Performance-Based Socio-Technical Evaluation of AI Tools in the Nigerian Education System

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Abstract

This study involved 770 students and 12 lecturers across six Nigerian universities to evaluate the socio-technical and performance impacts of AI tools. Results indicate that AI significantly enhances learning outcomes and engagement, though ethical awareness and digital equity remain moderate. Lecturer support and infrastructure are key predictors of effective adoption.

Keywords: *Generative AI; University; Academic performance; Digital equity.*

INTRODUCTION

The rapid emergence of artificial intelligence (AI) technologies, particularly generative AI tools such as ChatGPT, Gemini, and Copilot, has significantly reshaped higher education environments by influencing student learning practices, instructional methodologies, and academic assessment structures. These tools are increasingly embedded within university ecosystems, facilitating new modes of knowledge acquisition, personalized learning support, and automated academic assistance (Sajja *et al.*, 2025; Xiao *et al.*, 2023). Prior studies highlight their potential to enhance learning efficiency, expand access to educational resources, and reduce administrative workload for educators. However, alongside these benefits, the accelerated adoption of AI raises critical concerns regarding learning effectiveness, ethical integrity, digital inclusion, and institutional preparedness.

Existing literature presents mixed findings on the educational impact of generative AI. While some studies report improved student engagement and perceived usefulness, others indicate that excessive dependence on AI-generated content may negatively affect academic performance when not pedagogically guided (Wecks *et al.*, 2024). Furthermore, adoption behaviour has been shown to be strongly influenced by socio-technical factors such as perceived ease of use, trust, and institutional support, suggesting that technological capability alone does not guarantee positive learning outcomes (Shahzad *et al.*, 2024; Sajja *et al.*, 2025). Ethical challenges, including academic dishonesty, ambiguity in acceptable AI usage, and insufficient regulatory frameworks, have also emerged as pressing issues within higher education discourse (McDonald *et al.*, 2024).

Although prior research has primarily concentrated on student perceptions or isolated learning outcomes, there remains a significant gap in comprehensive performance-based socio-technical evaluations that simultaneously examine learning effectiveness, infrastructure readiness, ethical awareness, lecturer integration, and digital equity. This gap is particularly pronounced in African university contexts, where uneven access to digital infrastructure and limited institutional policies may amplify disparities in AI adoption and educational opportunity.

In response to these limitations, this study proposes a performance-based socio-technical evaluation model for assessing AI tool adoption in higher education. The objectives of this research are to: (i) evaluate the impact of AI tools on student learning performance; (ii) examine socio-technical readiness within university environments; (iii) assess levels of ethical awareness and digital equity; and (iv) develop a composite performance framework to guide responsible AI integration. The novelty of this study lies in its holistic integration of performance metrics with socio-technical theory, offering an empirically grounded framework that extends beyond perception-based analyses.

By incorporating learning outcomes, institutional factors, and equity considerations into a unified evaluation model, technology-assisted review (Nnameka and Ogochukwu, 2024), this research provides actionable insights for policymakers, educators, and university administrators, particularly within developing educational contexts.

MATERIALS AND METHODS

This study adopted a quantitative cross-sectional survey design to evaluate the socio-technical and performance impacts of AI tools (ChatGPT, Gemini, and Copilot) in higher education. The research was conducted among undergraduate and postgraduate students from selected Nigerian universities, representing typical African academic environments characterized by increasing digital adoption amid infrastructural challenges.

Convenience sampling was used, and participation was voluntary. Data were collected using a structured Google Forms questionnaire consisting of 45 items covering learning outcomes, user acceptance, ethical awareness, digital equity, socio-technical readiness, lecturer integration, and overall AI impact. Responses were measured on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The survey was distributed electronically and completed anonymously over two weeks.

The study integrates Socio-Technical Systems Theory with a performance evaluation framework. Five indices were computed: Learning Performance Index (LPI), Socio-Technical Readiness Index (STRI), Ethical Awareness Index (EAI), Lecturer Integration Index (LII), and Digital Equity Index (DEI). These were aggregated to derive the Overall AI Adoption Performance Score (OAPS):

$$OAPS = \frac{(LPI+STRI+EAI+LII+DEI)}{5} \quad (1)$$

Scores of 1.0–2.4 indicated low readiness, 2.5–3.4 moderate readiness, and 3.5–5.0 high readiness.

Data were analyzed using SPSS and Microsoft Excel. Descriptive statistics summarized responses, Cronbach's Alpha assessed reliability (≥0.70 acceptable), Pearson correlation examined relationships between AI usage and learning performance, and multiple regression identified socio-technical predictors of academic outcomes. Content validity was ensured through expert review. Ethical approval and informed consent were obtained, and all data were handled confidentially.

The process diagram is provided in Fig. 1.

RESULTS AND DISCUSSION

This study evaluated the socio-technical and performance impacts of AI tools (ChatGPT, Gemini, Copilot) across six Nigerian universities, involving 740 undergraduate students, 30 postgraduate students, and 12 lecturers. The study quantified AI adoption effectiveness using performance indices and examined impacts on learning outcomes, ethics, digital equity, and institutional integration (Table 1).

