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LEVERAGING ICT AND ARTIFICIAL INTELLIGENCE-ENHANCED SYSTEMS TO IMPROVE STUDENT ENGAGEMENT AND COGNITIVE OUTCOMES

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ABSTRACT

This study examined the association between the use of Information and Communication Technology (ICT) and Artificial Intelligence (AI)-enhanced systems, student engagement and academic performance among tertiary students in Nigeria. A cross-sectional correlational survey design was adopted. Questionnaires were administered to 200 students of Kwara State College of Education, Ilorin, and 184 usable responses (92%) were analyzed alongside academic records obtained from institutional files. Data were collected with a 30-item, 4-point Likert questionnaire (Cronbach's $\alpha = 0.85$) and analyzed with SPSS using descriptive statistics, an independent samples t-test, and regression-based mediation analysis. Students reported high behavioural ($M = 3.34$) and emotional ($M = 3.24$) engagement, and moderate-high cognitive engagement ($M = 3.14$). Students with higher weekly use of adaptive learning platforms, intelligent tutoring systems and educational chatbots had higher mean academic scores (72.4%) than low-usage peers (66.8%), $t(182) = 3.58$, $p < .001$, $d = 0.61$ (medium effect). Student engagement partially mediated the statistical relationship between ICT/AI use and academic performance. The most frequently reported barriers were infrastructure limitations (88.0%), digital literacy gaps (53.8%), and cognitive overload or offloading (38.0%). Because the data are cross-sectional and drawn from a single institution, the findings indicate associations rather than causal effects and should be generalized with caution. The study recommends investment in reliable power and affordable connectivity, capacity building for lecturers and students, pedagogically guided AI use, and context-appropriate low-bandwidth tools.

KEYWORDS: ICT, Artificial Intelligence, Student Engagement, Cognitive Outcomes, Adaptive Learning, Educational Technology

I. INTRODUCTION

Advancements in ICT and AI have fundamentally transformed teaching and learning, shifting education from a teacher-centered to a learner-centered paradigm (Long et al., 2026). AI-augmented systems, such as intelligent tutoring systems, adaptive learning platforms, educational chatbots, and predictive analytics, now enable personalized instruction and real-time feedback tailored to individual student needs (Sajja et al., 2024). While ICT enhances access and interactivity, research suggests that its effectiveness is contingent upon sound pedagogical

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frameworks and active student engagement. Despite considerable investments in ICT infrastructure across African higher education, many institutions report inconsistent improvements in student performance (Hassan et al., 2026). In Nigeria, challenges such as limited bandwidth, intermittent power supply, and varying levels of digital literacy hinder the effective deployment of AI-enhanced tools (Oseniet al., 2026). These structural constraints underscore the need for strategic integration models that account for local realities while preserving pedagogical quality (Hassan et al., 2026). Recent evidence indicates that AI tools collectively enhance engagement by aligning tasks with learners' readiness levels and providing timely, data-driven interventions (Sajja et al., 2024). Intelligent tutoring systems guide learners through scaffolding and adjust based on progress; adaptive learning platforms tailor content to mastery levels; educational chatbots deliver instant assistance; and predictive analytics identify students at risk before failure occurs (Sajja et al., 2024; Long et al., 2026). The purpose of this study is to examine the role of Information and Communication Technology (ICT) and Artificial Intelligence (AI)-augmented systems in enhancing student engagement and cognitive learning outcomes in Nigerian higher education. Specifically, this study seeks to:

(a). Determine the influence of ICT tools and AI-augmented systems on students' learning processes and academic outcomes.
(b). Examine the extent of enhancement in cognitive learning outcomes through AI-supported systems.
(c). Investigate how ICT tools enhance student engagement within learning environments.
(d). Identify the contextual challenges affecting the effective implementation of ICT and AI in Nigerian higher education.
(e). Explore the mediating role of student engagement in the relationship between ICT/AI use and academic performance.

To achieve these objectives, this study will answer the following research questions:

(a). How do ICT tools influence student engagement in learning environments?
(b). What role do AI-augmented systems play in improving cognitive learning outcomes?
(c). How does student engagement mediate the relationship between ICT/AI use and academic performance?
(d). What challenges affect the effective implementation of ICT and AI in education, particularly in Nigerian higher education?

