Reported evidence	Interpretation	Relevance to this paper
Study context	66 tertiary institutions; 119,032 students in the population	Large multi-institutional Nigerian context	Supports the need for context-sensitive AI research policy
Sample	11,903 research-active students	Substantial analytical sample	Provides recent Nigerian evidence rather than relying only on international literature
AI use → digital wisdom	$\beta = .120; p < .001$	Statistically significant but small association	AI use may support digital judgement, but effect size matters
AI use → digital competence	$\beta = .102; p < .001$	Statistically significant but modest association	Access to AI does not by itself guarantee strong digital capability
AI use → research engagement	$\beta = .214$ (behavioural); .964 (cognitive); .165 (emotional), all reported as significant	Relationships vary considerably by engagement dimension	AI should be examined by function and outcome rather than treated as a single benefit

Recent Nigerian evidence helps place the discussion in a local context. Iferi et al. (2026) examined the relationship between AI-tool use, digital wisdom, digital competence and three dimensions of research engagement among higher education students in Nigeria. The study covered 66 tertiary institutions across three geopolitical regions and reported a population of 119,032 students; a multistage procedure produced a sample of 11,903 research-active students. The authors found statistically significant relationships between AI use and several research-related outcomes, although they cautioned that many of the effects were modest and should not be interpreted as strong causal effects. [Ncitem0turn0search0Q](#)

Evidence from recent Nigerian Research

Figure 1. Internal consistency of constructs reported by Iferi et al. (2026). Note: this figure reproduces reported reliability coefficients and is not original data from the present conceptual paper.

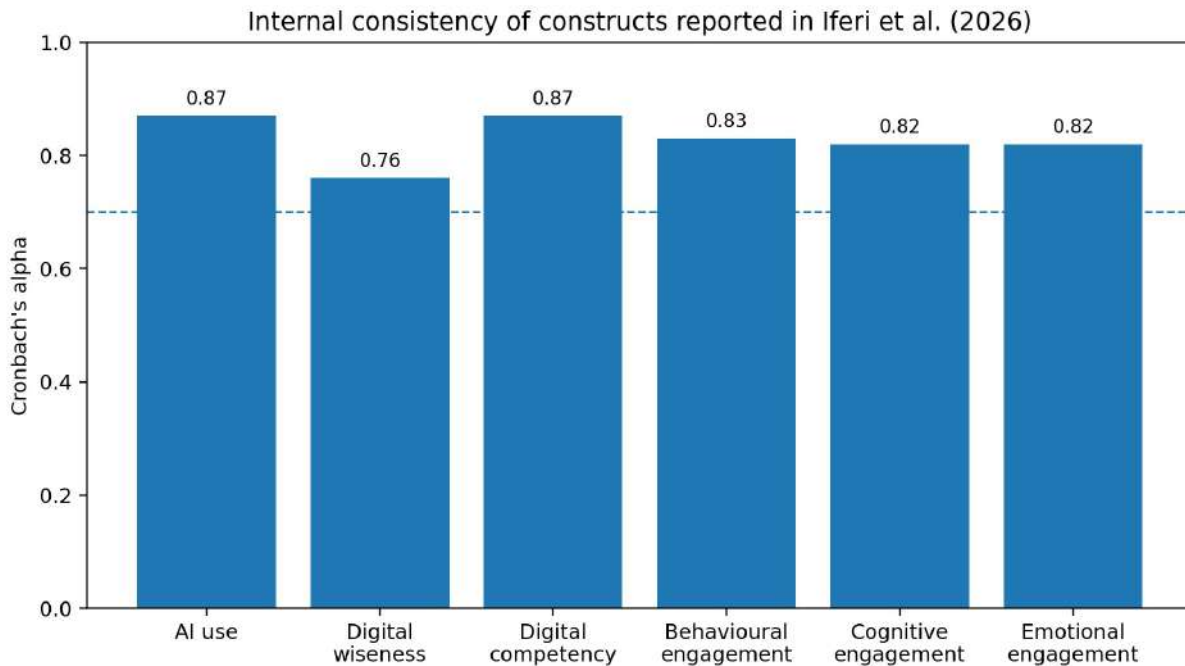
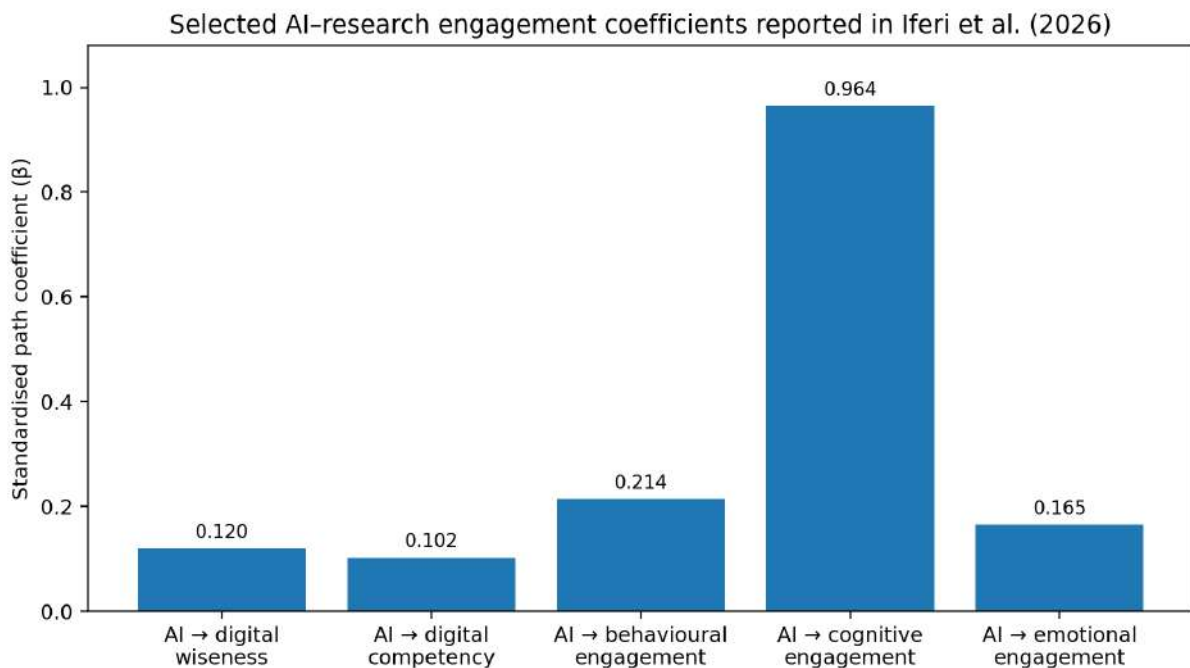