Demographics

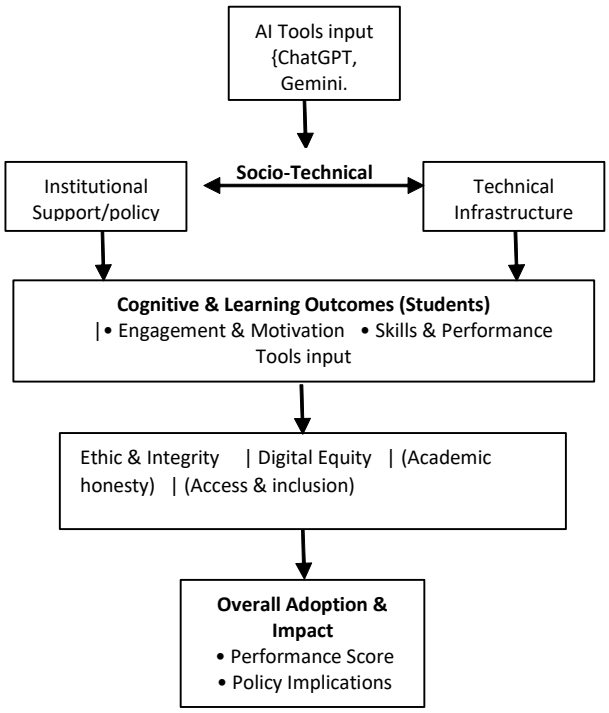

Fig. 1: Performance-based socio-technical evaluation model.

Of the 770 students, 58% were male undergraduates and 42% female; postgraduate students included 18 males and 12 females. The 12 lecturers represented diverse faculties, providing complementary perspectives on AI integration. Most students (84%) had prior experience with AI tools, whereas lecturers reported varied adoption levels in classrooms.

Key Performance Findings

Cognitive & Learning Outcomes

Students exhibited high engagement and learning performance (Engagement/Motivation: M = 3.94, SD = 0.62; Skills/Performance: M = 3.89, SD = 0.65). Lecturers confirmed enhanced comprehension and participation. Regression showed engagement and motivation significantly predicted learning performance ($\beta = 0.42$, $p < 0.01$).

Ethics & Integrity

Table 1: Performance scores.

Dimension	Mean	SD	Interpretation
Cognitive & Learning Outcomes (Engagement & Motivation)	3.94	0.62	High
Skills & Academic Performance	3.89	0.65	High
Ethics & Integrity (Academic Honesty)	3.14	0.81	Moderate
Digital Equity (Access & Inclusion)	2.58	0.84	Low
Lecturer Integration & Institutional Support	2.93	0.71	Moderate
Overall Adoption & Impact (OAPS)	3.30	0.68	Moderate

Moderate awareness was observed (M = 3.14, SD = 0.81). While 72% acknowledged potential misuse, only 35% received formal guidance, emphasizing the need for institutional policies on AI ethics.

Digital Equity

Access disparities were significant (M = 2.58, SD = 0.84), with 46% of students reporting unreliable internet or limited device access, indicating potential widening of educational inequalities.

Lecturer Integration & Institutional Support

Moderately rated (M = 2.93, SD = 0.71), with 58% of lecturers actively using AI. Infrastructure gaps hindered full adoption. Institutional support significantly predicted AI adoption performance ($\beta = 0.36$, $p < 0.05$).

Overall Adoption & Performance Score (OAPS)

M = 3.30 (SD = 0.68), reflecting moderate readiness. Cognitive and learning benefits were strong, but socio-technical, ethical, and equity constraints limited full adoption.

Empirical Contributions

Learning Enhancement

AI tools significantly improve engagement and performance, demonstrating clear academic benefits in African higher education.

Predictive Socio-Technical Factors

Lecturer support ($\beta = 0.36$, $p < 0.05$) and student engagement ($\beta = 0.42$, $p < 0.01$) are key predictors of adoption effectiveness.

Ethical Gaps

Moderate scores reveal awareness without structured guidance, highlighting the need for formal AI integrity policies.

Digital Inequities

Limited infrastructure and device access restrict equitable adoption, emphasizing institutional intervention priorities.

Framework Validation

The OAPS confirms that the performance-based socio-technical model effectively quantifies AI adoption and can guide policy and planning.

These findings provide robust quantitative evidence from six Nigerian universities, covering 770 students and 12 lecturers, contributing significantly to understanding AI adoption in higher education contexts.

CONCLUSION

This study assessed the socio-technical and performance effects of generative AI tools—ChatGPT, Gemini, and Copilot—at six Nigerian universities, involving 770 students and 12 lecturers. The findings reveal that these AI tools significantly improve learning outcomes, engagement, and academic performance, supporting self-directed learning and comprehension of complex topics.

The performance-based socio-technical evaluation framework effectively measured AI adoption by considering cognitive outcomes, ethical awareness, digital equity, and institutional support. Although the learning benefits were significant, adoption faced challenges due to moderate lecturer integration, inadequate institutional guidance on academic integrity, and unequal access to digital resources.

Recommendations for future action include enhancing institutional policies and lecturer training, establishing formal AI-specific ethical guidelines, and upgrading infrastructure for equitable access. Expanding this framework to additional universities and disciplines could improve its generalizability.

Grant Support Details

The present research did not receive any financial support to conduct the research.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

Ethical Considerations

Participants provided informed consent, and participation was voluntary. Responses were anonymous and securely stored to ensure privacy. Ethical clearance was obtained from the university. The study avoided harm or sensitive questions, and findings are reported objectively to respect participant contributions

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