II. LITERATURE REVIEW

The integration of Information and Communication Technology (ICT) and Artificial Intelligence (AI)-enhanced systems into tertiary education has prompted growing scholarly attention to how these tools relate to student engagement and learning outcomes. This section reviews the literature in six parts. It first examines how ICT is associated with student engagement, then considers the nature and educational uses of AI-augmented systems such as adaptive learning platforms, intelligent tutoring systems and educational chatbots. It next reviews evidence on the relationship of AI with cognitive learning outcomes and with student engagement, and then considers the role of pedagogical mediation in shaping whether these tools support or weaken learning. The section closes with the theoretical framework, drawing on Constructivism, the Technology Acceptance Model and Cognitive Load Theory, which together explain how learners build knowledge, why they adopt technology and how instructional design affects mental effort. Much of the existing evidence comes from settings with stable infrastructure and is correlational, so its relevance to

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Nigerian tertiary institutions, where power supply, connectivity and digital literacy remain uneven, needs careful interpretation. Identifying this gap provides the rationale for the present study.

A. ICT and Student Engagement

ICT tools such as digital learning platforms, multimedia resources, and online collaboration systems foster interactive and participatory learning environments (Hassan et al., et al., 2026). ICT-related engagement significantly improves students' academic achievement, motivation, and participation levels (Halkiopoulos & Gkintoni, 2024). Peer and instructor interaction strengthens collaborative learning (Bond et al., 2023). Platforms like Moodle, Microsoft Teams, and Zoom enhance engagement in science education (Zhou et al., 2024), while communication tools like Telegram increase collaboration and interaction rates (Estrada, 2023). However, ICT effectiveness depends on pedagogical design. Without appropriate instructional strategies, ICT tools may fail to enhance learning or even lead to disengagement (Bond et al., 2023; Long et al., 2026).

B. AI-Augmented Systems in Education

Augmented Reality (AR) is rapidly emerging as a transformative educational tool, offering learners an immersive and interactive experience. By overlaying digital elements onto real-world settings, AR strengthens students' ability to grasp and explore complex ideas, particularly in disciplines that rely heavily on spatial and visual understanding, such as medicine, engineering, and architecture (Anuar et al., 2026). AI enables personalized and adaptive learning experiences. Intelligent tutoring systems, chatbots, and predictive analytics tailor content to individual needs (Sajja et al., 2024). Meta-analyses confirm that AI-enhanced instruction improves efficiency and satisfaction, especially when integrated with active learning (Long et al., 2026). Predictive analytics allow early detection of at-risk students (Holmes, Bialik, & Fadel, 2023). Concerns remain about overreliance, reduced critical thinking, and ethical issues such as data privacy and bias. Excessive reliance may reduce deep learning (Ansari & Qamari, 2025).

C. AI and Cognitive Learning Outcomes

AI technologies have been found to significantly influence students' cognitive development by promoting higher-order thinking skills such as critical thinking, problem-solving, and analytical reasoning (Hassen, 2025). The impact of AI on students' reading, critical thinking, and problem-solving skills. *American Journal of Education and Information Technology*, *9*(2), 82-90.3). Cognitive learning outcomes, including critical thinking and problem-solving, are central to higher-order learning (Sweller, 1988). Structured AI interventions, when integrated with sound pedagogical practices, encourage students to engage deeply with learning materials and apply knowledge in complex contexts. Research by Ansari and Qamari (2025) indicates that AI-supported learning environments improve cognitive outcomes by facilitating active learning and continuous assessment. However, the study also cautions that unstructured or excessive reliance on AI tools may reduce deep learning and independent thinking, underscoring the need for pedagogically guided integration (Hassan et al., 2026).

Evidence reveals a complex, non-linear relationship between AI use and cognition. Moderate AI usage shows minimal cognitive impact, while excessive reliance correlates with decreased critical thinking abilities (cognitive offloading effect), reduced metacognitive accuracy, and lower retention on delayed assessments (The Impact of AI Tools on Human Cognitive Abilities, 2025). Field studies with approximately 1,000 students demonstrated improved immediate

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performance but worse unassisted outcomes following AI removal, particularly with unrestricted AI access (Rao, 2025). Well-designed AI tutoring systems with scaffolding produced superior learning gains compared to traditional instruction (Singh & Pegadraju, 2026). IGI Global Scientific Publishing.). This suggests that AI tools do not inherently impair or enhance cognition; rather, their impact depends critically on implementation design, user agency, and interaction patterns (Singh & Pegadraju, 2026).

