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EDITORIAL

Volume 3(1)

Harnessing Generative AI and Emerging Technologies for Institutional Transformation

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The contemporary landscape of higher education is undergoing a fundamental paradigm shift driven by the unprecedented velocity of technological innovation. At the forefront of this disruption is Generative Artificial Intelligence, whose rapid emergence and widespread adoption have sent shockwaves through academic systems worldwide. Tools powered by large language models, such as ChatGPT, Claude and Gemini, have moved rapidly from experimental novelties to ubiquitous features of the educational ecosystem. This shift has placed higher education institutions in a delicate, high-stakes balancing act to be able to navigate the chaos of academic disruption while striving to harness the transformative potential of artificial intelligence.

This tension touches the core philosophical and operational pillars of academia. On one hand, Generative AI presents immediate vulnerabilities regarding academic integrity, intellectual honesty, cognitive atrophy due to student over-reliance, and the proliferation of algorithmic hallucinations and fabricated citations. On the other hand, it offers an unprecedented opportunity to streamline administrative workflows, democratise access to personalised tutoring, and reimagine research methodologies across disciplines.

This third volume of the Multidisciplinary Journal of Distance Education Studies, hosted by the Department of Distance Education of the University of Ghana, critically examines this evolving frontier. The papers compiled in this issue move beyond superficial rhetoric, offering rigorous empirical, theoretical and methodological insights into how educational technology is being operationalised across diverse contexts. From managing AI integration in university settings to

deconstructing multimodal instructional design, exposing multi-level digital divides in rural basic education, and quantifying the ecological footprint of distance learning in the Global South, this volume provides a comprehensive exploration of technology as a complex, double-edged driver of educational change.

Opening this volume, Arkaifie and colleagues offer a powerful theoretical lens for understanding the systemic impact of Generative AI on higher education. By framing this transition through Lorenz's Chaos Theory, the authors demonstrate that the initial state of educational chaos introduced by generative AI tools is not merely a precursor to collapse, but a catalyst for self-organisation and systemic evolution. In complex dynamic systems, small perturbations can yield profound, non-linear outcomes. Similarly, the introduction of easily accessible AI models has destabilised long-standing pedagogical conventions. Arkaifie et al. outline the primary vectors of disruption, including serious risks to academic integrity through essay generation, cognitive dependency that threatens critical thinking, and algorithmic unreliability through false citations. The authors, however, argue that this chaotic disruption naturally gives rise to new forms of order and stability. These positive, emergent patterns manifest through significantly reduced administrative workloads for faculty, the creation of highly responsive, personalised learning support systems for students, and streamlined research synthesis workflows. Navigating this dual dynamic effectively requires proactive governance rather than passive reaction. The authors emphasise that institutions must move away from unenforceable blanket bans, choosing instead to develop adaptive institutional policies, transition toward authentic assessment models, and establish robust AI literacy frameworks.

Building directly upon this broader institutional analysis, Olatunji grounds the discussion in empirical reality through an investigation of AI adoption within Open and Distance Learning environments. Specifically focusing on faculty engagement at the National Open University of Nigeria, Olatunji investigates how academic staff navigate the transition from theoretical awareness to practical utilisation. The study reveals high levels of awareness across academic disciplines alongside substantial practical adoption in course content creation, automated student feedback systems, and scholarly research workflows. Importantly, the empirical data reveals no statistically significant gender differences in either awareness or actual utilisation among faculty members, pointing to a commendable level of demographic equity in early technology uptake. It is interesting to note that Olatunji highlights a critical nuance in the form of an evident awareness-utilisation gap. The author highlights a critical conceptual awareness of how AI capabilities is widespread, the depth and sophistication of actual pedagogical integration lag behind. Grounding the findings in the Unified Theory of Acceptance and Use of Technology, Olatunji demonstrates that high individual awareness alone does not automatically translate into effective instructional transformation. To bridge this gap, the author recommends that distance learning institutions must actively provide robust facilitating conditions, including sustained professional

development, high-speed AI-enabled digital infrastructure, and explicit ethical guidelines that empower faculty to innovate safely.

Moving from AI frameworks to the foundational mechanics of instructional design, distance education relies heavily on the strategic presentation of learning materials. A central pillar of successful distance models is the intentional integration of innovative instructional modalities capable of bridging the physical and psychological distance between learner and institution. Addressing this critical domain, Ugaduh and Uduma present a compelling investigation into the semiotics of multimodal learning resources within distance education environments, drawing specifically on philosophical discourse articulation at the National Open University of Nigeria. The authors explore how visual scaffolding, graphic representations and multimodal media function as key semiotic vehicles that help self-directed distance learners demystify abstract, complex academic concepts. Ugaduh and Uduma demonstrate that while multimodal resources hold vast potential for clarifying complex theoretical ideas, their efficacy is far from automatic. Unstructured or excessively complex visual media can easily trigger cognitive overload, confusing learners rather than guiding them. Moreover, effective multimodal design requires deliberate visual syntax, careful alignment between graphical elements and textual commentary and structured scaffolding to ensure that every visual element serves a clear cognitive purpose rather than acting as mere decoration. Ultimately, the authors remind us that as distance learning platforms become increasingly feature-rich, instructional designers must remain grounded in semiotic and cognitive principles to foster deeper and meaningful student engagement.

While discussions surrounding AI and multimodal media assume a functional level of digital access, the fourth paper in this issue shifts our focus to the stark socio-technical realities of basic education in resource-constrained environments. Authored by Ayerakwa and colleagues, the study offers a critical examination of multi-level digital inequality in rural Ghana, focusing on internet access, continuity of use and institutional mediation. Employing a concurrent convergent mixed-methods design, the authors evaluate how digital participation is actualised among rural basic school students. The study synthesises van Dijk's Multi-Level Digital Divide Framework, Hargittai's Second-Level Digital Divide Theory, and Sen's Capability Approach to move beyond simple binary metrics of computer ownership. The empirical findings challenge simple assumptions about technology access by uncovering layered disparities in usage quality, frequency and institutional support. A striking finding of the study is that only a small fraction of surveyed rural students identified their school as their primary point of internet access, whereas a vast majority relied on private home access, often using shared, unreliable family smartphones with capped mobile data. Because schools in these resource-constrained settings lack functional computing facilities and stable internet connectivity, the responsibility for digital access has been privatised. This disproportionately disadvantages students from lower socio-economic backgrounds whose households cannot sustain continuous data costs. The authors

argue convincingly that simply distributing hardware is wholly insufficient, recommending that educational policy address the broader institutional, pedagogical and financial frameworks required to convert raw digital access into continuous and capability-enhancing learning opportunities.

The final contribution to this volume, authored by Ugaduh, expands the analytical horizon of distance education into environmental sustainability and climate action. The empirical study addresses a major gap in the literature by quantifying the lifecycle environmental benefits and carbon mitigation potential of single-mode distance learning models operating in developing contexts. While distance education is widely celebrated for democratising educational access, Ugaduh frames it through Ecological Modernisation Theory, positioning it as an effective tool for structural decarbonisation. Using the National Open University of Nigeria as a case study, Ugaduh analyses primary survey data alongside localized transport emission metrics and lifecycle assessment benchmarks. The empirical findings present a striking contrast between traditional campus models and distance learning. While conventional campus-based universities require students to commute several days per week, the distance learning model dramatically reduces physical visits to study centres, yielding a ninety percent drop in travel frequency. Ugaduh offers a nuanced critique of the regional energy paradox in the Global South, where uncoordinated power grids often force households to rely on small fossil-fuel generators during online study. Nevertheless, the empirical modeling proves that the massive, cumulative emission savings gained from eliminating daily vehicle commutes and paper-heavy materials easily absorb and overcome this household energy overhead. Ultimately, Ugaduh demonstrates that Open and Distance Learning is not merely an educational delivery system, but an effective policy mechanism for climate mitigation that can help developing nations fulfill their obligations under international climate agreements.

The collective findings of Volume 3 underscore a unified narrative. Thus, educational technology is neither an inherent panacea nor an unavoidable detriment. Instead, its ultimate impact depends on the quality of institutional leadership, pedagogical design, socio-economic support and ecological awareness that accompany its adoption. To synthesize the key themes of this volume, future research and policy in distance education must prioritize four interconnected areas. Institutions must lead the AI transition through adaptive governance and ethics rather than prohibition. Instructional design must remain pedagogy-driven, ensuring that multimodal tools reduce cognitive load rather than create noise. Educational policy must address structural digital divides by strengthening institutional infrastructure in underserved communities, and higher education frameworks must explicitly integrate environmental sustainability into their long-term strategies.

Ultimately, the contributions assembled in Volume 3 of the Multidisciplinary Journal of Distance Education Studies illuminate the complex, multi-faceted nature of modern educational technology. From navigating the disruptive potential of

Generative AI and refining multimodal instructional design to exposing structural digital divides in rural contexts and leveraging distance learning for environmental decarbonisation, this volume underscores a central truth that technology alone is not a panacea. It is imperative to highlight that true educational transformation requires deliberate institutional mediation, robust ethical frameworks, equitable infrastructural support and ecologically conscious policy design. As distance learning continues to evolve at the intersection of technological innovation and social necessity, the empirical and theoretical insights presented in this issue provide a vital roadmap to guide scholars, educators, and policymakers toward a more inclusive, resilient and sustainable educational future.

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A DANCE BETWEEN ORDER AND CHAOS: AN INTEGRATIVE REVIEW ON THE CONVERSATIONS AND CASES OF GENAI'S DUAL ROLE IN EDUCATION

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ABSTRACT

ChatGPT and its allied technologies have introduced a state of "educational chaos," igniting widespread discussions about the dual potential of artificial intelligence (AI) in education; both beneficial (order) and detrimental (chaos). Although ChatGPT has recently celebrated its second anniversary, conversations surrounding its educational applications show no signs of waning. Significant developments have emerged across three main dimensions involving teacher instructional strategies and student learning, institutional policies, and research practices. However, there are limited studies that present useful cases capturing these three areas within a single study. Using an integrative review approach, the study first identifies key dialogues on the contentious role of advanced AI technologies in education and secondly reports actual interesting cases of its use in education across the three domains. A total of 21 articles sourced from Web of Science (WoS) and Google Scholar published between 2023 and 2024 were critically analysed. The chaos theory by Edward Lorenz served as a useful framework for understanding the complexities surrounding GenAI's impact on education and how human ingenuity has leveraged technology for various tasks. The findings reveal that while ChatGPT enhances personalised learning,

supports instructional design, and streamlines research, it also presents challenges such as academic integrity, over-reliance on AI-generated content, and the risk of misinformation. Institutional responses range from outright bans to adaptive policies integrating AI literacy and ethical guidelines. It is recommended that a safe and cautious approach be employed in integrating GenAI into education to maximise its full benefits and subsequently reduce its potential harmful effects.

Keywords: *artificial intelligence, chatbot, ChatGPT, chaos theory, technologies*

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Introduction

Artificial intelligence (AI) has been integrated into our world the past few years. Yet, its impact on the educational landscape has been both transformative and “chaotic”, resulting in both beneficial (order) and detrimental (chaos) outcomes. As Biswas et al. (2018) note, while chaos is difficult to define, it is easily recognised when it occurs. Similarly, AI has undeniably introduced a chaotic transformation to education. The chaos theory provides an appropriate conceptual lens for this review because it captures the non-linear, unpredictable, and emergent dynamics that AI technologies introduce into the educational system. As such, by framing the discussion through chaos theory, the study can systematically explore how seemingly disorderly disruptions can generate both instability and new forms of order in instructional practices, policy and research. AI has propelled educational progress in ways that mirror its disorderly essence, presenting both benefits, referred to as order, and challenges, described as chaos in this context. This has propelled researchers and practitioners to refuse to take the back seat but delve into it so as to understand and adopt the appropriate strategies to enjoy the benefits as institutions overcome the challenges. Similar to the rapid changes in society due to COVID-19, the pressing challenge for researchers today is to discern between the order and chaos that AI technologies like ChatGPT pose to the educational system.

By way of explanation, ChatGPT is a large language model (LLM), equipped with natural language processing (NLP) abilities, which enable individuals to use queries and prompts to get tailored responses and ideas to their questions. By using a conversational style, ChatGPT is recognised to stand out among other LLMs because it realistically engages users through a dialogue style. This provides users with responses that are viewed to be more unique and tailored toward the needs of the individuals (Rahman & Watanobe, 2023; Yu, 2023). The use of ChatGPT has been massive across the globe, with the global south not being an exception because of the high performance in its application domains, as emphasised by researchers like Kasneci et al. (2023). The use of such an application within the educational setup has challenged the traditional way of teaching, learning and assessment. It has also forced educators and practitioners to either embrace its potential or question its use, with some calling for a total ban within educational settings (Reuters, 2023; Yadava, 2023; Zhou et al., 2023).

While Michel-Villarreal et al. (2023) argue that empirical studies are needed to evaluate the effectiveness of ChatGPT in developing course outlines and content, other researchers have noted that the application is useful in such activities for educators (Rahman & Watanobe, 2023). Through the preparation of lesson plans, putting together learning activities, carrying out assessments and giving feedback and guidance (Kasneci et al., 2023; Kooli, 2023; Rahman & Watanobe, 2023; Zhuo et al., 2023), ChatGPT has been noted to be a valuable tool to educators. Playing such roles by ChatGPT has helped educators to reduce their workload and diminish the stressful processes they go through playing such essential roles. In terms of the research role of educators, ChatGPT supports educators from aiding in idea generation to drafting final papers for publication.

Students, on the other hand, are not left out of the enormous benefits of utilising ChatGPT in their educational endeavours. However, the controversial debate for the ban of ChatGPT in education stems from the concerns raised by some academics who believe that the extent of over-reliance of students to complete their assignments and other school-related projects through the use of such software is likely to affect their critical thinking skills (Deshpande & Szefer, 2023; McGee, 2023; Yu, 2023). By using ChatGPT, students are provided with more coherent feedback prompted by the meaning and intent of their questions, and the feedback could also be modified to meet their needs (Deng & Lin, 2023). This convenience could encourage students to engage in academic dishonesty through plagiarism and the presentation of incorrect information and sometimes biased data without proper academic scrutiny (Chan & Hu, 2023; Lim et al., 2023; Lo, 2023; Lund & Ting, 2023). Such practices risk the potential of producing half-baked graduates who may lack judgement abilities for the job market, as well as lead to academic crises on the reputations of academic institutions. These have led to urgent calls for educators to provide guidance and training to help students understand and properly use these tools to enhance academic activities and foster the development of ethically responsible graduates. Equally, others are also calling for clear guidelines in the form of policies to regulate the incorporation of AI and its allied technologies into education to enhance academic integrity and prepare students to meet the workplace demand for digital and AI skills.

Amid the order and chaos brought about by the unpredictable pace of AI advancement, three primary dimensions have emerged in the rapid integration of ChatGPT in education; teacher instructional strategies and student learning, instructional policies, and research practices. Though the transformation may look chaotic, there seems to be hope that order may ultimately emerge and be restored if the necessary steps are taken. To properly draw conclusions and clearly implement any meaningful strategies, further studies are required. As such, given the limited studies, this research utilises an integrative review approach to capture and analyse useful cases that will address the three dimensions. Specifically, the study explores key discussions on the role ChatGPT is playing in education and provides evidence of interesting cases demonstrating its usefulness within the educational sphere through the use of Edward Lorenz's (1963) chaos theory. This approach provides a detailed perspective of how ChatGPT is changing traditional education practices and sheds light on both the possible benefits and challenges of such technologies. Accordingly, this integrative review is guided by the following research questions: (1) How is ChatGPT shaping instructional strategies, policies, and research practices in education? (2) What benefits ("order") and challenges ("chaos") emerge from its integration into educational settings? Given the qualitative and exploratory nature of this integrative review, no formal hypotheses are proposed.

Construing the Complexities of AI Adoption through the Chaos Theory

Chaos theory, pioneered by Edward Lorenz (1963), was first applied in physics and mathematics to explain how small, seemingly insignificant events can generate large, unpredictable impacts on complex systems. Lorenz showed that minor variations, though initially unnoticed, can accumulate and interact to produce outcomes that defy precise predication. As Galatzer-Levy (2009) notes, chaotic systems are impossible to determine precisely within a system at a specific time in the future because they follow differential equations that will result in an unpredictable outcome. However, Feigenbaum (1983) holds that, while these chaotic systems may appear unpredictable, they are bounded, and the patterns they create can result in mathematical constants, offering a measure of structure within the chaos.

Lorenz illustrated this with the “butterfly effect”, where the flap of a butterfly’s wings could, over time, trigger a distant tornado. This metaphor captures how small, unconnected events may generate far-reaching and disruptive consequences. Because these changes are inherently unpredictable, chaos theory calls for new approaches that recognise and manage uncertainty rather than attempting to ignore or eliminate it (Akmansoy & Kartel, 2014). A core implication of the butterfly effect is that institutions will experience diverse outcomes based on their unique contexts (McMillan, 2008). A strategy that succeeds in one setting may fail in another, even under similar conditions. Institutions must, therefore, carefully evaluate which AI tools best fit their needs if they are to emerge from the “chaos” through resilience.