Figure 2. Selected standardized path coefficients reported by Iferi et al. (2026). Note: the figure is included as an evidence snapshot; the coefficients are not estimates from the present paper.



heoretical Framework

The discussion is informed by three complementary perspectives. The first is research quality assurance, which places emphasis on originality, methodological rigour, significance and clear communication. From this perspective, AI should be judged by whether it strengthens or weakens those dimensions rather than by how impressive its output appears.

The second perspective is the Technology Acceptance Model and related adoption research (Davis, 1989; Venkatesh et al., 2012). These perspectives help explain why researchers adopt technologies. Perceived usefulness is important, but actual use is also shaped by facilitating conditions such as reliable internet access, institutional support, digital literacy and clear policies. This is especially relevant to Nigerian higher education.

The third perspective is responsible research and innovation, which emphasizes anticipation of risks, reflection on assumptions, inclusion and responsiveness (Owen et al., 2013). Together with research-integrity scholarship (Steneck, 2006; COPE, 2023), this perspective reinforces the idea that AI adoption should not be driven by convenience alone. Researchers must also consider privacy, fairness, transparency, accountability and the consequences of error.

Methods

This paper used a PRISMA-informed conceptual review rather than a full systematic review or meta-analysis. Searches were undertaken across Scopus, Web of Science, Google Scholar and ERIC using combinations of terms relating to artificial intelligence, generative AI, academic research, educational research, literature review, research integrity and higher education. The review focused on material published between 2021 and 2026, together with relevant policy and professional guidance.

Sources were considered in relation to four practical criteria: accuracy and citation grounding; breadth of coverage; accessibility and cost in the Nigerian higher education context; and safeguards for research integrity. The review synthesized the evidence conceptually rather than assigning numerical scores to the studies. The QUERI framework presented below emerged from this synthesis.

The QUERI framework for AI-assisted educational research

The QUERI framework is proposed as a simple decision framework for researchers who use AI during the research process. The acronym represents Quality, Use, Ethics, Rigour and Integrity. The five dimensions are interdependent: a tool that improves efficiency but weakens integrity is not a successful research intervention.

1. **Quality (Q).** AI should be used where it makes a defensible contribution to research quality. It may help a researcher broaden a literature search, compare themes across studies, identify possible gaps or improve the clarity of a manuscript. It should not replace the researcher's reading, interpretation or judgement. A literature review generated without close engagement with the original sources may sound polished while remaining shallow or incomplete.

2. **Use (U).** The researcher should remain the primary intellectual agent. AI may act as an assistant, but responsibility for the research question, methods, evidence, interpretation and final text remains with the researcher. Responsible use includes keeping a record of significant AI assistance, checking outputs and following the disclosure requirements of the institution or target journal.