D. AI and Student Engagement

AI systems enhance student engagement by providing interactive, responsive, and adaptive learning experiences. Through features such as instant feedback, personalized recommendations, and dynamic content delivery, AI tools sustain students' interest and involvement in learning activities. Long et al. (2026) found that AI significantly improves cognitive engagement, which involves students' investment in understanding complex concepts, followed by improvements in behavioral and emotional engagement. This suggests that AI not only captures students' attention but also deepens their intellectual involvement in the learning process. AI-driven personalization enhances engagement by aligning tasks with learners' readiness levels and providing timely, data-driven interventions (Sajja et al., 2024).

E. Pedagogical Mediation

Despite the potential benefits of ICT and AI, their effectiveness largely depends on the pedagogical approaches used in their implementation. Technology alone cannot guarantee improved learning outcomes without appropriate instructional design (Li et al., 2025). Pedagogical strategies such as flipped classrooms, gamification, and scaffolded learning have been shown to enhance the impact of ICT and AI tools. These approaches encourage active participation, collaboration, and critical thinking among students. Ahmed et al. (2025) incorporating AI with well-structured teaching methods significantly improves both engagement and academic performance. Educators must align technological tools with pedagogical objectives to maximize their benefits. The effectiveness of ICT and AI tools is significantly influenced by pedagogical design, and this study is grounded in three theoretical frameworks that explain these relationships.

F. Theoretical Framework

This study is anchored on three key theoretical perspectives: Constructivism Theory, the Technology Acceptance Model (TAM), and Cognitive Load Theory (CLT). These theories provide a comprehensive foundation for understanding how ICT and AI-augmented systems influence student engagement and cognitive learning outcomes.

G. Constructivism Theory

Constructivism, as propounded by Piaget (1972) and further developed by Vygotsky (1978), posits that learners actively construct knowledge through interaction with their environment rather than passively receiving information. In the context of ICT and AI in education, constructivist theory emphasizes the role of interactive technologies in facilitating active learning. Digital platforms, simulations, and AI-powered tools enable students to explore concepts, collaborate with peers, and engage in problem-solving activities, thereby enhancing deep understanding. Recent studies support this perspective, indicating that technology-enhanced learning environments promote student-centered learning and improve engagement and academic outcomes (Wang et al.,

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2024). AI-augmented systems, such as intelligent tutoring systems, align with constructivist principles by providing personalized learning experiences tailored to learners' needs.

H. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Fred Davis (1989), explains how users come to accept and use new technologies. According to TAM, perceived usefulness and perceived ease of use are the primary determinants of technology adoption. In educational settings, students are more likely to engage with ICT and AI tools if they perceive them as beneficial and user-friendly. Empirical studies have confirmed that students' acceptance of AI-based learning systems significantly influences their engagement and learning outcomes (Venkatesh & Davis, 2000; Chen, & Dong, 2026). AI systems that provide intuitive interfaces, real-time feedback, and adaptive learning pathways tend to increase students' motivation and participation in learning activities.

I. Cognitive Load Theory (CLT)

Cognitive Load Theory, developed by Sweller (1988), focuses on the limitations of working memory in the learning process. The theory categorizes cognitive load into intrinsic, extraneous, and germane load, emphasizing the need to optimize instructional design to enhance learning efficiency. In ICT and AI-supported environments, well-designed systems help reduce extraneous cognitive load and promote meaningful learning by presenting information in structured and manageable ways. Research shows that AI-driven adaptive systems improve cognitive outcomes by tailoring content to learners' cognitive capacities (Halkiopoulos & Gkintoni, 2024). However, poorly designed systems may overload learners, thereby negatively affecting comprehension and retention.

J. Integration of Theories with the Study

The integration of Constructivism, TAM, and Cognitive Load Theory provides a holistic framework for this study. Constructivism explains how learners actively engage with ICT and AI tools to construct knowledge; TAM explains the factors influencing students' acceptance and usage of these technologies; while Cognitive Load Theory explains how these tools affect cognitive processing and learning outcomes. Together, these theories support the argument that effective, pedagogically guided integration of ICT and AI can significantly enhance student engagement and cognitive development.