Since its development, chaos theory has been applied across various fields, and this study extends its use to AI in education. Chaos theory was chosen over alternative complexity frameworks because it uniquely emphasises sensitivity to small changes and the emergence of unpredictable but patterned outcomes. These properties map directly onto the disruptive and fast-evolving dynamics of AI adoption in education, where minor shifts in policy, practice, or student use can cascade into major systemic consequences. These reflect how ChatGPT and its allied technologies have introduced a state of “educational chaos”, igniting discussions about the dual potential of AI in education, both order and chaos. In this context, chaos theory provides a valuable framework for understanding AI’s unpredictability and for challenging conventional practices that seek to preserve the status quo.

Analysing AI implementation through the lens of chaos theory highlights that it is not a linear process; rather, it encompasses fluctuating states and interrelated activities (Styhre, 2002). Undisputably, the advent of chatbots in the education ecosystem, especially in developing economies, has brought compelling challenges regarding ethics, affordability, higher levels of digital literacy and the like. Meanwhile, these innovations ought to be embraced if education in these economies can match up with their counterparts elsewhere (Adarkwah et al., 2023). It is in this context that Nonaka (1988) argues that nurturing internal chaos can align organisations more closely with their external environments.

Importantly, engaging chaos theory does not exclude traditional educational perspectives. For instance, constructivism emphasises learners’ active role in knowledge creation, while connectivism highlights the role of digital networks in shaping learning. AI both disrupts and enriches these traditions: it enhances constructivist opportunities for personalised learning

and expands connectivist networks but also risks encouraging over-reliance and diminishing critical thinking. Chaos theory complements these perspectives by adding a systems-level lens that captures how local disruptions ripple outward, producing emergent, unpredictable transformations across education.

Judging from the preceding and our search, the chaos theory has rarely been applied to the field of education. As far as our search could go, there is yet a study that applies this theory in the application of AI to the field of education. We take cognisance of the fact that in as much as the introduction of AI has introduced 'chaos', it holds the potential of revolutionising education for all educational institutions that embrace it. We, therefore, agree with MacMillan (2008) in her viewing institutions as chaotic systems within the context of AI, enabling the institutions to develop flexible strategies and decision-making frameworks to navigate complexity. We fully appreciate that long-term forecasting remains challenging under the circumstances presented by AI and its rapid evolution; chaos theory offers insights into underlying patterns that can aid short-term predictions and bolster institutional resilience.

Research Design

An integrative literature review was used to provide a broad understanding of the themes identified in the topic (Whittemore et al., 2014). An integrative literature review mainly addresses mature or emerging research topics that sometimes have contradictory evidence in the literature and will benefit from a comprehensive conceptualisation and synthesis (Torraco, 2005). The integrative literature review is best suited for dynamic topics that experience rapid growth in literature but have yet to be comprehensively reviewed or updated over a period of time (Torraco, 2016). First, studies on generative artificial intelligence (GenAI) use in education are relatively new, gaining significant attention following the launch of ChatGPT in November 2022. Additionally, research on GenAI has rapidly increased, but there is a paucity of studies that consolidate the teaching and learning, research, and institutional policy aspects in a single study. Using the integrative literature review approach allowed for the study's results to be synthesised using narrative analysis (Whittemore et al., 2014).

The five-stage criteria developed by Whittemore and Knafl (2005) were followed to guide the analysis; 1) problem identification (what are the key conversations on GenAI use in education and actual use cases in teaching and learning, research, and policy?) (2) literature search (described in the method section); (3) data evaluation (only highly-cited studies were included); (4) data analysis (a narrative analysis was used to present the results) and (5) presentation (narrative discussion).

Search Database

The Web of Science (WoS) database was consulted to retrieve influential articles on GenAI use in education. To ensure that significant studies not captured in WoS were included, a complementary manual search was conducted via Google Scholar. This manual search was carried out in three ways: by tracing backwards and forward citations of influential works, by performing author-based searches of leading scholars in GenAI and education, and by scanning keyword-based results across grey sources such as conference proceedings and book chapters that met the study's inclusion criteria. The initial search on WoS yielded 9,244 studies, and 15,100 studies

on Google Scholar were also retrieved. In total, 24,344 articles were obtained from both searches.

Search Strategy

To provide a comprehensive analysis of the literature on the topic, specific search terms based on the extant literature review were developed. To fully capture all pertinent literature, a broad range of search terms was developed involving "Generative AI", "conversational agents", "chatbots", "large language models", "ChatGPT", and "education". The search terms were used on both the WoS and Google Scholar databases. Specifically, the following search string was searched to solicit literature from WoS: "generative AI" OR "conversational agents" OR "chatbots" OR "large language models" OR "ChatGPT" AND "education". ChatGPT was used as part of the keywords as opposed to other GenAI technologies because it is the pioneer of advanced conversational agents that sparked the current debate/discussions on GenAI use in education. Additionally, among all the GenAI tools, it is the most researched. To confine our studies to include only relevant studies, clear inclusion/exclusion criteria were developed. We limited the search to the field of education at all levels and only articles published from 2023 and beyond, which is the peak year for studies on GenAI. The study followed the principles of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Moher et al., 2009). Importantly, a citation threshold of 200 was applied to ensure inclusion of highly influential work shaping the field. While this inevitably excluded some emerging but less-cited studies, the threshold was intended to focus the review on works with demonstrated academic and practical impact. No country restrictions were set for articles to allow for diverse perspectives on GenAI use in education (see Figure 1). Details about the eligibility criteria are presented in Table 1.

Table 1: Inclusion/Exclusion Criteria Table

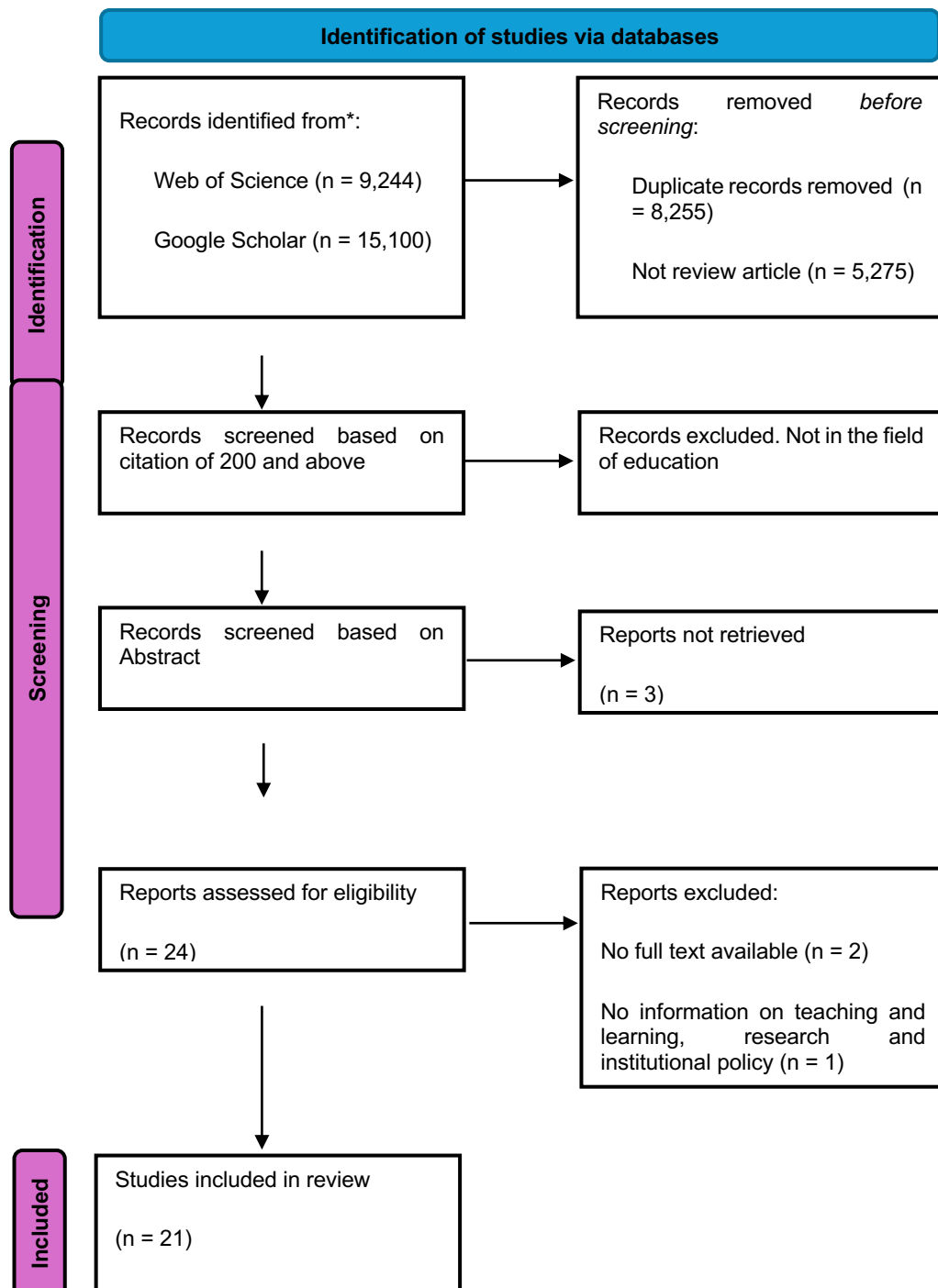
Criteria	Inclusion	Exclusion
Type of Document	Full research articles, reviews, opinion pieces, conference papers, and book chapters	Non-full-text research documents or preprints
Publication Year	Published in 2023 or later	Published before 2023
Field	Focused on Education	Outside the field of Education
Language	Articles in English	Articles in any language other than English
Citations	Highly cited articles (200 citations or more)	Articles with fewer than 200 citations
Focus	Articles focused on generative AI in an educational context	Articles not primarily about generative AI
Peer Review Status	Peer-reviewed articles	Non-peer-reviewed articles

Study Selection

The eligibility criteria guided the study selection. The selection process involved title and abstract screening against the inclusion criteria, removal of duplicates, and resolution of discrepancies through consensus among authors. Studies were

prioritised if they addressed contested or “chaotic” debates about GenAI in education and/or provided concrete use cases of policy guidance. The systematic approach followed helped in the inclusion of only relevant studies for the analysis. Figure 1 presents the processes of arriving at the papers selected and analysed for this study.

Figure 1: A PRISMA flowchart of the literature search process



Data Synthesis

The final records (n=21) involving 14 documents from WoS and seven from Google Scholar were analysed to identify key themes that align with the three main categories (teaching and learning, research, and institutional policy) of the study. Specifically, the studies were checked for discussions on either the GenAI in teaching and learning practices or for research or the development of institutional policies to guide a safe and responsible adoption. The three categories or themes underlined the diverse applications of GenAI in education. To enhance clarity and avoid repetition, the findings are summarised in a condensed thematic Table 2 (chaotic debates) and Table 3 (practical use cases), with the details presented in the appendix.

Table 2: Discussions of GenAI in Education (Themes from 12 studies)

Theme	Opportunities (Order)	Challenges (Chaos)
Teaching & Learning	- Personalised learning support - Reduced teacher workload - Inclusive learning opportunities - Feedback and scaffolding	- Plagiarism & academic dishonesty - Shallow learning & stifled creativity - Biased/inaccurate outputs - Threats to professional expertise
Research	- Drafting, editing, summarising - Language support for non-native speakers - Assistance with data analysis	- Fabricated references - Lack of peer-reviewed grounding - Intellectual outsourcing concerns
Institutional Policy	- Calls for authentic assessment - AI literacy and ethics training - Opportunities for flexible curriculum	- Institutional bans (schools, journals, conferences) - Fragmented or unclear regulations - Risk of widening digital divide

Table 3: Documented Use Cases of GenAI in Education (Themes from 9 studies)

Theme	Opportunities (Order)	Challenges (Chaos)
Teaching & Learning	- Support for exam prep and complex concepts (e.g. USMLE) - Customised lesson plans and activities - Continuous feedback & tutoring support	- Dependence leading to reduced critical thinking - Inaccurate/incomplete knowledge - Data privacy & authorship issues
Research	- Scientific writing support - Hypothesis generation - Pattern detection in large datasets	- Risk of bias and fabricated references - Lack of transparency in AI decision-making - Threats to research integrity
Institutional Policy	- Calls for ethical guidelines - Redesign of assessment methods - Integration into teacher training	- Bans in school & journals - Unequal access (digital divide) - Potential misuse in academic publishing

Box 1: Discussions of GenAI in Education

- **Academic integrity risk** were the most cited issue (14 of 21 studies), highlighting plagiarism, dishonest use, and assessment validity challenges.
- **Fabricated or unreliable references** appeared in 9 studies, raising concerns about credibility in research outputs.
- **Bias, misinformation, and shallow reasoning** were recurring limitations, with GenAI struggling on context-sensitive or higher-order tasks.
- **Institutional bans and prohibitions** were noted in 8 studies, though often paired with calls for regulation, guidance, and integration.
- The literature illustrates the “chaos” side of AI adoption: unpredictable consequences, destabilised norms, and contested governance.

Box 2: Actual Use Cases of GenAI in Education

- **Personalised learning benefits** were highlighted in 13 studies, including feedback, tutoring, scaffolding and customised assessments.
- **Teacher workload reduction** was cited in 11 studies, with GenAI supporting lesson planning, grading, and curriculum design.
- **Research support** appeared across multiple studies, from drafting and summarising to data analysis and language editing.
- **Collaboration and inclusivity:** 7 studies emphasised that GenAI can democratise access and support diverse learners, though risks of digital divide remain.
- These findings demonstrate the “order” side of chaos theory: patterns of innovation, efficiency, and expanded learning opportunities emerging from disruption.

Findings and Discussion

GenAI Order and Chaos in Education

- **Teaching and learning:** The review of the studies highlights the transformative potential of GenAI, particularly ChatGPT, in teaching and learning. This transformative nature presents both opportunities and challenges. Just like the butterfly effect, ignoring these implications could lead to significant disruptions in the not-too-distant future. The opportunities identified from the data analysis fall into four key themes: enhanced learning experiences, teacher support, skill development and inclusive education. With enhanced learning experiences, ChatGPT fosters personalised learning environments where students can prompt the tool to simplify complex concepts and receive tailored feedback that aligns with their individual needs (Khan & Khan, 2023; Hong, 2023). The tool also provides students with real-world scenarios that deepen

their understanding of topics. Additionally, its prompt responses accommodate diverse learning styles that can empower students to take ownership of their education (Farrokhnia *et al.*, 2024; Kasneci *et al.*, 2023). Approximately two-thirds of the reviewed studies (13/21) highlighted ChatGPT's potential for personalisation and scaffolding.

With teacher support, ChatGPT assists teachers in developing lesson plans, curricula, assessments and task grading (Kasneci *et al.*, 2023; Tlili *et al.*, 2023). Such support reduces teachers' workload and enables them to create engaging and relevant teaching materials. As a result, students benefit from enhanced feedback and more dynamic learning experiences (Khan & Khan, 2023; Farrokhnia *et al.*, 2024). Roughly half of the studies (11/21) mentioned workload reduction as a key benefit.

Again, properly guided use of the tool can help students enhance their critical thinking and analytical skills (Garcia-Penalvo, 2023; Kasneci *et al.*, 2023). ChatGPT's capacity to present diverse perspectives encourages learners to explore topics from multiple angles, promoting deeper understanding and intellectual curiosity. Such guided interactions can build their foundational skills and prepare them for the demands of the workplace.

Another opportunity worth noting from the studies was ChatGPT's ability to provide real-time assistance and mimic authentic human interaction. These features allow for a more inclusive educational experience, which supports students with varying needs and proficiency (Hong, 2023; Kasneci *et al.*, 2023).

In terms of the chaos or challenges, key themes included the impact on student skills, issues with accuracy and depth, ethical concerns and teacher professionalism. Over-reliance on ChatGPT and diminished creativity or critical thinking were flagged in more than half of the studies (12/21). The challenge with over-dependence poses a high risk of students becoming less innovative, less critical, and weaker problem-solvers, ultimately hindering their cognitive development (Farrokhnia *et al.*, 2024; Tlili *et al.*, 2023). It can also reduce students' willingness to engage in intellectual effort, thereby compromising the learning process (Garcia-Penalvo, 2023). When students bypass critical engagement in favour of quick AI-generated answers, the depth and quality of their understanding are significantly reduced, posing long-term risks to their academic and professional growth.

Moreover, issues of accuracy and depth were also noted in the studies as a challenge affecting teaching and learning. ChatGPT's output often lacks depth, accuracy, and insight when engaging in higher-order learning (Farrokhnia *et al.*, 2024). Its reliance on outdated data (post-2021) and inability to comprehend nuanced contexts can also lead to biased or irrelevant responses (Kasneci *et al.*, 2023; Khan & Khan, 2023). Thus, critical evaluation and careful verification are always needed to avoid misinformation.