3. **Ethics (E).** Ethical use includes protection of confidential information, participant privacy, fairness and equitable access. Researchers should not upload confidential research data or identifiable participant information to an AI service unless the data-management arrangements explicitly permit it. They should also be alert to the possibility that AI-generated summaries may under represent African scholarship or reproduce biases present in the underlying data.

4. **Rigour (R).** AI-assisted work must meet the same methodological standards as work completed without AI. Where AI is used for screening, coding, transcription, analysis or statistical assistance, the researcher should document the process and independently check important outputs. Any limitations in database coverage, model capability or the date of available information should be acknowledged where relevant.

5. **Integrity (I).** Integrity requires that every important claim can be traced to credible evidence. Researchers should verify AI-generated references against the original publications before citing them. AI should not be listed as an author, and its contribution should be disclosed where required by institutional or publisher policy. Similarity checks and other integrity tools can support quality assurance, but they should complement rather than replace scholarly judgement.

Table 1
Evaluation of Selected AI Research Tools across QUERI Dimensions

Tool	Main research use	Evidence/accuracy consideration	Accessibility	Integrity consideration
Semantic Scholar	Scholarly search and citation discovery	Links searches to indexed scholarly literature; output still requires source checking	Free access available	Source links and citation context can support verification
Elicit	Literature discovery and screening support	Useful for semantic search and evidence extraction; performance varies by task	Free and paid options	Claims and extracted evidence should be checked against original papers
Consensus	Evidence-oriented search	Designed to surface findings from academic studies; not a substitute for full-text appraisal	Free and paid options	Study type and source context can support critical appraisal
ResearchRabbit	Citation-network discovery	Useful for mapping relationships among papers; depends on indexed coverage	Free access available	Source-paper links support traceability
Scite	Citation context and post-publication monitoring	Helps distinguish supporting, contrasting and mentioning citations	Free and institutional access options	Can flag citation concerns and retractions

Grammarly / Paperpal / Trinka	Academic language and style	Useful for clarity and editing; should not determine substantive claims	Free and paid options	Researchers remain responsible for originality and final wording
Turnitin-related tools	Similarity and AI-related checks	Useful as screening evidence; automated AI detection is not conclusive	Usually institutionally licensed	Supports broader integrity checks when combined with human review

Source: Authors' synthesis based on the literature and tool-related sources listed in the references.

Table 2
QUERI Framework—Dimensions, Principles and Practical Application

Dimension	Focus	Core principle	Practical question
Q—Quality	Improve the strength of research	Use AI to extend, not replace, scholarly thinking	Does this use of AI make the research better?
U—Use	Responsible human control	The researcher directs and verifies AI assistance	Have I checked and documented the important outputs?
E—Ethics	Privacy, fairness and access	Protect people, data and equitable participation	Could this use expose data or reproduce bias?
R—Rigour	Methodological discipline	Document and independently check AI-assisted processes	Can another researcher understand and evaluate how AI was used?
I—Integrity	Trustworthiness and accountability	No fabricated evidence or undisclosed authorship	Can every important claim and citation be verified?

Source: Authors' original framework (2026).

Discussion

Where AI offers the clearest research value

The most convincing case for AI in educational research is not that it can conduct research on its own. Its immediate value is more modest and more practical: it can reduce the time spent on repetitive information-handling tasks. Searching for related studies, organizing references, producing a first-pass transcription, checking language and tracing citation relationships are examples of tasks where assistance can be useful. This can create more time for the work that cannot be delegated easily: reading critically, designing a sound study, interpreting evidence and making defensible arguments.

For researchers in Nigeria, these potential matters because the benefits of open or low-cost tools can partly offset resource limitations. Nevertheless, the phrase 'democratization of research' should be used carefully. Access to a free tool does not eliminate differences in internet reliability, research training, database coverage, computing resources or institutional support.

Nigerian context and the importance of institutional support

The Nigerian context adds another layer to AI adoption. Researchers may be attracted to AI because it helps them work faster, but sustainable use requires more than individual enthusiasm. Institutions need clear guidance on acceptable use, privacy, authorship, disclosure and the handling of research data. They also need practical training so that staff and postgraduate students can distinguish between useful assistance and unsupported AI-generated content.

Policy should therefore avoid two extremes. A blanket prohibition is unlikely to be effective as AI becomes embedded in common research software, while unrestricted use creates avoidable risks. A proportionate approach would define permitted uses, require human verification of substantive outputs and protect confidential research information.