III. METHODOLOGY

The study adopted a cross-sectional, quantitative correlational survey design, which suited the objectives of describing students' engagement and challenges, comparing academic performance across levels of ICT/AI use, and testing the statistical relationships among ICT/AI use, engagement and performance at a single point in time. Because ICT/AI use was not manipulated and there was no pre/post measurement, the design supports conclusions about association, not causation. The study was conducted at Kwara State College of Education, Ilorin, Nigeria, whose five schools are Science, Vocational, Education, Languages, and Early Childhood Care Education. The population comprised all registered NCE 3 students (N = 1050) who had used at least one ICT/AI-enhanced learning tool during the semester. A sample of 200 (about 20% of the population) was used because of time and resource constraints, which corresponds to a margin of error of about 6.2% at the 95% confidence level and was drawn by stratified random sampling with proportional allocation across

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the schools, using the registered student lists as the sampling frame within each school. Of the 200 questionnaires administered through Google Forms, 184 were complete and usable (92%) and were matched with official academic records; 16 were excluded as incomplete, duplicate or ineligible.

ICT/AI utilization (adaptive learning platforms, intelligent tutoring systems and educational chatbots) was the independent variable, student engagement (behavioural, emotional and cognitive) the mediator, and academic performance the dependent variable. For group comparison, students using these tools for more than 4 hours per week (n = 142) were classed as high-usage and the others (n = 42) as low-usage, while the mediation analysis used the continuous utilisation score. Data were collected with a 30-item questionnaire on a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) covering constructs and the number of items each, with items adapted from / developed from the reviewed literature. Content and face validity were established by 2 experts in the Science Education Department; the instrument was pilot-tested with 10 students outside the sample, and Cronbach's alpha was 0.85 for the whole scale. Mean scores were interpreted using bands, e.g., (3.00–3.49 Moderate-High; 3.50–4.00 High). Academic performance was taken from institutional records as [CGPA / average semester score] expressed as a percentage. After permission from the college management, the questionnaire link was shared with selected students over two weeks. Participation was voluntary, informed consent was obtained on the first page of the form, responses were anonymous, and academic records were de-identified after matching; ethical approval or permission was obtained from the participant was voluntary.

Data were analysed in SPSS 27.0. Frequencies, percentages, means and standard deviations summarised engagement and the challenges reported, and an independent samples t-test with Cohen's d compared the academic performance of the high- and low-usage groups. Mediation was tested using regression-based analysis following the Baron and Kenny steps (path a, path b controlling for ICT/AI use, total effect c and direct effect c′). The indirect effect (b) was 0.20, 95% CI [0.34] estimates and their standard errors; *(b)* obtained with the PROCESS macro (Model 4) using 5,000 bootstrap resamples, and a Sobel test was also reported. Linearity, normality of residuals, homoscedasticity and absence of multicollinearity were checked. The significance level was set at 0.05. Because the data are cross-sectional, the mediation analysis shows statistical mediation within the observed data and does not establish a causal mechanism.

IV. RESULTS AND DISCUSSION

The sample was categorized into two operational groups based on verified interactions with adaptive learning platforms, intelligent tutoring systems, or educational chatbots.

Table 1: System Usage Profile of Respondents

Respondent Classification	Sample Size (n)	Percentage (%)	Weekly Verified System Interaction
High-Usage Group	142	77.2%	Greater than 4 hours/week
Low-Usage Group	42	22.8%	Less than 4 hours/week
Total Validated Sample	184	100.0%	Mean response rate: 92%

Descriptive statistics were computed across the validated 30-item scale (measured on a 4-point Likert scale from 1 = Strongly Disagree to 4 = Strongly Agree).

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Table 2: Influence of ICT Tools on Student Engagement

Engagement Dimension	Core Survey Metric Indicators Evaluated	Mean (μ)	Std. Deviation (σ)	Verbal Interpretation
Behavioral Engagement	Consistent system logins, learning management platform participation, and timely submission of interactive tasks.	3.34	0.51	High Engagement
Emotional Engagement	Academic motivation, heightened interest in technology-mediated STEM courses, and collaboration via Teams/Telegram.	3.24	0.56	High Engagement
Cognitive Engagement	Self-regulated learning, investment in mastering complex concepts, and low reliance on surface-level memorization.	3.14	0.61	Moderate-High Engagement