Issues such as plagiarism, academic integrity, and data privacy in the use of ChatGPT and other related chatbots raise ethical concerns, which further complicate its integration into education (; Kasneci *et al.*, 2023; Tlili *et al.*, 2023). Moreover, the potential for ChatGPT to perpetuate biases and spread misinformation underscores the need for cautious implementation and ethical oversight (Garcia-Penalvo, 2023; Kasneci *et al.*, 2023). At the same time, excessive dependence on ChatGPT risks diminishing teachers' professional

expertise, which shifts the focus away from their critical role in fostering a comprehensive learning environment (Hong, 2023).

- **Research:** The review further offers a detailed exploration of ChatGPT's role in academic research, highlighting both its advantages and limitations. Among its potential benefits, key themes include the facilitation of research processes, efficiency in writing and editing, and bridging gaps in knowledge. However, its limitations are equally noteworthy, encompassing themes such as limitations in literature review and citation accuracy, ethical and professional issues, risk of bias and misinformation and erosion of research skills. On the positive side, this review identified that ChatGPT provides valuable support to researchers across various stages of the research process. The tool assists in generating research ideas, developing structured outlines, refining research designs, organising arguments, and drafting manuscripts (Dwivedi et al., 2023; Hong, 2023; Kasneci et al., 2023). This capability is especially useful for students and early-career researchers who may find it difficult to navigate the complex nature of research (Khan & Khan, 2023; Tlili et al., 2023). By offering guidance and foundational insights, ChatGPT helps them build confidence and competence in their fields, making the research process more approachable and manageable. It is significant to state that approximately half of the studies (10/21) referenced efficiency in writing and editing, especially for non-native English speakers.

ChatGPT also enhances efficiency in academic writing and editing. Researchers can leverage the tool to draft articles by breaking down complex writing tasks into manageable components. It also assists in refining and improving the overall quality of academic writing, ensuring clarity and coherence (Dwivedi et al., 2023; Khan & Khan, 2023). This feature is particularly valuable for non-native English speakers, who can use ChatGPT for language editing, grammar correction, and improving the fluency of their academic work. Additionally, the tool enables users to create well-structured outlines and maintain coherence throughout their manuscripts, thereby streamlining research workflows and improving productivity (Kasneci et al., 2023).

However, ChatGPT faces significant challenges when used in research, especially regarding literature review and citation accuracy. At least 8 of the studies identified fabricated or inaccurate references (hallucination) as a critical concern. It lacks access to peer-reviewed articles in its training data and is unable to incorporate recent developments, relying instead on information up to the year the system was last trained (2021 in the case of this study), which makes it unsuitable for comprehensive literature reviews (Dwivedi et al., 2023). Moreover, ChatGPT frequently fabricates references as well as provides incorrect citations, potentially undermining the reliability of research output. Such limitations underscore the need for critical evaluation and cross-verification of any information sourced from ChatGPT.

Ethical and professional issues were raised in one-third (7/21), particularly in relation to authorship and responsibility. In some cases, researchers have controversially listed ChatGPT as a co-author, sparking debates about intellectual responsibility. This has led some organisations like the World Association of Medical Editors and the International Conference on Machine Learning to ban such practices to ensure transparency and accountability (Dwivedi et al., 2023; Khan & Khan, 2023).

Another challenge worth noting relates to bias and misinformation. ChatGPT outputs can perpetuate biases and misinformation if not critically evaluated. As noted by Kanseci et al. (2023), its lack of deep contextual understanding limits its ability to produce nuanced insights, which is particularly problematic for complex research topics. Moreover, its reliance on outdated information (training data up to 2021) poses additional challenges for research requiring the most recent data and findings (Khan & Khan, 2023).

Although ChatGPT can assist researchers in conducting their research, it also has the potential to diminish individual research skills. However, it is clear that over-reliance on AI tools like ChatGPT may hinder the development of essential skills such as critical thinking, problem-solving and writing proficiency (Tlili et al., 2023).

- **Institutional policy:** The reviewed studies highlight diverse institutional responses to the use of ChatGPT in educational settings, with policies reflecting both its potential and the challenges it introduces. Concerns over ChatGPT's impact on academic integrity have led some institutions to adopt restrictive measures. One-third of the reviewed studies (7/21) referenced bans or restrictions, such as those implemented in New York City. Similarly, some universities have implemented policies prohibiting the use of AI tools in essay writing and other academic submissions. The essence of this move is to preserve or promote originality and critical thinking in student work (Dwivedi et al., 2023).

To adapt to the changes introduced by AI technologies, some institutions are revising curricula to incorporate digital literacy and AI competencies (Farrokhnia et al., 2024). More than one-third (8/21) discussed policy revisions aimed at balancing regulation with innovation. This includes integrating higher-order learning outcomes and authentic assessments, such as self-assessment and collaborative tasks, to minimise the risks of academic dishonesty and reliance on AI for rote or mundane tasks. Furthermore, educators are encouraged to use ChatGPT as a tool to enhance critical thinking and problem-solving skills. For example, Garcia-Penalvo (2023) underscores the importance of training students in the ethical use of AI, equipping them with skills to critically evaluate AI-generated content rather than solely relying on it.

There is also a call for educational institutions to develop comprehensive guidelines to ensure equitable access and responsible use of AI. These guidelines should include training for both educators and students on ethical usage, proper citation practices, and awareness of AI limitations.

GenAI actual use cases

This section of the findings presents cases of GenAI's actual use. From the review, the studies demonstrate that GenAI, including ChatGPT, holds significant potential to transform teaching and learning practices, research and institutional policy. In terms of teaching and learning practices, AI tools provide educators and students with a powerful tool to enhance educational outcomes, but they also present challenges that require careful management.

- **Teaching and learning:** From the review, ChatGPT is considered a tool that provides tailored learning experiences by offering students tailored feedback and resources that cater to their individual needs. It also acts as a virtual tutor, helping students engage with content, practice skills, and prepare for exams

(Javaid et al., 2023; Rasul et al., 2023). Collaborative learning is encouraged through scenarios that promote teamwork, fostering a more inclusive and interactive environment (Baidoo-Anu & Owusu Ansah, 2023; Rasul et al., 2023). The tool also facilitates scaffolding in teaching by breaking down complex topics, aiding students in understanding and engaging with material at a deeper level (Cooper, 2023). ChatGPT can also support diverse learning styles and inclusive education (Kasneci et al., 2023).

Educators, on the other hand, also benefit from ChatGPT as it assists them in lesson planning, creating assessments, generating rubrics and reducing administrative workloads. Additionally, it enables teachers to save time in crafting high-quality teaching materials and innovative strategies for classroom engagement (Baidoo-Anu & Owusu Ansah, 2023; Kung et al., 2023). Furthermore, it helps in saving time, as it allows teachers to focus on higher-value activities, such as engaging directly with students and refining instructional approaches (Cooper, 2023; Kung et al., 2023).

Despite its advantages, the integration of ChatGPT in teaching and learning presents several challenges. One major concern is its impact on student skills. Over-reliance on ChatGPT can diminish creativity, critical thinking, and problem-solving abilities, which are essential for lifelong learning and workplace success (Javaid et al., 2023; Lim et al., 2023; Rasul et al., 2023). Students may also engage less in independent learning, relying instead on AI-generated content (Rasul et al., 2023). The tool has also been linked to academic dishonesty, with students sometimes copying AI-generated work without acknowledgement (Javaid et al., 2023; Rudolph et al., 2023). This undermines academic integrity and raises concerns about plagiarism (Kasneci et al., 2023). ChatGPT occasionally provides inaccurate, outdated, or biased information and struggles to verify the authenticity of its sources (Baidoo-Anu & Owusu Ansah, 2023; Cooper, 2023). Additionally, questions of data privacy and intellectual property remain unresolved, complicating its ethical use in education. Again, while effective for basic learning tasks, ChatGPT is less capable of producing content requiring higher-order thinking, which can stifle the cognitive development of students (Farrokhnia et al., 2024; Rudolph et al., 2023).

- **Research:** The review of the studies further reveals that using ChatGPT for research presents numerous benefits. It supports researchers in writing various sections of academic papers, organising ideas, and generating coherent arguments. Authors such as Salvagno et al. (2023) and Rasul et al. (2023) highlight its ability to provide language editing services and drafting assistance, which is particularly beneficial for non-native English speakers. Additionally, ChatGPT aids researchers in identifying gaps in the literature, generating new ideas, and answering questions that clarify misunderstandings. Javaid et al. (2023) and Rasul et al. (2023) also emphasise its utility as a research tool for detecting patterns in data and facilitating efficient data analysis. Furthermore, ChatGPT helps researchers save time by performing tasks like summarising academic literature and enhancing research workflows, as noted by Rudolph et al. (2023) and Rasul et al. (2023). It also provides insights into academic trends, helping to process and organise research data effectively.

Despite these advantages, significant challenges accompany the use of ChatGPT in research. Cooper (2023) and Lim et al. (2023) warn that ChatGPT often hallucinates by fabricating references, providing inaccurate information, and lacks evidence to support its outputs. Rasul et al. (2023) also note its

tendency to oversimplify complex ideas and generate fake references, undermining academic credibility. Ethical concerns are raised by Salvagno et al. (2023), Baidoo-Anu and Owusu Ansah (2023) and Rasul et al. (2023), who highlight issues such as potential plagiarism, bias in generated content, and over-reliance on AI, which could diminish critical thinking skills. Moreover, ChatGPT lacks the ability to generate truly original ideas and perform critical or deep analyses of complex subjects, as emphasised by Salvagno et al. (2023) and Rudolp et al. (2023). Further limitations of ChatGPT include its restricted knowledge base, which is constrained by the training data's cut-off date, leading to outdated or incomplete information, as noted by Baidoo-Anu & Owusu Ansah (2023) and Cooper (2023).

- **Institutional policy:** The findings reflect the evolving institutional approaches to the use of GenAI in education. Policies are shaped by the potential benefits and significant risks associated with their use, aiming to maximise their advantages while mitigating ethical and academic concerns. Institutions and stakeholders have emphasised the need for clear guidelines to regulate ChatGPT usage responsibly. This includes policies for ethical AI use, acknowledging its contributions transparently, and incorporating critical thinking into teaching practices (Baidoo-Anu & Owusu Ansah, 2023; Lim et al., 2023).

The role of AI in fostering equitable access to education is also emphasised, with policies advocating for a balance between innovation and accessibility to prevent widening the digital divide (Lim et al., 2023; Salvagno et al., 2023). These approaches highlight the importance of collaboration among educators, students, administrators, and policymakers to address the challenges and opportunities presented by AI technologies.

Institutions and publishers have taken proactive steps to address the ethical implications of Gen AI use in education. Leading academic publishers, such as Nature, prohibiting listing GenAI as an author, while mandating clear acknowledgement of its use in research (Cooper, 2023). The growing concerns surrounding AI's impact on academic integrity have led to calls for robust policies to detect AI-generated content and uphold the credibility of scholarly work (Salvagno et al., 2023). Some institutions have gone further, implementing outright bans on ChatGPT to prevent misuse and safeguard academic standards. However, such bans may have unintended consequences, potentially driving the covert use of AI tools and exacerbating the digital divide. Students and educators without equitable access to these technologies risk being left behind, creating further disparities in academic opportunities (Lim et al., 2023).

Implications

The findings of this study reveal a dualistic impact of GenAI, particularly ChatGPT, on education. These implications, through the lens of chaos theory, emphasise both the "order" (transformative potential) and the "chaos" (disruptive consequences) of these technologies. This perspective sheds light on the dual nature of GenAI's influence on teaching and learning. Chaos theory's central tenet, the butterfly effect, emphasises how small, seemingly insignificant changes in AI applications can lead to far-reaching consequences. For instance, the decision to use ChatGPT for personalised student feedback might catalyse broader institutional shifts, including changes in pedagogy, curriculum design and policy frameworks. This perspective reveals the unpredictable

and non-linear nature of AI's impact, emphasising the need for adaptive strategies to navigate these dynamic shifts effectively.

On one hand, ChatGPT and other GenAI tools enhance personalised learning, reduce teacher workload, and democratise access to knowledge. On the other hand, they raise significant concerns around academic integrity, data privacy, bias, and the erosion of critical thinking. Addressing this tension requires a deliberate balance between innovation and accountability. Educational institutions could develop comprehensive AI usage policies that promote transparency, safeguard ethics, and build critical AI literacy. For instance, policies might require both students and researchers to disclose when and how AI tools are used in academic work, ensuring clarity in attribution and accountability. Similarly, assessment practices may need to shift from rote memorisation toward authentic, problem-solving tasks that are less susceptible to AI-enabled shortcuts. Embedding AI literacy within teacher training and professional development would further prepare educators to guide students in critically evaluating AI-generated content while avoiding overreliance.

These implications are particularly pressing in under-resourced contexts such as African or other LMIC higher education systems. While GenAI could help bridge gaps in access to high-quality teaching and research support, limitations in digital infrastructure, affordability, and digital literacy risk widening the educational divide. In such settings, chaos theory's emphasis on sensitivity to initial conditions is particularly relevant, without targeted policy interventions and investments, minor disparities in access could snowball into systemic exclusion. Equitable AI adoption, therefore, requires capacity building, affordable access, and policy frameworks that explicitly account for structural inequalities.

Finally, this study highlights the need for future empirical research to move beyond conceptual reviews. Comparative studies across well-resourced and under-resourced institutions would shed light on how structural conditions shape GenAI adoption and outcomes. Longitudinal studies could also track how institutional policies evolve over time, offering insights into adaptive strategies that sustain resilience in chaotic and uncertain educational environments. By embedding these empirical approaches, future research can generate actionable evidence to guide inclusive, ethical, and context-sensitive AI integration in education.

Conclusion and Recommendation

The study provides a nuanced exploration of the transformative yet disruptive impact of GenAI tools like ChatGPT, on education. By applying chaos theory, the research reveals that AI's influence mirrors the duality of order and chaos, offering benefits such as personalised learning, teacher support, and efficiency in research while simultaneously presenting challenges related to academic integrity, ethical concerns and critical thinking. Through the lens of chaos theory, the study demonstrates how small changes, such as the introduction of AI tools in classrooms or research processes, can create far-reaching ripple effects across pedagogy, curriculum design, and institutional policies. These impacts highlight the need for adaptive strategies and ethical frameworks to navigate the unpredictable nature of AI in education.

Viewing from the lens of chaos theory, the study reveals the importance of resilience and adaptability in addressing AI's challenges. Institutions must recognise and embrace the interplay between structure and unpredictability, fostering systems that encourage innovation while mitigating risks. The findings further emphasise the necessity of policies that promote equitable access, responsible use, and critical

evaluation of AI tools. By doing so, the educational sector can leverage AI's potential while safeguarding academic standards and fostering a culture of ethical and informed technology integration.

Recommendations

To navigate the transformative yet disruptive impact of GenAI tools, educational institutions must develop adaptive policies that balance innovation with accountability. These policies should establish clear guidelines on how AI tools, such as ChatGPT, can be integrated into teaching, learning and research. Specific measures must address academic integrity, like plagiarism, misinformation, and data privacy concerns. Transparency in AI applications is critical to building trust and ensuring that students and educators use these tools responsibly. Again, policies should include mandatory documentation of AI contributions to ensure accountability in academic and professional contexts. Such policies must be revisited regularly to accommodate the rapidly evolving nature of AI technologies and their applications in education.

Educational institutions should consider revising their curricula to incorporate digital literacy and AI competencies, emphasising critical thinking, problem-solving, and ethical decision-making. Promoting AI literacy is essential for maximising the benefits of these tools while minimising their misuse. Through such revised curricula, students and educators would be equipped with the skills needed to critically evaluate AI-generated content and understand its limitations. Additionally, the curriculum should emphasise the ethical use of AI, helping students to recognise biases, inaccuracies, and ethical implications inherent in AI outputs. By fostering a culture of informed and responsible AI use, institutions can ensure that students and educators alike are prepared to leverage these tools effectively.

Moreover, ensuring equitable access to AI tools is essential to prevent the widening of the digital divide. Institutions should take proactive steps to make these technologies accessible to all students and educators, regardless of socio-economic status. Policymakers should also focus on providing underserved regions, especially the global south, with the necessary digital infrastructure and ensuring that AI solutions remain affordable and accessible. This effort requires collaboration between governments, private technology providers, and educational stakeholders to create opportunities for all institutions, regardless of their geographic or economic contexts. By bridging the digital divide, AI can be a force for democratising education rather than perpetuating inequalities.

Lastly, fostering collaboration among stakeholders is key to managing the complexities of AI adoption. Educators, administrators, students, and policymakers should work together to develop comprehensive strategies that address both the opportunities and challenges of AI integration in education. By fostering open dialogue and shared responsibility, stakeholders can collectively shape a future where AI enhances educational outcomes while preserving ethical and pedagogical standards.