Hallucination and citation reliability

Hallucination is one of the most serious risks in AI-assisted academic writing because fluent language can disguise factual error. A generated reference may contain a real author with the wrong

title, a plausible journal with an incorrect volume or a completely invented publication. The danger is greater when researchers copy references without opening and checking the original source.

The practical response is simple, although it requires discipline: important claims and citations must be checked against primary or authoritative sources. Retrieval-oriented research tools can make this process easier, but retrieval does not remove the need for appraisal. A source may be genuine and still be irrelevant, outdated or misinterpreted.

Equity, bias and African scholarship

AI tools may broaden access to global scholarship, but access should not be confused with balanced representation. Search and synthesis systems depend on the material they can retrieve and the patterns in their underlying data. Researchers working on African education should therefore examine whether Nigerian and other African studies are adequately represented in an AI-generated evidence base.

A practical safeguard is to combine AI-supported discovery with deliberate searches of Nigerian and African journals, institutional repositories and other relevant local sources. This does not mean rejecting international evidence; it means ensuring that local evidence is not overlooked simply it is less visible in an AI-generated summary.

Conclusion

AI has a legitimate and potentially valuable role in educational research, but its contribution should be measured by the quality of the research it supports rather than by the sophistication of the tool itself. AI can help researchers discover literature, organize information, improve language, explore data and perform selected quality-assurance tasks. These benefits are particularly relevant in resource-constrained higher education environments.

At the same time, AI does not remove the central responsibilities of a researcher. Evidence must still be appraised, methods must still be defended, interpretations must still be justified and citations must still be verified. The most serious risks identified in this review—hallucinated information, fabricated citations, privacy problems, bias and over-reliance—are manageable only when human oversight is built into the research process.

The QUERI framework provides a practical way of keeping that oversight visible. By asking whether AI improves Quality, whether it is being used responsibly, whether Ethics have been considered, whether methodological Rigour has been maintained and whether research Integrity has been protected, researchers can make more balanced decisions about when and how to use AI. The central principle is that AI should support scholarly work while responsibility for the research remains with the researcher.

Suggestions

1. Develop clear institutional guidance on AI-assisted research, covering acceptable uses, disclosure, authorship, data protection and responsibility for final outputs.
2. Provide practical AI research-literacy training for academic staff and postgraduate researchers, with particular emphasis on source verification, prompt design, bias, privacy and research integrity.
3. Encourage researchers to use AI primarily for supportive tasks—such as literature discovery, organization, language refinement and preliminary analysis—while retaining direct control over research design and interpretation.
4. Require independent verification of AI-generated citations, quotations, statistical claims and other substantive evidence before they are included in a manuscript, report or thesis.
5. Encourage researchers to combine AI-assisted discovery with deliberate searches for Nigerian and African scholarship so that local evidence is not systematically overlooked.
6. Include a short AI-use statement in research reports, theses and journal manuscripts where required, indicating which tools were used, for what purposes and what human checks were applied.

7. Institutions should periodically review their AI guidance because tools, capabilities and publisher policies are changing rapidly. The principles of transparency, accountability and scholarly integrity should remain constant even as specific tools change.

Practical QUERI self-audit

Before submitting research in which AI has been used, the researcher should be able to answer 'yes' to the following questions:

- Did AI assist my work without replacing my own intellectual engagement?
- Have I recorded or disclosed the important ways in which AI was used?
- Have I protected confidential and participant-related information?
- Have I independently checked AI-assisted analysis and substantive claims?
- Have I verified every AI-generated citation against the original source?
- Have I considered whether relevant Nigerian or African scholarship may have been missed?

Table 4

Practical comparison of AI research tools

Tool	Best suited for	Main strength	Main caution	Recommended use
Semantic Scholar	Literature discovery	Broad scholarly search and citation links	Coverage is not universal	Initial literature search and citation tracing
Elicit	Literature screening and evidence extraction	Helps organize and compare studies	AI summaries require source checking	Screening support and evidence organization
Consensus	Evidence-oriented questions	Connects answers to academic studies	Should not replace appraisal of full papers	Rapid evidence discovery
ResearchRabbit	Citation-network exploration	Visualizes relationships among papers	Depends on available indexed links	Finding related and influential studies
Scite	Citation context	Shows supporting, contrasting and mentioning citations	Access and coverage vary	Citation verification and monitoring
Grammarly Paperpal / Trinka	Academic language editing	Improves clarity and style	Can alter wording without understanding the researcher's intended meaning	Final language refinement after substantive writing
Turnitin	Similarity and integrity screening	Supports text-similarity checking	AI detection is not conclusive evidence of misconduct	Final quality-assurance screening

Note. Tool capabilities and access arrangements change over time; researchers should verify current functionality and institutional licensing before adoption.

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