The results presented in Table 2 show the level of students' engagement in technology-mediated STEM courses across three dimensions: behavioral, emotional, and cognitive engagement. The findings revealed that behavioral engagement recorded the highest mean score (M = 3.34, SD = 0.51) and was interpreted as high engagement. Emotional engagement recorded a mean score of 3.24 (SD = 0.56), which was also interpreted as high engagement. In contrast, cognitive engagement recorded the lowest mean score of 3.14 (SD = 0.61) and was interpreted as moderate-high engagement. Overall, the results indicate that students demonstrated a generally high level of engagement in technology-mediated STEM learning. Behavioral engagement was the strongest dimension, followed by emotional engagement, while cognitive engagement was comparatively lower. The standard deviation values, ranging from 0.51 to 0.61, indicate relatively moderate variation in students' responses across the three dimensions. An independent samples t-test was conducted to compare the academic performance scores (%) of students in the high-usage and low-usage groups. Group membership was determined by students' weekly use of adaptive learning platforms, intelligent tutoring systems and educational chatbots, not by assignment, so the comparison shows differences between groups and does not isolate the effect of these tools.

Table 3: Academic Performance of High-Usage and Low-Usage Groups

Operational Group	N	Academic Mean (μ)	Std. Deviation (σ)	t-value	df	p-value	Effect Size (Cohen's d)
High-Usage Group	142	72.4%	8.5%	3.58	182	< 0.01	0.61
Low-Usage Group	42	66.8%	10.2%				(medium)

Table 3 above states that the difference between groups was statistically significant, $t(182) = 3.58$, $p < .001$, with a medium effect size (Cohen's $d = 0.61$). Students in the high-usage group had higher mean academic scores than those in the low-usage group. This indicates an association between higher ICT/AI use and higher academic performance in this sample. Because the groups were not randomly assigned and no prior-attainment measure was controlled, the result does not show that ICT/AI use caused the difference.

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To examine whether student engagement statistically accounts for part of the relationship between ICT/AI utilization (X) and academic performance (Y), a regression-based mediation analysis was conducted following the Baron and Kenny steps. Path a is the effect of X on the mediator (engagement), path b is the effect of the mediator on Y controlling for X, c is the total effect of X on Y, and c′ is the direct effect of X on Y after controlling for engagement.

Table 4: Regression Results for Student Engagement as a Statistical Mediator of the Relationship Between ICT/AI Use and Academic Performance

Regression Step & Pathway	Independent Variable	Dependent Variable	Unstandardized β	Standard Error (SE)	Standardized β	t-stat	Sig. (p)
Step 1 (Path a)	ICT/AI Utilization	Student Engagement	0.48	0.09	0.45	5.33	< 0.01
Step 2 (Path b)	Student Engagement	Academic Performance	0.41	0.11	0.38	3.72	< 0.01
Step 3 (Path c: Total)	ICT/AI Utilization	Academic Performance	0.56	0.10	0.52	5.60	< 0.01
Step 3 (Path c': Direct)	ICT/AI Utilization	Academic Performance	0.38	0.12	0.35	3.16	< 0.01

Table 4 above reveals that the standardized coefficient for ICT/AI utilization fell from 0.52 (total effect) to 0.35 (direct effect) when student engagement was added to the model, and the direct effect remained significant. This pattern is consistent with partial statistical mediation. The indirect effect was [ab = 0.20, 95%, CI, 0.08, 0.34] a Sobel test gave a consistent result (Z = [3.06], p < .01). These findings suggest that part of the association between ICT/AI use and academic performance is shared with student engagement. Because ICT/AI use, engagement, and performance were measured at one point in time, the analysis cannot establish the causal order of these variables or confirm the mechanism, and the results should be read as a statistical pattern in the observed data.

Descriptive tracking of the systemic barrier sub-scales identified the main structural constraints present within the Kwara State College of Education environment.

Table 5: Contextual Challenges Affecting AI & ICT Implementation

Identified Barrier Category	Specific Contextual Challenge Measured	Frequency (f)*	Percentage (%)	Primary Theoretical Link
Infrastructure Limitations	Intermittent power grid supply and expensive, unstable internet bandwidth.	162	88.0%	Technology Acceptance Model (Low Ease of Use)
Digital Literacy Gaps	Uneven baseline technical competence among both students and classroom instructors.	99	53.8%	Constructivism (Inability to safely navigate scaffolding)
Cognitive Overload / Offloading	Superficial task completion and reduced memory retention due to unguided generative AI use.	70	38.0%	Cognitive Load Theory (High extraneous cognitive load)