Limitations

This study offers an insightful analysis of the integration of GenAI, particularly ChatGPT, in education. However, several limitations must be considered to provide a nuanced understanding of the findings. One notable limitation of the study is its primary focus on ChatGPT, which, while highly influential, represents only one among

many GenAI tools. This narrow scope excludes other emerging technologies that may have similar or distinct functionalities, potentially limiting the broader applicability of the findings across the diverse landscape of AI-driven tools. Additionally, the study draws heavily on recent literature from 2023 onward, ensuring its relevance but potentially omitting foundation research or earlier trends that could provide a more comprehensive historical perspective.

Again, as an integrative literature review, the study synthesises existing research without conducting primary empirical investigations. While this approach effectively identifies trends and patterns, the findings lack direct observational or experimental validation, which could have strengthened the evidence base. By acknowledging these limitations, the study highlights the need for continuous research, empirical validation, and contextualised approaches to fully understand and harness the transformative potential of GenAI in education while mitigating its risks.

Lastly, it should be noted that this study is based on a qualitative synthesis of existing literature. As such, while proportional trends (e.g., "x out of 21 studies") are reported to highlight recurring patterns, these should not be interpreted as statistical generalisations. Instead, they provide an indicative sense of the dominant conversations emerging in the rapidly evolving discourse on GenAI in education.

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Appendix

Table 2: Chaotic discussions of GenAI in education across the three themes

No.	Author/Year	Title	Category	Findings
Tlili et al. 2023		What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education	Teaching and Learning Practices	ChatGPT is used by both teachers and students to obtain baseline knowledge of essential and complex topics.
				ChatGPT use by learners can also diminish their innovative capacities and critical thinking.
				It can lessen teacher workload, such as preparing teaching content,
			Research	There are issues of response quality, personality and emotions, academic integrity, and other ethical issues Some researchers took humanisation to another level by treating ChatGPT as a human, where they listed it as one of the co-authors in an article published in an academic journal
Khan & Khan 2023		ChatGPT Reshaping medical education and clinical management	Institutional Policy	New York City decided to ban it in its schools
				Educators can use ChatGPT to assess the work of students, help break complex concepts into understandable formats and enable educators to create and engage students through relevant content and pedagogy
				Can be adjusted to suit the learning styles of students and assist in personalised learning
			Teaching and Learning Practices	Assist students and professionals with accurate and up-to-date information on medical topics Provide students with real-world clinical scenarios to gain a deeper understanding of topics

		Sometimes ignores the context of the prompt and produces irrelevant information
		Lack of data input after 2021
		May lack human-like understanding
	Research	Provide research assistance to students at various stages of the research
	Institutional Policy	ChatGPT has been rejected as an author by the World Association of Medical Editors
Dwivedi et al., 2023	Opinion paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy	Research AI chatbots can assist in writing articles, data analysis and assist in the entire research process ChatGPT can aid in writing and language editing to bridge the English gap for non-native speakers ChatGPT cannot perform literature review because it lacks peer reviewed articles in its training Attempt to make ChatGPT/ other AI chatbots co-authors Outsourcing the crafting of papers to AI programmes
	Teaching and Learning	ChatGPT can help to improve the critical thinking skills of students through the critique of ChatGPT outcomes

ChatGPT can provide students with personalised feedback

Instructors can use AI to grade students, which will reduce the workload of instructors

ChatGPT can assist teachers in lesson plans and developing curriculum

ChatGPT support diverse learning styles and promotes inclusive learning

ChatGPT outputs are mostly biased and sometimes not accurate

ChatGPT erodes academic integrity

Some of the information provided by ChatGPT are not update and gets confused with complex questions

Quotes from ChatGPT are not reliable and are attributed to wrong or fake authors

Frequent use of ChatGPT by students can limit their skills in writing, critical thinking, problem solving and creativity.

**Institutional
Policy**

AI tools have been banned for writing papers by the International Conference on Machine Learning, but can be used to edit and improve text

			Gen AI has been banned as an author, and when it is used in research, it must be documented
			Some universities have instituted policies to prohibit the use of AI in essays
			Access to ChatGPT has been banned in New York City Schools
Farrokhnia al., 2024	etA analysis of ChatGPT: Implications for educational practice and research	SWOT of Learning Practices	and ChatGPT produces more credible and plausible responses ChatGPT can produce context driven information based on the personalised needs of the learner and at a faster pace Provide both students and teachers with access to information in real-time towards teaching and learning Provide students with customised feedback and instructions Assists teachers in preparing lesson notes, assessments, and providing students feedback Information provided by ChatGPT on topics may lack depth, insight, accuracy and dated Produce bias and discriminatory information Inability to produce higher-order thinking information and stifle the cognitive skills of students

			Lacks a deep understanding of the learning styles of students as well as the curriculum for a particular topic
			Use of it in answering exams questions poses a threat to academic integrity
			High risk of plagiarism and misinformation
		Institutional Policy	Adjusting curricula to incorporate the use of new technologies and higher-order learning outcomes with appropriate tasks
			Adopt authentic assessment with self-assessment
Kasneci et al., 2023	ChatGPT Good? opportunities and challenges of large language models for education	Teaching and Learning	LLM enhance the learning experiences of students by providing prompt feedback and personalised learning ChatGPT assist teachers in their lesson planning, giving assessment feedback and saves time Questions and prompts generated can stimulate students' critical thinking and writing skills Provides an opportunity for inclusive education for all AI can support students in collaborative learning and writing LLM can perpetuate societal/context biases Stifle the creativity, critical thinking and problem-solving skills of students and teachers Ethical concerns, including plagiarism, data privacy and affects academic integrity

		Outputs of AI-generated text may lack accuracy
		Assist in generating research outlines and research process
Garcia-Penalvo, 2023	The perception of Artificial Intelligence in educational contexts after the launch of ChatGPT: Disruption or Panic?	Research Teaching and Learning ChatGPT has the capacity to promote critical analysis, having access and generating appropriate questions and a source of comparison Loss of authorship attribution when ChatGPT is used without reference or proper citation Prone to error without verification of responses Students are likely to bypass intellectual effort ChatGPT has the limitation of reasoning and can spread misinformation with its easy-to-use functionalities
		Institutional Policy Call for educators to help train students to use it ethically
Hong, 2023	The impact of ChatGPT on foreign language teaching and learning: Opportunities in education and research	Educators should incorporate critical thinking in their teaching methods Enable students to engage in authentic conversations that mimic human interaction Enable students to get immediate feedback and act as personalised tutor Enable teachers to mark and provide students with appropriate feedback, as well as reduce workload ChatGPT and other AI tools undermine academic integrity and the validity of academic activities like assignments May limit teachers' professional expertise when teachers over rely on it
		Research ChatGPT can help to generate research ideas
King, M. R., & ChatGPT. (2023)	A conversation on artificial intelligence, chatbots, and plagiarism in	Teaching and Learning Research ChatGPT acknowledged that plagiarism is a concern for higher educational institutions because of the way students access and use information

	higher education.			ChatGPT suggests academics should adopt a variety of assessment methods to reduce plagiarism
				Academic institutions should have stricter policies on plagiarism and stronger forms of punishment
				Institutions should use plagiarism detection software
		Research		ChatGPT generated fake authors as references
Haug & Drazen (2023)	Artificial intelligence and machine learning in clinical medicine, 2023	Research		AI could help to improve and simplify clinical trials through comprehensive analyses of data.
				AI has the potential to create synthetic control groups
				AI can help predict and understand the outcomes of events
		Institutional Policy		There are uncertainties in using AI and machine learning for clinical trials, especially in protocols and reporting, which must be addressed
Singhal et al. (2023)	Large language models encode clinical knowledge	Teaching and Learning		Large language models (LLMs) facilitate human-AI interaction by helping learners to ask complex medical questions and receive well-structured answers.
				LLMs can help align with specific learning domains for structured learning
				LLMs support education and medical learning by providing students with relevant clinical knowledge through reasoning abilities
				Responses and knowledge contained within LLMs can be biased and limited due to the training of the data used
				LLMs are limited by the knowledge contained within their training data
		Research		LLMs can help retrieve relevant literature, summarise key medical findings
Thirunavukarasu et al. (2023)	Large language models in medicine	Teaching and Learning	and	LLMs act as virtual tutors and assist students in explaining complex medical concepts, provide instant feedback and guide in problem-solving

	LLMs assist in generating medical case studies, quizzes and other educational materials
	LLMs support self-directed learning in creating study plans and tracking progress
	LLMs can generate misleading or incorrect medical information
	LLMs can facilitate academic dishonesty
Research	LLM assist researchers to efficiently review and synthesise literature by extracting key insights from published medical research and identifying gaps
	LLMs facilitate research writing and reporting, and the content can be tailored for different audiences
	LLMs support peer reviewers to detect plagiarism, identify errors and potential biases in research papers
	They can support analysing large datasets and generating synthetic medical data
	LLMs can produce factually incorrect or fabricated information and responses require rigorous validation
	Responses may fail to incorporate the latest scientific discoveries and guidelines due to the dataset used to train the LLMs
	The sources of information from LLMs are mostly not known, which makes it difficult to account for the accuracy of their outputs
	LLM training data are often biased, have privacy and data security risks, risk of plagiarism and scientific misconduct
Institutional Policy	Cambridge University Press has given out explicit guidance on the use of AI
	Some peer-reviewed journals have placed an outright ban on the use of LLMs
	Call for clear policies to regulate AI use in medicine

	Strict guidelines on patient data protection are required and should be aligned with other laws
	Call for strict enforcement of regulations developed

Table 3: Actual use cases of GenAI in education across the three themes

No.	Author/Year	Title	Category	Findings
				Order Chaos
	Salvagno et al., 2023	Can artificial intelligence help for scientific writing?	Research	ChatGPT can help researchers in writing the various sections of an article and provide appropriate justification when necessary May be difficult to identify text written by ChatGPT and humans Will need human guidance, supervision and input to produce an appropriate scientific paper May produce bias and inaccurate data and results ChatGPT is faster than humans in comprehending a text deeply and connecting evidence to draw conclusions Create further digital divide with payment options
			Institutional Policy	Call for programmes to detect written content generated by AI
	Kung et al., 2023	Performance of ChatGPT on USMLE potential for AI-assisted medical education using a large language model	Teaching and Learning	ChatGPT has an increasing accuracy to pass USMLE without prior training The ability of ChatGPT depends on human input and, therefore, may provide biased information on the subjective view of the trainer or information ChatGPT can support medical students to understand complex concepts with clear

			and logicalChatGPT may provide explanations inaccurate information as well as perform ChatGPT can performpoorly based on a a comprehensivedomain-specific prompt reasoning and provide insight to validate clinical concepts ChatGPT can ease the burden of educators by helping to create content for medical education
Cooper, 2023	Examining science education in ChatGPT: An exploratory study of generative artificial intelligence	Teaching and Learning	ChatGPT can supportChatGPT lack the educators in theirrequired evidence to teaching pedagogy support the output from prompt ChatGPT can provide students with an understanding of concepts through scaffolding Outputs are biased and cannot verify the ChatGPT can reduceauthorship of the the workload ofinformation provided teachers in creating learning materials ChatGPT can supportChatGPT raises questions on data students and teachersprivacy in their writing skills Allowing students to generate text first before searching for references to back the text is unethical Over-reliance on ChatGPT by students reduces their creativity and critical thinking skills
		Research	ChatGPT can supportProvide inaccurate and in language editing non-existing references ChatGPT can help to organise ideas and generate arguments The author has instructed his students not to reference ChatGPT directly in their assignments

Institutional Policy		ChatGPT has generated debates among editors, researchers and other stakeholders as to accept it as an author or not
		Nature and all Spring Nature journals do not accept any large language model as an author, and authors who use LLM must acknowledge it in the method or acknowledgement sections
Lim et al., 2023	Teaching and learning Generative AI and the future of education: Ragnarok or reformation? A paradoxical perspective from management educators	Gen AI is a transformative resource that can assist educators and students in assessing information, assessment, creating critical thinking assignments, and empower progress through idea generation. Generative AI may provide false information and create knowledge gaps Generative AI can promote plagiarism Generative AI can promote cognitive bias
		Gen AI have rich resource collection and can provide timely and elaborate responses Responses from Generative AI may not be reliable
		Hinder the democratization of knowledge and widen the socio-economic gap Gen AI has increased access to improved education and democratisation of knowledge
Research		References provided by ChatGPT are not reliable
Institutional Policy		Has been banned in some schools Placing a ban on it may rather increase its use
		A call to integrate its use, but a policy to increase the digital divide Placing a ban is likely to increase the digital divide

			regulate the extent of use
			Share responsibility among educators, students, institutions and administrators in dealing with Gen AI-related challenges and opportunities
			Guidelines should be provided to guide practice and research in education
b	Javaid et al. (2023)	Unlocking the opportunities through ChatGPT tool towards ameliorating the education system	Teaching and learning ChatGPT is a great resource for student through the creation of customised learning plans, explanations and clarification of concepts, improving outcomes, opportunity to practice and help to prepare for exams ChatGPT sometimes provide incorrect and unethical responses. Reduce students' ability to engage in independent learning and critical thinking
			Students have been encouraged to copy the work of ChatGPT as their own without acknowledgement ChatGPT provide biased information and raises concerns on data security, intellectual property and privacy
			Assist students in research and provide them with accurate, clear and crisp answers to questions asked, writing assistant Provide students with immediate feedback and act as a teaching assistant
			Assists educators to develop class activities to help students bring out their creativity, evaluate students and develop rubrics
		Research	Provide students with research tools that help them to generate ideas, answer

			questions and clarify misunderstanding
Baidoo-Anu & Owusu Ansah, 2023	Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning	Teaching and Learning	ChatGPT has enabled educators to save time in creating testing exams, as well as generating rubrics ChatGPT sometimes fabricate references and provide incorrect information ChatGPT has limited knowledge beyond 2021 ChatGPT and other Gen AI can provide students with continuous feedback and act as a virtual teacher by providing students with explanations of complex concepts Increase students' dependence on AI leading to students' inability to think critically ChatGPT can promote collaboration among students by providing them with collaborative scenarios ChatGPT can assist teachers to come out with high-quality assessment practice
		Institutional Policy	A call for institutions to embrace ChatGPT and other Gen AI into education and regulate its use Some institutions have banned the use of ChatGPT for teachers and students Institutions to rethink their traditional assessment methods A call for integrating the use of AI in teacher education and training
Rudolph et al., 2023	ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	Teaching and Learning	ChatGPT can help students to understand concepts and provide quick responses ChatGPT is less competent in providing higher-order thinking content ChatGPT is a threat in assessing students

		ChatGPT can provide based on traditional personalised assessment methods assistance to students like written in solving problems assignments
		ChatGPT has helped to ChatGPT can generate reduce the workload in inaccurate information of teachers and innovate teaching strategies
		ChatGPT lack deep understanding of subject matter and Assist students to critical analysis access information and formulate ideas
		A threat to academic integrity, as it allows ChatGPT can provide students to plagiarise assistance to teachers without being caught. in their writing and providing assessments on students
		ChatGPT can support students to work as a team and promote collaboration
	Research	ChatGPT can help to ChatGPT provide improve data incorrect references and processing and inaccurate information analysis efficiently
		Can assist in ideas Oversimplify complex summarising academic literature and identifying trends
		Provide biased data based on it training
Rasul et al., 2023	The role of ChatGPT in higher education: Benefits, challenges, and future research directions	ChatGPT can help teachers to provide support to students by and engage in creating personalised learning experience plagiarism undermining academic integrity
		ChatGPT can provide a tailored learning

	experience according to the needs of each student Some of the information provided may be inaccurate and biased ChatGPT can provide students with personalised feedback May limit critical and resources to graduate skills like enhance learning outcomes collaboration, critical thinking and problem-solving skills required at Reduce administrative workload the workplace ChatGPT can make it difficult to assess students' critical thinking and collaborative skills ChatGPT can help to create assessments that will foster critical thinking
Research	ChatGPT can provide a summary of research, references which could generate drafts and support writing, especially for non-work native English speakers ChatGPT generate fake references which could undermine the credibility of academic writing Help to save time for students and researchers Assist in data analysis by detecting patterns in data and supporting research efforts Provide writing assistance for researchers
Institutional Policy	A call for institutions to implement training programs for both students and academics on the responsible use of ChatGPT Redesigning assessment and integration of AI in the curriculum

		Developing ethical guidelines and policies to curtail the unethical aspects of ChatGPT
		Develop policies to help ensure equitable access
Gilson et al., (2023)	How does ChatGPT perform on the United States Medical Licensing Examination (USMLE)? The implications of large language models for medical education and knowledge assessment	Teaching and learning ChatGPT's conversational interface helps students receive feedback, explanations, and follow up on USMLE related questions. ChatGPT's responses are limited to information available up to its training data cutoff in 2021 ChatGPT demonstrates a higher accuracy level in answering questions compared to previous models ChatGPT provides students with interactive learning opportunities similar to peer discussions.
Wang et al., (2023)	Scientific discovery in the age of artificial intelligence	Research AI enhance scientific discoveries which cannot be easily probed The large datasets of AI may likely lead to incomplete and biased results AI reduces the need for manual and repetitive tasks in research labs AI systems can be misused for unintended applications It may be difficult to enable scientists to replicate research focus on high-level results using AI because of the nature of training and evolving datasets Large-scale experimental data can be processed by scientists more efficiently through the use of AI It may be difficult to understand how AI models arrive at their conclusions Over reliance on AI tools may affect researchers critical analysis skills AI can facilitate hypothesis generation, accelerate the research process

and experimental procedures scientific investigations	optimise forPotential breaches intellectual theft	of data and property
AI models can provide highly accurate simulations		

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LECTURERS' AWARENESS AND UTILISATION OF ARTIFICIAL INTELLIGENCE IN OPEN AND DISTANCE LEARNING IN THE NATIONAL OPEN UNIVERSITY OF NIGERIA

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ABSTRACT

Artificial Intelligence (AI) is increasingly transforming teaching, learning, assessment, and research in Open and Distance Learning (ODL), yet evidence on lecturers' awareness and utilisation of AI in the National Open University of Nigeria (NOUN) remains limited. This study investigated lecturers' awareness and utilisation of AI in the Faculty of Education, NOUN. A descriptive survey design was adopted, and a census of all 150 lecturers was conducted using two researcher-developed instruments. Data were analysed using descriptive statistics and independent samples *t*-test. The findings revealed that lecturers had a high level of AI awareness (weighted mean = 2.67) and a high level of AI utilisation (weighted mean = 2.56). No significant gender differences were found in lecturers' awareness ($t = -0.411, p > .05$) or utilisation ($t = 0.414, p > .05$) of AI. Although utilisation was high, it lagged slightly behind awareness, suggesting that increased awareness alone may not guarantee effective pedagogical integration of AI. The findings underscore the need for institutional strategies that move beyond awareness creation to sustained support for AI implementation in ODL. The study recommended regular professional development programmes, institutional AI policies and ethical guidelines, and increased investment in AI-enabled infrastructure to promote effective teaching, learner engagement, and research productivity in ODL institutions.

Keywords: Artificial Intelligence, Open and Distance Learning, Lecturers' Awareness, AI Utilisation, National Open University of Nigeria

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Introduction

Digital technologies have advanced at a rate never witnessed before in the twenty-first century, radically changing many facets of human endeavour, including education. Artificial Intelligence (AI) has become one of the most revolutionary technical advancements, having the potential to transform research, teaching, learning, evaluation, and educational administration. The ability of computer systems and computers to carry out tasks that often require human intellect, such as reasoning, learning, decision-making, problem-solving, language processing, and pattern recognition, is known as AI (Kaplan & Haenlein, 2019). According to Russell and Norvig (2021), AI encompasses computational systems capable of perceiving their environment, learning from data, and taking actions that maximise the likelihood of achieving specified goals. Through sophisticated algorithms, machine learning, natural language processing, and predictive analytics, AI systems can analyse large volumes of data, generate insights, and automate complex tasks with remarkable efficiency.

UNESCO (2023) noted that AI is increasingly influencing educational systems worldwide by enhancing access to knowledge, supporting personalised learning, and improving educational management processes. The increasing adoption of AI across educational settings has generated significant interest among educators, researchers, policymakers, and institutions globally. Educational systems are progressively leveraging AI technologies to enhance instructional delivery, personalise learning experiences, improve learner engagement, facilitate assessment processes, and support institutional decision-making. According to Holmes et al. (2019), AI has the capacity to transform education by providing adaptive learning experiences that respond to individual learners' needs, preferences, and abilities. Similarly, Zawacki-Richter et al. (2019) observed that AI applications in higher education are increasingly being utilised to support personalised learning, student retention, assessment, and administrative decision-making. The integration of AI into education therefore represents a paradigm shift from traditional teacher-centred

approaches towards more adaptive, learner-centred, and technology-driven pedagogical models. Consequently, educational institutions worldwide are exploring innovative ways of incorporating AI technologies into their teaching and learning ecosystems.

Open and Distance Learning (ODL) institutions are particularly well positioned to benefit from the opportunities presented by AI. ODL is an educational approach that provides flexible learning opportunities to students regardless of geographical location, age, occupation, or socio-economic status. According to Moore and Kearsley (2012), ODL seeks to overcome barriers to education by enabling learners to access instructional resources and engage in academic activities through technology-mediated platforms. ODL institutions rely heavily on Information and Communication Technologies (ICTs) for course delivery, learner support, assessment, and communication, making them ideal environments for the integration of AI-powered educational solutions. As digital technologies continue to evolve, ODL institutions are increasingly adopting intelligent systems to improve instructional effectiveness, learner engagement, and educational accessibility.

The National Open University of Nigeria (NOUN), established to widen access to higher education and promote lifelong learning, represents the largest Open and Distance Learning institution in Nigeria. Since its establishment, NOUN has utilised various digital technologies to facilitate teaching, learning, assessment, and learner support services across its numerous study centres nationwide. The university's commitment to technology-enhanced learning aligns with global trends in ODL and positions it strategically for the adoption and utilisation of AI technologies. As higher education increasingly embraces digital transformation, the integration of AI into NOUN's academic and administrative processes offers opportunities for improving educational quality, learner satisfaction, institutional efficiency, and academic productivity. Technology-driven innovations remain central to the achievement of NOUN's mandate of providing accessible and quality higher education to diverse categories of learners across Nigeria (National Open University of Nigeria, 2024).

For lecturers, these AI-powered technologies offer numerous opportunities to enhance professional practice. They can support the development of instructional materials, facilitate curriculum design, generate assessment items, automate routine administrative tasks, analyse student performance data, provide personalised feedback, and assist in scholarly research. AI tools can also enhance communication between lecturers and

learners, improve responsiveness to student inquiries, and support evidence-based decision-making. According to Kasneci et al. (2023), AI technologies have demonstrated considerable potential for improving instructional efficiency and supporting educators in managing diverse learning needs. Consequently, the effective utilisation of AI has the potential to improve teaching effectiveness, increase productivity, and enrich learning experiences within ODL environments.

Despite the numerous benefits associated with AI integration, successful implementation depends largely on the awareness, acceptance, competence, and utilisation levels of educators. Lecturers remain central to the educational process and play a critical role in determining how emerging technologies are adopted and applied within instructional contexts. Their understanding of AI concepts, capabilities, limitations, ethical implications, and pedagogical applications significantly influences their willingness and ability to integrate these technologies into teaching and learning activities. Davis's (1989) Technology Acceptance Model posits that users' acceptance of technology is influenced by their perceptions of its usefulness and ease of use. AI literacy extends beyond basic awareness by equipping educators with the knowledge, skills, and critical understanding required to evaluate, use, and integrate AI technologies responsibly in educational practice. Consequently, awareness represents the initial stage of AI literacy, as educators must first understand the existence, capabilities, and potential applications of AI before they can develop the competencies necessary for its effective and ethical use. According to Long and Magerko (2020), increasing AI awareness should be accompanied by improved AI literacy, institutional support, and policy frameworks to promote responsible AI adoption in higher education. Awareness, therefore, serves as the foundation upon which utilisation is built.

Awareness is an individual's level of knowledge, understanding, perception, and consciousness regarding a particular phenomenon, innovation, or technology. In educational technology, awareness is considered a prerequisite for technology adoption because individuals are more likely to utilise technologies they understand and perceive as beneficial. In the context of AI, awareness encompasses educators' knowledge of AI concepts, functionalities, opportunities, limitations, and ethical implications, as well as their understanding of how AI can be applied to teaching, learning, assessment, research, and educational administration. Grassini (2023) emphasised that effective AI integration in

education depends on educators possessing adequate knowledge of AI technologies and their pedagogical and ethical implications.

Similarly, UNESCO (2023) highlighted that AI-aware educators should understand both the opportunities and risks associated with AI to ensure its responsible use in education. Empirical evidence also suggests that lecturers' awareness of AI significantly influences their readiness to adopt AI tools in higher education (Thomas et al., 2024). Although awareness of AI has increased across African higher education institutions following the emergence of generative AI tools, its effective utilisation remains constrained by inadequate training, institutional support, and policy frameworks (Ojubanire et al., 2025). Recent scholars have conceptualised AI awareness as educators' understanding of how AI technologies function and their potential applications in teaching, learning, assessment, research, and educational administration. Artificial Intelligence awareness involves not only knowledge of AI tools and systems but also an understanding of their ethical, social, and educational implications.

Within Open and Distance Learning (ODL) environments, the utilisation of AI has become particularly important because of the technology-dependent nature of instructional delivery. ODL institutions serve large and diverse learner populations who often require flexible, personalised, and continuous academic support. AI technologies provide mechanisms for addressing these needs through intelligent tutoring systems, adaptive learning platforms, virtual assistants, chatbots, automated grading systems, and learning analytics tools. The utilisation of AI among lecturers encompasses a wide range of academic activities. In teaching, lecturers employ AI-powered tools to develop instructional materials, generate lesson content, design learning activities, and create assessment items.

Within the National Open University of Nigeria (NOUN), lecturers' utilisation of AI is particularly significant because of the institution's reliance on technology-mediated instructional delivery. The effective utilisation of AI can enhance learner support services, improve teaching effectiveness, facilitate timely feedback, strengthen research productivity, and promote institutional efficiency. However, the extent to which lecturers utilise AI technologies may depend on their level of awareness, digital competence, access to technological resources, and institutional encouragement. Given the central role of lecturers in the implementation of educational innovations, understanding their utilisation of AI is essential for developing strategies that promote effective technology integration

within the university. Therefore, this study investigated lecturers' awareness and utilisation of AI in Open and Distance Learning in the National Open University of Nigeria.

Statement of the Problem

Artificial Intelligence has become an important technological innovation in higher education, with increasing applications in teaching, learning, assessment, research, and learner support. In Nigeria, awareness of AI tools such as ChatGPT, Gemini, Copilot, learning analytics systems, and intelligent tutoring platforms has grown considerably among academics due to the rapid expansion of digital technologies and the global prominence of generative AI. However, evidence from recent studies suggests that while many lecturers are aware of AI technologies, their actual utilisation for instructional and academic purposes remains uneven because of challenges such as inadequate training, limited technological infrastructure, ethical concerns, and insufficient institutional support. As the largest Open and Distance Learning institution in Nigeria, the National Open University of Nigeria (NOUN) relies heavily on technology-mediated instructional delivery and therefore stands to benefit significantly from the effective integration of AI. The utilisation of AI tools has the potential to enhance personalised learning, improve learner support services, facilitate assessment, strengthen research productivity, and increase institutional efficiency. Conversely, low or suboptimal utilisation of AI may limit these benefits, resulting in reduced instructional innovation, less effective learner support, and missed opportunities for improving educational quality within the ODL environment. Despite the growing relevance of AI in higher education, there is limited empirical evidence on the extent to which lecturers in NOUN are aware of and utilise AI technologies in their professional activities. This knowledge gap makes it difficult for the institution to develop appropriate policies, training programmes, and support mechanisms for effective AI integration. Therefore, this study investigated the level of lecturers' awareness and utilisation of AI tools in the National Open University of Nigeria.

1. What is the level of lecturers' awareness of Artificial Intelligence tools in the National Open University of Nigeria?
2. What is the level of lecturers' utilisation of Artificial Intelligence tools in the National Open University of Nigeria?

Gender has frequently been examined as a demographic variable in studies investigating the adoption and utilisation of emerging educational technologies, including Artificial Intelligence (AI). Although AI is increasingly becoming an integral component of teaching, learning, and research, empirical evidence on whether male and female lecturers differ in their awareness and utilisation of AI remains inconclusive. The current study therefore further investigated whether lecturers' gender influences their awareness and utilisation of AI within the Open and Distance Learning (ODL) context. Examining gender differences is important because demographic characteristics may shape access to digital technologies, technological confidence, professional development opportunities, and patterns of technology adoption in higher education.

Empirical studies have reported mixed findings regarding gender differences in AI awareness and utilisation among teaching faculty. For instance, Ofosu-Ampong (2024) found that although university lecturers generally demonstrated positive perceptions and acceptance of AI for teaching, gender did not significantly influence their willingness to adopt AI technologies. Similarly, Thomas et al. (2024) reported that lecturers' awareness and readiness to integrate AI into instructional practices were largely comparable across male and female academics, suggesting that institutional support and AI literacy are more influential than gender. Likewise, Ojubanire et al. (2025) observed that while awareness of generative AI tools was widespread among academics, variations in AI utilisation were associated more with training opportunities, institutional policies, and digital competence than with gender. These findings suggest that gender may not be a major determinant of lecturers' awareness and utilisation of AI, although further empirical evidence from the Nigerian ODL context remains necessary.

Based on these empirical findings, the following research questions were raised:

1. What is the significant difference between male and female lecturers' level of awareness of Artificial Intelligence tools in the National Open University of Nigeria.
2. What is the significant difference between male and female lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria.

Theoretical Framework

Unified Theory of Acceptance and Use of Technology

The model was propounded by Venkatesh et al (2003). The model identifies a range of factors including: performance expectancy, effort expectancy, social influence, and facilitating Conditions, which impact upon behavioural intention and use behaviour. The model uses a technology, in this case the Information and Communication Technology, that is influenced by people's perceptions of performance expectance, effort expectance, social factors and facilitating conditions which are moderated. The Unified Theory of Acceptance and Use of Technology (UTAUT) model has been applied in a variety of settings relating to the intended use of technology and facilitating conditions (Groves and Zemel, 2000; Teo, 2009). UTAUT tries to explain the degree of acceptance of the use of Information Technology. These theories assess whether the user will be able to accept the new technologies and the user's ability to deal with them. The UTAUT model employs four constructs that play a significant role as direct determinants of user acceptance and usage behaviour (Venkatesh et al, 2003): The first three constructs determine behavioural intention; and behavioural intention plus facilitating conditions determine use behaviour. Each of the constructs comprises a distinguishing set of criteria. One of the strengths of the model is its focus on usage (Use Behaviour) as a key dependent variable. The effects of its four core determinants, performance expectancy, effort expectancy, social influence, and facilitating conditions, on behavioural intention and technology use are moderated by gender, age, experience, and voluntariness of use. These moderating variables explain why individuals differ in their acceptance and utilisation of emerging technologies across different contexts.

The UTAUT model is relevant to this study because it explains the factors that influence lecturers' acceptance and utilisation of Artificial Intelligence (AI) tools in Open and Distance Learning. The theory posits that performance expectancy, effort expectancy, social influence, and facilitating conditions determine users' intention and actual use of technology. In the context of this study, lecturers are more likely to utilise AI tools if they perceive them as useful, easy to use, supported by colleagues and the institution, and backed by adequate infrastructure and training. Therefore, the UTAUT model provides a suitable framework for understanding lecturers' awareness and utilisation of AI technologies in the National Open University of Nigeria (NOUN).

Literature Review

Artificial Intelligence Awareness and Utilisation in Higher Education

Recent studies have examined educators' awareness and utilisation of Artificial Intelligence (AI) technologies in higher education across different contexts. The findings generally indicate increasing awareness of AI tools among academics, although actual utilisation varies considerably depending on institutional support, technological infrastructure, and digital competence. Grassini (2023) reported that university educators generally demonstrated a high level of awareness of generative artificial intelligence tools such as ChatGPT and recognised their potential to enhance teaching, learning, and academic productivity, although concerns regarding ethical use, academic integrity, and reliability remained significant. However, utilisation was largely concentrated on content generation, information retrieval, and assessment support, while more advanced applications such as learning analytics and adaptive learning systems remained underutilised. Similarly, Kasneci et al. (2023) observed that although educators recognised the potential of generative AI for enhancing teaching and research productivity, concerns regarding academic integrity, reliability, and ethical use constrained widespread adoption.

Studies conducted in other African countries reveal comparable trends. In Kenya, universities have increasingly explored AI-supported learning environments, yet utilisation remains constrained by inadequate infrastructure and limited AI literacy among educators (Mtebe & Raphael, 2023). A critical synthesis of the literature reveals a consistent pattern across contexts. Most studies report relatively high levels of awareness of AI technologies among educators, largely driven by the visibility of generative AI tools and increased digitalisation of higher education. However, awareness does not automatically translate into effective utilisation. The literature consistently identifies facilitating conditions, such as training, infrastructure, institutional policies, and technical support, as crucial determinants of actual use. This observation aligns with the Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasises that behavioural intention alone is insufficient unless supported by favourable facilitating conditions.

Despite the growing body of literature on AI in higher education, empirical studies focusing specifically on Open and Distance Learning institutions in Nigeria remain limited. Existing Nigerian studies have largely examined AI adoption in conventional universities, with little

attention given to lecturers in ODL environments such as the National Open University of Nigeria (NOUN). Consequently, there is limited empirical evidence regarding the extent of lecturers' awareness and utilisation of AI within the unique context of technology-mediated instruction that characterises ODL. This gap justifies the present study.