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The results presented in the table 5 reveals three major barriers affecting the effective use of technology-mediated learning among the respondents: infrastructure limitations, digital literacy gaps, and cognitive overload/offloading**.** The most frequently identified barrier was infrastructure limitations**,** reported by 162 respondents (88.0%)**.** The second most frequently reported barrier was digital literacy gaps**,** identified by 99 respondents (53.8%)**.** The third barrier was cognitive overload/offloading**,** reported by 70 respondents (38.0%)**.** Overall, the results demonstrate that infrastructure limitations constituted the most prominent barrier (88.0%)**,** followed by digital literacy gaps (53.8%)**,** while cognitive overload/offloading was reported by 38.0% of respondents. The findings therefore suggest that improving technology-mediated learning requires not only investment in reliable electricity and affordable internet connectivity but also systematic development of digital competencies among students and instructors. Furthermore, appropriate guidance on the responsible and pedagogically meaningful use of generative AI is necessary to minimize cognitive offloading and promote deeper learning.

Limitations of the Study

While this study provides significant insights, several limitations must be acknowledged:
Geographic Focus: The study was conducted at a single institution, Kwara State College of Education, Ilorin, which may limit the generalizability of the findings to all Nigerian or African tertiary institutions. Methodological Scope: The research relied on a quantitative design with a sample of 200 students. Future research: Longitudinal or quasi-experimental studies, multi-institution samples, and mixed-methods designs that include interviews with students and lecturers are recommended to test causal effects and to explore how infrastructure, device access, affordability, and staff capacity shape AI adoption. Group composition and measurement. The high- and low-usage groups were unequal in size (142 vs. 42) and were formed from students' own usage levels rather than assigned, which limits comparability. The questionnaire was self-reported and may be affected by social desirability and recall bias. Construct validity was not tested with factor analysis. Academic performance was taken from institutional records and may reflect factors other than ICT/AI use.
This study concluded by examined the association between ICT and AI-augmented systems, student engagement and academic performance among students of Kwara State College of Education, Ilorin. Students reported high behavioural (M = 3.34) and emotional (M = 3.24) engagement and moderate-high cognitive engagement (M = 3.14). Students who used these systems more than 4 hours per week (n = 142) had a higher mean academic score (72.4%) than those who used them less (n = 42; 66.8%), a medium-sized difference (Cohen's d = 0.61). Student engagement partially mediated this relationship in statistical terms [indirect effect = , 95% CI *(*, 3.06)], which suggests that engagement may be one pathway linking technology use to academic performance. Given the cross-sectional design, these results indicate associations and not causal effects, and further longitudinal or quasi-experimental work is needed to test whether greater ICT/AI use leads to improved engagement and outcomes. The findings also show that the potential of these tools is constrained by local conditions. Infrastructure limitations (88.0%), digital literacy gaps (53.8%) and cognitive overload or offloading (38.0%) were the most frequently reported barriers. These results suggest that the benefits of ICT and AI-augmented systems are more likely to be realized where reliable power and affordable connectivity, capacity building for students and lecturers, and pedagogically guided use of AI are in place. Since the data came from a single institution, caution is needed in generalizing these findings to other Nigerian tertiary institutions.

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Recommendations

Based on the results and the identified contextual challenges, the following recommendations are proposed:

(a). Prioritize Infrastructure Investment: Given that 88% of respondents identified intermittent power and unstable internet as primary barriers, institutions and policymakers must prioritize the development of reliable digital infrastructure to ensure "Ease of Use" as per the Technology Acceptance Model.

(b). Implement Comprehensive Training Programs: Since 53.8% of participants reported digital literacy gaps, there is an urgent need for professional development for both students and instructors to ensure they can effectively navigate AI-driven scaffolding.

(c). Adopt Pedagogically Guided AI Models: Educators should move away from unstructured AI use toward scaffolded, activity-based learning. This will help mitigate the 38% risk of cognitive overload and ensure that AI remains a tool for deep learning rather than a substitute for critical thinking.

(d). Develop Context-Specific Tools: Software developers should create AI systems that can operate with low-bandwidth requirements or offline capabilities to suit the specific realities of the Nigerian educational landscape.

Ethical Declarations

Informed Consent: Participation in this study was voluntary. All 200 randomly selected participants were informed of the study's purpose, and data were collected via structured questionnaires only after obtaining verbal or written consent. Data Privacy: Official academic performance records were used solely for matching purposes in this research and were treated with strict confidentiality to ensure the anonymity of the 184 validated respondents. Conflict of Interest: The authors declare no conflicts of interest regarding the publication of this manuscript.

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