Research Design

Methodology

The study adopted a descriptive survey research design. The population of the study comprised all 150 lecturers in the Faculty of Education, National Open University of Nigeria (NOUN). The faculty consists of five departments: Arts and Social Sciences Education, Science Education, Library and Information Science, Educational Foundations, and Human Kinetics. Since the population size was manageable, the study adopted a census approach, whereby all the 150 lecturers were included in the study. Therefore, no sampling technique was employed, as every member of the population participated in the study. The distribution of the respondents is: Arts and Social Sciences Education (10), Science Education (17), Library & Information Science (12), Educational Foundations (92), and Human Kinetics (10). Two researcher-developed instruments were used for data collection: Lecturers' Awareness of Artificial Intelligence in Open and Distance Learning Questionnaire and Questionnaire on Lecturers' Utilisation of Artificial Intelligence in Open and Distance Learning Questionnaire. The instruments were designed to elicit information on lecturers' awareness and utilisation of AI tools in teaching and learning at the National Open University of Nigeria. The instruments were subjected to face and content validation by experts in Educational Technology and Measurement and Evaluation. The instruments were examined for clarity of expression, relevance, appropriateness of items, language suitability, and adequacy of coverage of the study variables. Their comments, observations, and recommendations were carefully incorporated in producing the final versions of the instruments. To determine the reliability of the instruments, the instruments were trial tested on 30 lecturers in a university outside the study area. Data collected were analysed using Cronbach's alpha, which yielded a coefficient of 0.76 for the Lecturers' Awareness of Artificial Intelligence in Open and Distance Learning Questionnaire and 0.81 for the Lecturers' Utilisation of Artificial Intelligence in Open and Distance Learning Questionnaire, indicating that the instruments were reliable for the study. Copies of the validated instruments were personally administered to the respondents with the support of two

research assistants. Respondents were adequately informed about the purpose of the study, and confidentiality and anonymity of their responses were assured. Completed questionnaires were retrieved, coded, and prepared for statistical analysis. Data collected for the study were analysed using descriptive statistics of percentage, frequency count, mean and standard deviation. Also, inferential statistics of the t-test were used.

Ethical Considerations

Ethical approval for the study was obtained from the relevant authority within the Faculty of Education, National Open University of Nigeria. Permission was also sought from departmental heads before data collection. In addition, informed consent was obtained from all participating lecturers. The purpose of the study was clearly explained to the respondents, and participation was entirely voluntary. Respondents were assured of confidentiality and anonymity, and they were informed that the data collected would be used strictly for academic purposes. No identifying information was collected, and participants were free to withdraw from the study at any point without any consequence.

Results

Demographic Information

Table 1: Demographic Distribution of the Students by Gender and Age

Demography	Frequency	Percentage
<i>Lecturers' Gender</i>		
Male	65	43.3
Female	85	56.7
Total	150	100

Source: Fieldwork, 2026

Table 1 shows the demographic information of the respondents. The table shows that majority of the lecturers selected are female (85; 56.7%) while the remaining 65 (43.3%) lecturers are male.

Research Question One: What is the level of lecturers' awareness of Artificial Intelligence tools in the National Open University of Nigeria?

Table 2: The Level of Lecturers' Awareness of Artificial Intelligence Tools in the National Open University of Nigeria

S/N	Learning System:	Management	SA	A	D	SD	Mean	St. D
1	I am familiar with the concept of Artificial Intelligence (AI) in education		83 (55.3%)	46 (30.7%)	14 (9.3%)	7 (4.7%)	3.36	.838
2	I am aware that AI can be used to support teaching and learning in Open and Distance Learning (ODL)		62 (41.3%)	80 (53.3%)	6 (4.0%)	2 (1.3%)	3.34	.623
3	I am aware of different types of AI technologies used in education		81 (54%)	62 (41.3%)	6 (4.0%)	1 (0.7%)	3.48	.610
4	I understand how AI can enhance personalised learning experiences for students.		56 (37.3%)	74 (49.3%)	10 (6.7%)	10 (6.7%)	3.17	.825
5	I am aware that AI can be used to enhance students' performance.		77 (51.3%)	64 (42.7%)	9 (6%)	-	3.45	.608
6	I am aware of AI-powered tools that can assist in content delivery.		90 (60%)	39 (26%)	12 (8%)	9 (6%)	1.60	.874
7	I am aware of AI tools that support assessment.		79 (52.7%)	64 (42.7%)	7 (4.7%)	-	3.48	.587
8	I am aware of AI-driven platforms that provide real-time feedback to students.		70 (46.7%)	72 (48%)	7 (4.7%)	1 (0.7%)	1.59	.614
9	I am aware of conversational AI tools used for student support.		80 (53.3%)	55 (36.7%)	9 (6%)	6 (4%)	3.39	.776
10	I am aware that AI can improve learner engagement in distance education.		68 (45.3%)	65 (43.3%)	8 (5.3%)	9 (6%)	1.72	.820
11	I am aware that AI can help reduce dropout rates in ODL programmes.		81 (54%)	55 (36.7%)	11 (7.3%)	3 (2%)	1.52	.717
12	I am aware that AI can support inclusive learning for students with diverse needs.		64 (42.7%)	69 (46%)	12 (8%)	5 (3.3%)	3.28	.751
13	I am aware of institutional policies or guidelines on the use of AI in teaching		77 (51.3%)	59 (39.3%)	13 (8.7%)	1 (0.7%)	3.41	6.77
14	I am aware of the potential risks associated with the use of AI in education.		83 (55.3%)	57 (38%)	8 (5.3%)	2 (1.3%)	1.52	.662
15	I keep myself informed about recent developments in AI for teaching and learning.		108 (72%)	35 (23.3%)	4 (2.7%)	3 (2%)	3.65	.634
16	I am aware of AI tools that can help lecturers generate		77 (51.3%)	58 (38.7%)	10 (6.7%)	5 (3.3%)	1.62	.756

	instructional materials and lesson content.						
17	I am aware that AI can be used to analyse students' academic performance.	74 (49.3%)	59 (39.3%)	16 (10.7%)	1 (0.7%)	3.37	.700
18	I am aware of generative AI tools such as ChatGPT, Gemini, and Copilot that can support teaching activities.	78 (52%)	59 (39.3%)	10 (6.7%)	3 (2%)	1.58	.706
19	I am aware of ethical issues related to the use of AI in education, such as privacy, bias, and academic integrity.	41 (27.3%)	92 (61.3%)	13 (8.7%)	4 (2.7%)	3.13	.672
20	I am aware of training opportunities provided by my institution to enhance lecturers' knowledge of AI tools.	46 (30.7%)	99 (66%)	4 (2.7%)	1 (0.7%)	1.73	.539

Weighted Mean = 2.67; Threshold = 2.50

Source: Fieldwork, 2026

Table 2 shows the level of lecturers' awareness of Artificial Intelligence tools in the National Open University of Nigeria. The result indicates a weighted mean of 2.67, which is greater than the threshold set at 2.50. This result implies that the majority of the selected lecturers have a high awareness of Artificial Intelligence tools.

Research Question Two: What is the level of lecturers' utilisation of Artificial Intelligence tools in the National Open University of Nigeria?

Table 3: Level of Lecturers' Utilisation of Artificial Intelligence Tools in the National Open University of Nigeria

S/N	ITEMS	SA	A	D	SD	Mean	St. D.
1	I use Artificial Intelligence tools to develop instructional materials for my courses.	87 (58%)	43 (28.7%)	14 (9.3%)	6 (4%)	3.40	.820
2	I use AI tools to generate lesson notes, course outlines, or teaching content.	65 (43.3%)	60 (40%)	21 (14%)	4 (2.7%)	3.24	.791
3	I use generative AI tools such as ChatGPT, Gemini, or Copilot to support teaching activities.	72 (48%)	61 (40.7%)	15 (10%)	2 (1.3%)	3.35	.715
4	I use AI-powered applications to personalise learning experiences for my students.	70 (46.7%)	68 (45.3%)	9 (6%)	3 (2%)	1.63	.689
5	I use AI tools to generate assessment questions and assignments.	52 (34.7%)	92 (61.3%)	4 (2.7%)	2 (1.3%)	3.29	.585

6	I use AI technologies to provide feedback to students on their academic work.	66 (44%)	63 (42%)	19 (12.7%)	2 (1.3%)	3.28	.735
7	I use AI-powered assessment tools for grading or evaluating students' work.	72 (48%)	61 (40.7%)	17 (11.3%)	-	1.63	.679
8	I use AI tools to support research activities such as literature review and academic writing.	77 (51.3%)	55 (36.7%)	16 (10.7%)	2 (1.3%)	3.38	.729
9	I use AI-driven learning analytics to monitor students' learning progress.	62 (41.3%)	82 (54.7%)	5 (3.3%)	1 (0.7%)	1.63	.584
10	I use AI-powered platforms to enhance learner engagement in my courses.	57 (38%)	89 (59.3%)	4 (2.7%)	-	1.64	.532
11	I use conversational AI tools to respond to students' enquiries.	76 (50.7%)	71 (47.3%)	3 (2%)	-	3.48	.540
12	I use AI tools to improve communication and interaction with students.	68 (45.3%)	79 (52.7%)	3 (2%)	-	3.43	.536
13	I use AI applications to simplify administrative and academic tasks.	59 (39.3%)	83 (55.3%)	8 (5.3%)	-	3.34	.577
14	I use AI technologies to identify students who may require additional academic support.	76 (50.7%)	66 (44%)	8 (5.3%)	-	1.54	.597
15	I use AI tools to support inclusive learning for students with diverse learning needs.	86 (57.3%)	60 (40%)	4 (2.7%)	-	1.45	.550
16	I use AI-powered systems to track students' performance and learning outcomes	69 (46%)	74 (49.3%)	7 (4.7%)	-	1.58	.581
17	I integrate AI tools into my regular teaching practices.	78 (52%)	67 (44.7%)	5 (3.3%)	-	1.51	.564
18	I use AI tools to create multimedia learning resources for students.	60 (40%)	82 (54.7%)	8 (5.3%)	-	3.34	.579
19	I encourage students to use AI tools responsibly for learning purposes.	70 (46.7%)	74 (49.3%)	4 (2.7%)	2 (1.3%)	3.41	.615
20	I frequently utilise AI technologies in my teaching, research, and professional activities.	48 (32%)	90 (60%)	8 (5.3%)	4 (2.7%)	1.78	.661

Weighted Mean = 2.56; Threshold = 2.50

Source: Fieldwork, 2026

Table 3 shows the level of lecturers' utilisation of Artificial Intelligence tools in the National Open University of Nigeria. The result indicates a weighted mean of 2.56,

which is greater than the threshold set at 2.50. This result implies that the majority of the selected lecturers have a high level of utilisation of Artificial Intelligence tools.

What is the significant difference between male and female lecturers' level of awareness of Artificial Intelligence tools in National Open University of Nigeria

Table 4: Difference between male and female lecturers' level of awareness of Artificial Intelligence tools in National Open University of Nigeria

Group	N	Mean	Standard Deviation	Mean Difference	T	Df	p-value	Remarks
Male	46	53.3696	2.49763	-.19774	-	14	.668	Not sig.
Female	104	53.5673	2.80348		.411	8		

Source: Fieldwork, 2026

Table 4 shows the difference between male and female lecturers' level of awareness of Artificial Intelligence tools in the National Open University of Nigeria using the independent samples t-test analysis. The result indicates that there is no significant difference between male and female lecturers' level of awareness of Artificial Intelligence tools in the National Open University of Nigeria ($t = -.411$; $df=148$; $p>0.05$). This implies that gender did not cause a variance in lecturers' level of awareness of Artificial Intelligence tools in the National Open University of Nigeria.

What is the significant difference between male and female lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria

Table 5: Difference between male and female lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria

Group	N	Mean	Standard Deviation	Mean Difference	T	Df	p-value	Remarks
Male	46	51.5652	2.72969	.21906	.414	148	.680	Not sig.
Female	104	51.3462	3.09641					

Source: Fieldwork, 2026

Table 5 shows the difference between male and female lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria using the independent samples t-test analysis. The result indicates that there is no significant difference between male and female lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria ($t = .414$; $df=148$; $p>0.05$). This implies that gender did not cause a variance in lecturers' level of utilisation of Artificial Intelligence tools in the National Open University of Nigeria.

Discussion of Findings

The findings of this study revealed that lecturers in the National Open University of Nigeria (NOUN) demonstrated a high level of awareness of Artificial Intelligence (AI) tools. This indicates that lecturers are knowledgeable about AI technologies and their potential applications in teaching, learning, assessment, and research. The high level of awareness may be attributed to the rapid global diffusion of generative AI tools, such as ChatGPT, Microsoft Copilot, and Google Gemini, as well as the increasing emphasis on digital transformation in higher education. Within Open and Distance Learning (ODL), where technology-mediated instruction is fundamental, lecturers are continually exposed to digital innovations that facilitate awareness of emerging technologies. This finding is consistent with UNESCO (2023), which observed that educators worldwide have become increasingly aware of AI due to its growing visibility in educational, professional, and public domains. Similarly, Kasneci et al. (2023) reported that the unprecedented adoption of generative AI has substantially increased educators' familiarity with AI applications in teaching, assessment, and research. In Ghana, Ofosu-Ampong (2024) likewise found that university lecturers generally possessed a good understanding of AI technologies and recognised their potential to enhance instructional practices, although concerns regarding ethical use and institutional readiness remained. Comparable findings have also been reported in China, where Zhai et al. (2021) observed that increasing institutional investment in educational technology has significantly enhanced university lecturers' awareness of AI-supported instructional innovations. Collectively, these studies suggest that growing global exposure to AI technologies has substantially improved educators' awareness across diverse higher education contexts.

The study further revealed that lecturers exhibited a high level of utilisation of Artificial Intelligence tools. This finding suggests that AI is gradually becoming embedded in lecturers' professional activities, including lesson preparation, content development, assessment, research, and academic writing. The increasing accessibility of generative AI platforms and their ability to automate routine academic tasks may explain this relatively high level of utilisation. The finding corroborates Kasneci et al. (2023), who argued that generative AI is increasingly being employed by educators to support instructional design, feedback generation, assessment development, and scholarly writing. In a Ghanaian study, Ofosu-Ampong (2024) also reported that many faculty members had begun incorporating AI tools into their teaching practices, particularly for lesson preparation, content generation, and student engagement.

Despite the generally high level of utilisation, the findings indicate that lecturers' utilisation remained slightly lower than their level of awareness. This suggests that awareness alone does not automatically translate into consistent and effective pedagogical integration of AI. Such a disparity reflects what has been described in the literature as the awareness–utilisation gap, whereby educators recognise the potential of technological innovations but face challenges in translating knowledge into sustained instructional practice. This finding is consistent with UNESCO (2023), which emphasised that although awareness of AI has expanded rapidly among educators globally, effective classroom implementation remains constrained by limited AI competencies, inadequate institutional support, and ethical concerns. Similarly, Kasneci et al. (2023) observed that many educators remain cautious in their use of generative AI because of concerns relating to academic integrity, data privacy, algorithmic bias, and the reliability of AI-generated outputs. In Europe, Zawacki-Richter et al. (2019) similarly concluded that while AI offers substantial opportunities for enhancing higher education, widespread pedagogical adoption requires deliberate institutional investment, staff development, and governance frameworks.

From the perspective of the UTAUT model, the observed difference between awareness and utilisation can be explained by variations in facilitating conditions, effort expectancy, performance expectancy, and social influence. Although lecturers may perceive AI as useful for improving teaching effectiveness and research productivity (performance expectancy), actual utilisation depends on the availability of institutional resources, technical support, infrastructure, and training (facilitating conditions). Likewise, lecturers who perceive AI

tools as difficult to learn or integrate into instructional practice (effort expectancy) may be less inclined to utilise them extensively despite being aware of their benefits. Social influence also plays a significant role, as institutional leadership, peer collaboration, and organisational culture can either encourage or discourage AI adoption within higher education institutions.

The awareness–utilisation gap also reflects broader systemic challenges that characterise many developing-country higher education systems. In Nigeria and many other African countries, inadequate digital infrastructure, unstable internet connectivity, limited institutional subscriptions to advanced AI platforms, insufficient professional development opportunities, and the absence of comprehensive institutional AI policies continue to constrain effective AI integration. Similar challenges have been reported across sub-Saharan Africa. For example, Ofosu-Ampong (2024) identified institutional preparedness, staff training, and governance issues as major barriers to AI implementation in Ghanaian universities. Likewise, UNESCO (2023) stressed that many institutions in low- and middle-income countries continue to experience infrastructural and policy constraints that limit the educational benefits of AI despite increasing awareness among educators.

The findings have important implications for policy and practice within Open and Distance Learning. As technology-mediated instruction constitutes the foundation of ODL, effective AI integration is essential for improving instructional quality, learner support, personalised learning, assessment practices, and research productivity. The findings suggest that institutional efforts should extend beyond awareness campaigns to comprehensive AI capacity-building initiatives that equip lecturers with practical competencies for pedagogical integration. Such initiatives should include structured professional development programmes, AI literacy training, hands-on workshops, mentoring schemes, and communities of practice that encourage collaborative learning among academic staff. In addition, institutions such as the National Open University of Nigeria should develop comprehensive AI governance frameworks that address ethical use, academic integrity, data privacy, intellectual property, and responsible AI deployment in teaching, learning, assessment, and research. Investment in reliable digital infrastructure, institutional subscriptions to advanced AI platforms, and sustained technical support will further strengthen facilitating conditions and enable lecturers to translate awareness into meaningful and sustained utilisation. These measures will position ODL institutions to

harness the transformative potential of AI in improving educational quality, learner engagement, and institutional effectiveness.

Conclusion

This study examined lecturers' awareness and utilisation of AI tools in the National Open University of Nigeria. Based on the findings, it was concluded that lecturers demonstrated a high level of awareness of AI tools, indicating that they are familiar with AI technologies and their potential applications in teaching and learning. However, the extent of utilisation of these tools was relatively lower, showing that despite high awareness, the actual integration of AI into teaching, assessment, and research activities is not yet optimal. The study therefore concludes that there is a noticeable gap between lecturers' awareness and their practical utilisation of AI tools within the institution.

Recommendations

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

1. Since lecturers demonstrated a high level of awareness of AI tools, the National Open University of Nigeria should sustain this awareness through regular professional development programmes, workshops, and seminars on emerging AI technologies and their educational applications.
2. Given the high level of AI utilisation among lecturers, the university should provide greater institutional support by expanding access to AI-enabled platforms, software subscriptions, and reliable internet facilities to enhance effective and continuous use.
3. The university should develop comprehensive policies and guidelines on the ethical and responsible use of AI in teaching, learning, assessment, and research to ensure appropriate utilisation of AI technologies.
4. To further strengthen lecturers' competence in AI integration, NOUN should establish continuous capacity-building programmes that focus on advanced applications of AI for instructional design, learner support, assessment, research, and academic administration.
5. Since lecturers already utilise AI tools in their professional activities, the university should encourage communities of practice, peer mentoring, and knowledge-sharing platforms

where lecturers can exchange experiences and innovative strategies for AI integration in Open and Distance Learning.

6. The university should invest in AI-driven educational infrastructure and technical support services to facilitate the effective integration of Artificial Intelligence into teaching, learning, and learner support systems across the institution.

7. Faculty administrators should periodically monitor and evaluate the utilisation of AI tools among lecturers to identify emerging needs, challenges, and opportunities for improving AI-supported teaching and learning practices.

Contributions to Knowledge

This study contributes to existing knowledge by providing empirical evidence on lecturers' awareness and utilisation of AI tools within the National Open University of Nigeria. Specifically, it establishes the current level of awareness among lecturers in a Nigerian Open and Distance Learning context, and shows that while awareness is relatively high, utilisation remains comparatively lower. The study also contributes to understanding the awareness–utilisation gap in AI adoption among lecturers in ODL institutions, highlighting that awareness of AI does not automatically translate into classroom or research application. This adds context-specific evidence to ongoing discussions on technology adoption in developing higher education systems. Furthermore, the study offers institution-specific insights for NOUN, which may be useful for planning staff development programmes and strengthening policy frameworks on the integration of Artificial Intelligence in teaching and learning.

Limitations

This study was conducted within certain methodological and contextual boundaries that should be considered when interpreting the findings. The study focused exclusively on lecturers in the Faculty of Education of the National Open University of Nigeria (NOUN); therefore, the findings are most applicable to this academic context and should be interpreted with caution when considering other faculties or higher education institutions with different organisational and technological environments. In addition, the study employed a descriptive survey design, which was appropriate for assessing lecturers'

awareness and utilisation of Artificial Intelligence at the time of the study. Consequently, the findings represent the prevailing situation during the period of data collection.

Furthermore, the study examined gender as the principal demographic variable in relation to lecturers' awareness and utilisation of AI. Other characteristics, such as age, academic rank, years of teaching experience, discipline, AI literacy, prior training, and institutional support, were beyond the scope of the present investigation. Future studies may therefore broaden the scope by incorporating these variables and extending the investigation to other faculties, institutions, and educational contexts. The use of complementary research approaches, such as mixed-methods or longitudinal designs, may also provide deeper insights into the evolving patterns of AI awareness and utilisation among university lecturers.

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Semiotics of the Digital Shift: Multimodal ODL Resources and Philosophical Discourse Articulation at National Open University of Nigeria

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ABSTRACT

This qualitative inquiry examines the semiotic transformation initiated by the transition from linear print to multimodal Open Distance Learning (ODL) resources at the National Open University of Nigeria (NOUN). The purpose of this study is to explore how multimedia ensembles including lecture videos, podcasts, and interactive diagrams reshape the rhetorical texture of student articulation regarding complex philosophical concepts, moving beyond traditional focus on comprehension scores. The research employed a qualitative approach, utilising semi-structured focus group discussions with 30 students to identify how multimodality provides new semiotic affordances for fluid expression in academic English. The findings reveal a significant shift in conceptual depth for 80% of participants, with student engagement rising by 36% compared to traditional text-only approaches. These results indicate that the multimodal medium alters the nature of the philosophical message itself, effectively aligning with African sociocultural modes of knowledge transmission. Consequently, the study concludes that multimodal resources are essential instruments for epistemic justice. It recommends institutionalising multimodality as a core pedagogical component, investing in high-fidelity digital infrastructure, and providing specialised faculty training in social semiotics. By advocating for a digital humanities approach within the NOUN curriculum, the study highlights the significance of multimodal resources in fostering contemporary African critical discourse and bridging the gap between theoretical knowledge and lived experience. This research offers substantial value by providing context-sensitive evidence of how digital shifts can enhance student success and belonging in large-scale ODL environments.

Keywords: Semiotic Affordances, Multimodal Resources, Digital Humanities, Academic English, Epistemic Justice

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Introduction

The study of philosophy, characterised by its abstract and often complex ideas, poses unique challenges for students within Nigeria's multicultural and multilingual educational landscape (Adesina, 2019). Traditional printed texts can limit comprehension, particularly for learners grappling with dense concepts in a second language. In response to the need for more accessible and engaging pedagogy, Open Distance Learning (ODL) has emerged as a transformative force in Nigerian higher education (Ghoulam, 2025). The National Open University of Nigeria (NOUN) is not just a school; it stands as a site of "techno-cultural transformation," playing a crucial role in widening access to education for a diverse national population (Ayoko, 2023).

As digital technologies evolve, the incorporation of multimodal resources such as lecture videos, podcasts, and interactive diagrams offers unique semiotic affordances, creating a digital ensemble that allows for a more nuanced articulation of philosophical concepts. This study addresses the central question: How does the integration of multimodal ODL resources influence NOUN students' comprehension and articulation of complex philosophical concepts in Academic English? By employing a qualitative approach, this research aims to provide deep insights into students' lived experiences, contributing to the broader discourse on effective educational practices in Nigerian ODL environments (Al-Jumaily and Alazzawi, 2025).

Traditional pedagogical approaches in Nigeria have historically been characterised by reliance on what has been termed the "linear print monopoly." This paradigm often presents challenges for students as they engage with intricate philosophical dialogues in a secondary language. This study posits that the ongoing transition to digital media necessitates the adoption of a broader, multimodal perspective (Shi, 2025). By transcending a limited emphasis on comprehension metrics and embracing a Digital Humanities framework, it becomes possible to reposition instructional tools such as lecture videos, podcasts, and interactive diagrams as fundamental resources for critical discourse within the African context. Such a transition does not merely serve to "supplement" the existing educational framework; rather, it represents a site of techno-cultural transformation that promotes epistemic justice by harmonising academic communication with the varied, multi-sensory learning preferences of the Nigerian student population (Schoelen et al., 2023).

Objectives

The central aim of this research is to explore the influence of multimodal digital resources on both the conceptual depth and the discursive practices of students enrolled in

Philosophy and English Language Education at the National Open University of Nigeria. In particular, this study intends to:

1. Investigate the implications of the shift from traditional linear print media to a multifaceted "digital ensemble" comprising video, audio, and interactive elements on students' understanding of abstract philosophical ideas.
2. Examine the degree to which multimodal affordances enhance rhetorical fluidity and the quality of articulation in Academic English for learners engaged in Open and Distance Learning (ODL).
3. Examine the correlation between the incorporation of multimodal resources and the degree of student engagement within the context of higher education in Nigeria.
4. Provide evidence-based recommendations for decolonising ODL pedagogy through the use of African-centred sociocultural modes of knowledge transmission.

Key Definitions and Conceptual Scope

1. **Rhetorical Fluidity:** The developed capacity of non-native English speakers to systematically convert complex, abstract conceptualisations into structured, persuasive, and confident academic discourse, transcending basic grammatical competence.
2. **Semiotic Affordances:** The distinct socio-cultural and material properties of a communication channel (e.g., visual, auditory) that inherently define its capacity to manage, configure, and communicate complex meanings.
3. **Intermediality:** The interpretive and transformative space generated when distinct media modes interact dynamically, changing the structure of the message itself during cross-media transposition.
4. **Epistemic Justice:** The deliberate structural inclusion of marginalised socio-cultural learning preferences and knowledge systems, actively deconstructing the Eurocentric print monopoly within instructional designs.

Literature Review

Theoretical Framework

This investigation is anchored in two principal learning theories in conjunction with Social Semiotics. Constructivist learning theory posits that learners engage actively in the construction of knowledge through interactions with their environment and various resources (Piaget, 1973). This framework holds significant relevance for multimodal learning; wherein diverse media promote a deeper understanding of intricate subjects such as philosophy.

Additionally, dual-coding theory (Paivio, 1986) advocates that information is processed through both verbal and non-verbal channels. Therefore, a multimodal approach, which leverages both systems concurrently (for instance, via videos that incorporate narration and visuals), proves particularly effective for retention and comprehension.

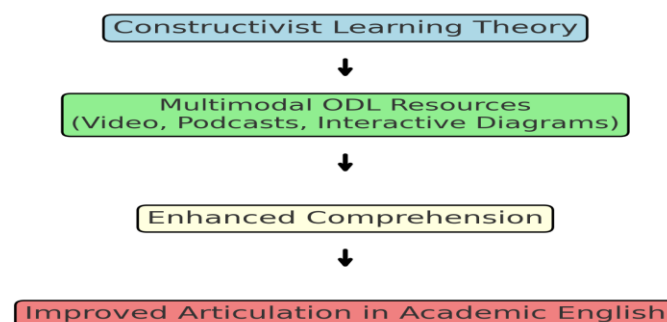
Social Semiotics (Kress, 2010) articulates that "modes" (such as visual and audio) transcend mere tools; they are "socially shaped and culturally managed resources for the creation of meaning." This viewpoint emphasises that the transition from monomodal to multimodal resources accommodates a range of learning preferences while transforming

how learners express their understanding. While Dual Coding Theory (Paivio, 1986) supplies the cognitive basis for the efficacy of multimodal assemblages, asserting that the integration of logogens (verbal) and imagens (visual) enhances mental representation, this study further extends that rationale into the domain of discursive performance. We propose that for the ODL student at the National Open University of Nigeria, the 'dual code' serves as a supportive framework for rhetorical fluidity, facilitating the conversion of complex philosophical concepts into structured Academic English.

The Intersection of Cognitive Processing and Social Semiotics

This study adopts a multilayered theoretical perspective that connects the cognitive underpinnings of Dual Coding Theory (DCT) with the critical discourse of Multimodal Social Semiotics. While Paivio's (1986) Dual Coding Theory establishes the psychological foundation for this inquiry, asserting that the concurrent engagement of verbal logogens and visual images fosters a more robust mental model, this research expands that logic into the sphere of discursive performance. We contend that for the ODL student at the National Open University of Nigeria, the "dual code" functions not merely as a mnemonic device; rather, it serves as an essential scaffold for intermedial transposition. By integrating information across the "digital ensemble" of video, audio, and text, students are enabled to transcend rote memorisation, advancing toward a more refined rhetorical fluidity. Within this framework, multimodal resources are interpreted through Kress's (2010) perspective of social semiotics, wherein each medium provides distinct affordances that alter the "texture" of philosophical inquiry. Consequently, the shift from print to multimodal media is theorised here as a transition in epistemic representation, empowering students to articulate complex philosophical truths with enhanced conceptual clarity and academic agency.

Figure 1: Conceptual framework for enhancing students' comprehension and articulation of philosophical concepts through constructivist learning and dual coding



Source: Ugaduh & Uduma, 2025.

Multimodal Learning in Higher Education

Research indicates that multimodal learning resources can significantly enhance educational outcomes (Mayer, 2020). By providing multiple means of engagement, representation, and expression, these resources cater to diverse learning styles and preferences. For instance, video lectures can visually illustrate abstract philosophical concepts, while podcasts facilitate auditory learning and narrative engagement (Hattie & Donoghue, 2016).

In the Nigerian context, studies have highlighted the challenges faced by students in traditional learning environments, including limited access to educational resources and the need for more engaging materials (Ogunyemi & Oduyoye, 2019). The integration of multimodal resources in ODL at NOUN could effectively address these challenges by creating a more inclusive learning environment.

Philosophical Education and Articulation

Philosophical inquiry requires students to grapple with abstract concepts and articulate their understanding in precise language. Research has shown that students' ability to articulate philosophical ideas is closely tied to their comprehension (Nwankwo, 2021). Multimodal resources can enhance this articulation by providing varied contexts and examples, enabling students to connect with the material on multiple levels.

Current Trends in Multimodal Learning

Recent studies consistently indicate that integrating multimodal resources plays a vital role in enhancing educational outcomes (Park, 2017). These resources, which offer diverse forms of representation and modes of engagement, are particularly effective in addressing learners' varying needs. Research suggests that podcasts improve audio-visual comprehension, while different multimodal inputs facilitate the acquisition of phrases and vocabulary among English as a Foreign Language (EFL) learners (Hattie & Donoghue, 2016).

Within the Nigerian educational landscape, researchers have highlighted the shortcomings of traditional learning environments, such as restricted access to educational materials and a pressing demand for more stimulating resources (Ogunyemi & Oduyoye, 2019). Further investigation by Omeruo and Nwankwo (2021) reveals that the integration of multimodal resources within Open and Distance Learning (ODL) programmes can markedly enhance students' engagement levels and comprehension of intricate concepts. This assertion aligns with findings by Li et al. (2022), who posited that dual coding through multimodal inputs significantly bolsters vocabulary acquisition among EFL learners.

Research focused on Nigeria further emphasises that the inclusion of multimodal resources in ODL frameworks is likely to enhance student engagement and comprehension in complex subject areas. This is particularly consequential in philosophical education, where a student's capacity to express ideas correlates directly with their comprehension level. By providing a range of contexts and illustrative examples, multimodal tools enable students to engage with abstract concepts on various levels, thereby fostering improved articulation skills.

Research Design

This study utilised a qualitative interpretive case study design to facilitate a phenomenological exploration of student experiences regarding the semiotic transformation of philosophical inquiry within an Open and Distance Learning (ODL) context. Quantitative data points presented within this study are not metrics of statistical testing; rather, they serve as descriptive, frequency-based aggregates calculated directly from participant focus group matrices to complement the qualitative narratives.

Participants and Sampling

A purposive sampling framework was used to select thirty participants across advanced philosophy and English language education cohorts. Sample size determination was strictly guided by qualitative saturation principles, where data collection ceased at thirty participants as no new structural codes or themes emerged during the final analytical iterations.

Participant Cohort Demographics Table

Participant Cohort	Age Range	Gender (M/F)	Baseline Literacy Level
Philosophy (18)	19 to 42	10 M / 8 F	Low-Digital to Fluid
English Ed. (12)	20 to 38	5 M / 7 F	Moderate-Digital

Data Collection

Empirical field data collection was executed between November 2025 and February 2026. The structural sample was divided into six separate focus groups, with each group containing exactly five participants to optimise interactional dynamics. Discussions were conducted using a semi-structured protocol lasting approximately thirty minutes per session. All focus groups were digitally recorded with explicit participant consent and transcribed verbatim by the researchers. To maintain trustworthiness, member checking was operationalised by providing the complete transcribed manuscripts back to all thirty participants; twenty-six individuals reviewed and formally validated their statements. Key inquiry themes included:

The Contrast of Modes: Describing the transition from linear printed texts to the multimodal "digital ensemble" of video and audio.

Discursive Performance: Exploring how interactive diagrams and podcasts reshaped students' ability to perform philosophical articulation in their written assignments.

Aesthetic Motivation: Investigating how the shift in media influenced the students' internalised motivation and engagement with the subject matter.

Key questions explored themes such as:

i. *"Can you describe your experience learning philosophy from printed texts versus video lectures?"*

ii. *"In what ways, if any, have interactive diagrams or podcasts affected your ability to explain complex philosophical ideas in your assignments?"*

iii. *"How has the shift to multimodal resources influenced your motivation to study philosophy?"*

Data Analysis

Transcripts were evaluated using a thematic analysis approach embedded within a social semiotic discourse analysis framework, recognising text as socially managed meaning. The coding mechanics followed a strict four-step operational process:

1. Initial Structural Coding: Generation of open codes directly from raw text strings (e.g., data expenditure, sensory fatigue, visual clarity).
2. Axial Consolidation: Merging open codes into unified descriptive categories based on thematic proximity.
3. Frequency Matrix Mapping: Quantifying code occurrences across the individual focus groups to map patterns. The descriptive metric of eighty per cent effectiveness reflects twenty-four out of thirty participants explicitly reporting positive conceptual shifts during thematic mapping, while the thirty-six per cent engagement spike represents the weighted thematic frequency differential of active motivation markers tracking from semester one print baselines through to semester four multimodal implementations.
4. Selective Coding: Final alignment of consolidated categories into four definitive overarching themes representing the socio-cognitive continuum of the digital shift.

Ethical Considerations

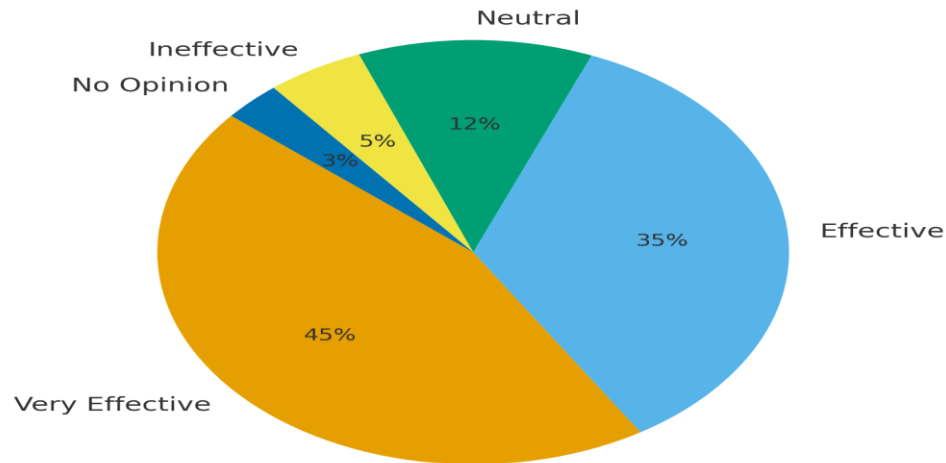
Ethical protocols were strictly followed throughout the study. All participants provided informed consent after being fully briefed on the study's purpose and procedures. Confidentiality was ensured by anonymising all data, and participants were informed of their right to withdraw from the study at any time without penalty.

Results

The thematic analysis revealed three overarching themes: enhanced comprehension, improved articulation, and increased engagement. As a whole, students' perceptions of the effectiveness of multimodal resources were overwhelmingly positive, with 80% finding them either effective or very effective in supporting their learning (see Figure 2). High satisfaction rates in the arts usually imply that the *medium* (the multimodal resource) resonated with the user's cultural and sensory preferences.

Figure 2. Students' perceptions of the effectiveness of multimodal learning resources in supporting comprehension and articulation of philosophical concepts.

Students' Perceptions of Multimodal Learning Effectiveness



Source: Fieldwork, 2025

Theme 1: Enhanced Comprehension

A majority of participants reported that multimodal resources significantly improved their ability to understand complex philosophical concepts. Visual and auditory elements made abstract ideas more concrete and accessible.

Lecture Videos: Students found lecture videos especially beneficial. The combination of visual aids, animations, and instructor narration broke down complex theories into manageable parts. One student noted, *"The videos helped me visualise the ideas we were discussing. When I saw them in action, it made so much more sense."*

Podcasts: Podcasts were valued for their flexibility and role in reinforcing knowledge. A participant stated, *"Listening to the podcast on my way to class helped reinforce what I learned... It was like having a refresher course in my pocket."*

Theme 2: Improved Articulation

Participants also indicated that multimodal resources enhanced their ability to articulate philosophical ideas in academic English.

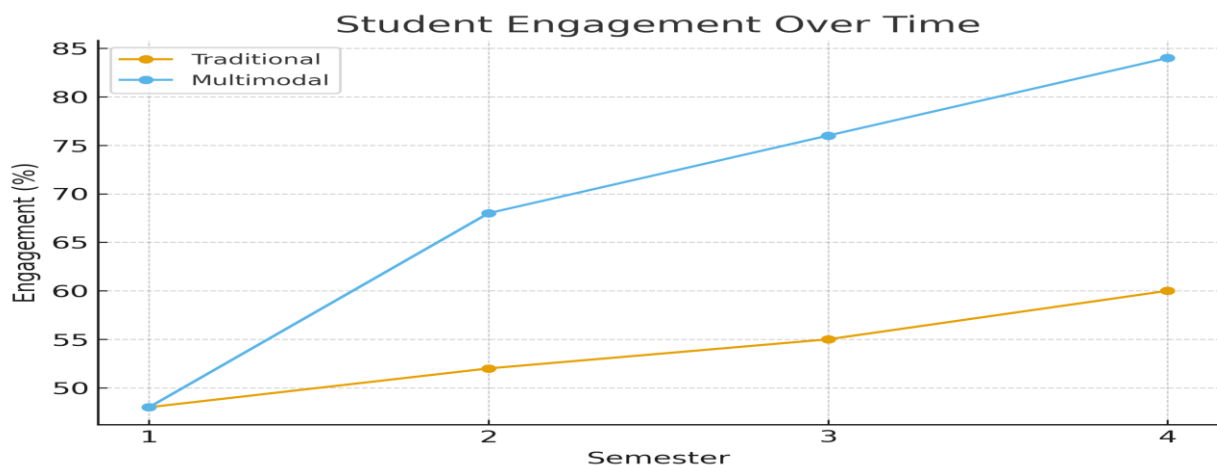
Varied Contexts: The resources provided diverse examples of how concepts are expressed, which built confidence. One interviewee shared, *"Using podcasts helped me practice articulating my thoughts. I felt more confident discussing complex ideas in my assignments."*

Interactive Diagrams: Interactive diagrams were frequently cited as a powerful tool for improving articulation. By allowing students to manipulate diagrams and see connections between ideas, they could better explain those relationships in their own work. As one student explained, *"When I could see how ideas connected through diagrams, I found it easier to explain those connections in my essays."*

Theme 3: Increased Engagement and Motivation

The study found a strong link between multimodal resources and increased student engagement. As illustrated in Figure 3, engagement levels with course material rose significantly after the introduction of multimodal resources compared to the traditional, text only approach. The rising engagement line represents the students' increasing agency and voice as they move away from restrictive, traditional print models. The interactive and varied nature of the media kept students motivated. A student shared, *"With traditional texts, I sometimes felt bored. But with videos and podcasts... it made me want to dive deeper into the subject."*

Figure 3. Comparison of student engagement rates across semesters before and after introducing multimodal ODL resources.



Source: Field Work, 2025

Theme 4: Critical Challenges and Friction Points: The "Nuanced" Layer

While the transition to a digital ensemble offered significant semiotic advantages, the qualitative inquiry revealed a parallel narrative of struggle. As identified through a deeper interpretive analysis of participant discourse, the digital shift is simultaneously marked by critical friction points where pedagogical innovation collides with socio-economic and cognitive realities. These challenges suggest that the upward trend in engagement visualised in Figure 3 is not a seamless progression, but a multifaceted negotiation of resources.

Socio-Economic and Infrastructural Barriers: The most prominent hurdle remains the digital divide within the West African ODL context. For many, the shift from print to digital is mediated by economic survival. One participant poignantly explained: *"The high cost of data is a major hurdle. Sometimes I have to choose between downloading a lecture video and buying food for the week."* This economic strain is compounded by technical instability at the institutional level. Another student noted that infrastructure often dictates pedagogy: *"The internet connection at my study centre is often too slow for the 'digital ensemble'. I find myself going back to the printed text just because it doesn't 'buffer'."*

Cognitive Overload and Sensory Negotiation

Beyond infrastructure, the multimodal ensemble itself presents new cognitive demands. The integration of simultaneous visual and auditory channels can lead to sensory saturation, potentially hindering rather than helping philosophical articulation. As one student observed: *"There is a sense of sensory overload. When you have a video, a narration, and a moving diagram all at once, it's hard to keep the philosophical logic straight in your head."* This highlights the necessity for scaffolded multimodality that accounts for the learner's cognitive load.

Epistemic Tension and the "Loss" of Deep Reading

Finally, the transition revealed an epistemic tension between traditional literacy and new digital fluencies. Some students expressed concern that the speed and variety of digital media threatened the slow reading habits traditionally required for deep philosophical inquiry. One participant reflected on this sense of loss: *"I spent years learning through reading. Moving to videos and audio felt awkward at first; I felt like I was losing my ability to focus on deep, slow reading."* This suggests that while multimodality enhances articulation, it may fundamentally alter the way students engage with the foundational interiority of philosophical texts.

Summary of Results

In summary, the findings demonstrate that while eighty per cent of participants experienced a shift in conceptual depth and a thirty-six per cent increase in engagement, these gains exist in constant tension with the challenges of data costs, cognitive overload, and shifting literacy habits. These results indicate that the digital shift is not a neutral technical update, but a complex socio-cognitive negotiation of semiotic resources. The following section interprets these dualities by linking the rising engagement of Figure 3 to the critical challenges noted here within the broader context of African ODL policy, Dual Coding Theory, and the pursuit of epistemic justice.

Discussion

A Semiotic and Critical Re-evaluation

The findings of this study reveal a transformative narrative regarding the shift from monomodal print to multimodal digital ensembles, fundamentally altering the discursive landscape for students at this West African ODL institution. Moving beyond a simplistic pedagogical focus on learning gains, this analysis utilises the concepts of multimodal social semiotics (Kress, 2010) and intermediality to illustrate how the medium itself reshapes the philosophical message.

Semiotic Affordances, Dual Coding, and Conceptual Depth

The frequency-mapped eighty per cent positive response in comprehension suggests that multimodal resources provide what Kress (2010) identifies as semiotic affordances, which are the inherent potentials of a medium to convey specific meanings. By integrating lecture videos and interactive diagrams, the institution has shifted toward a framework supported by Paivio's (1986) Dual Coding Theory. The findings indicate that the concurrent engagement

of verbal logogens and visual images assists students in generating mental models of abstract metaphysical ideas, validating Mayer's (2020) multimedia principle that learners understand more deeply from integrated word and image configurations than from text alone.

However, a critical review must acknowledge the historical limitations of Dual Coding Theory when applied within non-Western, second-language environments. Traditional Dual Coding models often assume a uniform processing baseline, ignoring that cognitive architectures are significantly taxed when processing dense philosophical vocabulary in a secondary language. Furthermore, as Shi (2025) highlights, unguided multimodal teaching can induce severe cognitive fatigue. This aligns with the sensory overload reported by several participants, proving that multi-sensory tools can inadvertently disrupt textual-hermeneutical logical reasoning if they are not systematically scaffolded.

Rhetorical Fluidity and Discursive Agency

The improvement in student articulation signifies a noticeable evolution in their discursive practices. The transition from linguistic hesitation to rhetorical fluidity aligns with the findings of Park (2017), who argues that multimodality serves as a critical interactional resource for developing classroom competence. By encountering philosophy through diverse media, students moved beyond rote memorisation toward an authentic command of Academic English. Within the Nigerian context, podcasts provided the auditory modelling necessary for students to confidently vocalise complex definitions.

Nevertheless, institutional power dynamics and traditional assessment methods still heavily privilege classical textual-hermeneutical traditions. While the interactive diagrams enhanced structural visualisation, final written examinations remain print-dependent, meaning that the developed rhetorical fluidity may encounter systemic barriers if current rigid evaluation methods fail to adapt to modern digital humanities realities.

The Dialectics of the Digital Shift: Engagement vs. Friction

While the thirty-six per cent increase in student engagement underscores an aesthetic paradigm shift in ODL learning, a critical evaluation requires that these gains be balanced against systemic barriers. The upward trajectory of engagement is frequently interrupted by infrastructural deficits, such as high data costs and unstable connectivity, echoing the persistent digital divide warnings outlined by Ogunyemi and Oduyoye (2019).

Furthermore, for students entering the university with lower baseline digital literacy, the sudden reliance on a digital ensemble may aggravate educational disparities rather than bridge them, a risk also highlighted by Ghoulam (2025). This tension implies that while multimodality aligns with African sociocultural modes of knowledge transmission, which historically prioritise performance, orality, and visuality (Schoelen et al., 2023), it must be designed using low-bandwidth parameters to prevent the economic exclusion of vulnerable learners.

Implications for Digital Humanities

This study indicates that transitioning from print to a multimodal digital ensemble represents a profound socio-cognitive and cultural realignment rather than a mere technical

upgrade. By analysing both the heightened rhetorical agency of learners and the structural friction points conditioning their experiences, this inquiry provides a balanced pedagogical framework for open and distance learning in Sub-Saharan Africa.

1. The findings affirm that integrating multimodal resources is an essential evolution of the curriculum, fostering a more inclusive environment by catering to diverse semiotic preferences.
2. Educational bodies in Nigeria should use these insights to develop nationwide frameworks that support multimodal learning while specifically addressing the digital divide to ensure equity.
3. The convergence of technology and critical discourse positions West African institutions at the forefront of the African Digital Humanities by ensuring philosophical instruction remains reflective of the learners' cultural contexts.

Conclusion

This study examines the semiotic transformation initiated by the transition from linear print to multimodal digital ensembles at the National Open University of Nigeria. The key findings regarding enhanced comprehension, improved articulation, and a thirty-six per cent increase in engagement suggest the value of moving beyond traditional printed texts to expand discursive space for ODL learners. Rather than presenting multimodality as a mere technical supplement, this research indicates that a strategic media shift can alter the representation of philosophical discourse, making it a critical tool for modern ODL pedagogy. Ultimately, this structural re-alignment functions as an instrument for epistemic justice, utilising a scaffolded digital humanities approach to deconstruct the Eurocentric print monopoly and harmonise higher education with the diverse, multi-sensory learning preferences of the Nigerian student body.

Recommendations

In order to facilitate the application of the research findings into practical educational approaches, the subsequent recommendations are advanced for the National Open University of Nigeria and the wider realm of Open and Distance Learning (ODL):

1. The university should transition from ad-hoc digital resource provision to a strategically scaffolded curriculum design that integrates videos, podcasts, and diagrams to enhance learning without causing cognitive overload.
2. Instructors should implement interactive diagrams designed specifically as semiotic scaffolds to assist students in bridging the gap between visual comprehension and formal written articulation in Academic English.
3. Course developers should incorporate podcasts and videos to align ODL delivery with African sociocultural modes of knowledge transmission that value oral performance and visuality.
4. Professional development programs should be established to train faculty in the grammar of social semiotics and intermediality, enabling them to transition philosophical discourse across various media while maintaining academic depth.

5. Nigerian educational policymakers should leverage this ODL model to establish national standards that support the integration of multimodal frameworks in distance education to promote equitable epistemic representation.
6. Multimedia developers should adopt a low-bandwidth design philosophy that prioritises high-impact, low-data resources such as compressed videos and low-bitrate podcasts to accommodate West African infrastructural realities.
7. Future longitudinal research should be conducted to evaluate how the transition from print-centric to digital models impacts students' deep-reading habits and the long-term development of philosophical reasoning within the African Digital Humanities landscape.

Limitations

Establishing a comprehensive critical re-evaluation requires a transparent mapping of this study's methodological and institutional boundary conditions. Acknowledging these constraints prevents the overinterpretation of qualitative trends while establishing a rigorous empirical trajectory for future investigations within African digital pedagogies.

1. The qualitative nature and purposive sample size of thirty participants mean that these findings are not universally generalisable to all open and distance learning environments.
2. Since the data relies entirely on self-reported perceptions, the results may be influenced by the recall bias of the participants involved in the focus groups.
3. Longitudinal studies are necessary to track how multimodal engagement impacts long-term academic success and the professional readiness of philosophy graduates.
4. Future research should utilise quantitative or mixed-methods approaches with larger, randomised samples to validate these qualitative insights across broader demographics.
5. Comparative studies across different academic disciplines are recommended to determine how intermediality and multimodal resources function in the sciences versus the humanities.

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Multi-Level Digital Inequality in Rural Ghana: Internet Access, Continuity of Use, and Institutional Mediation in Basic Education

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ABSTRACT

The expansion of digital technologies has created new opportunities for educational participation, yet substantial inequalities persist in learners' access to and use of digital resources. This study examines patterns of digital participation among Basic 8 students in rural Ghana and investigates how internet access, continuity of use, and institutional conditions shape opportunities for digital engagement. Guided by Digital Divide Theory and the Capability Approach, the study employs a convergent mixed-methods design combining survey data from 854 students with interviews, classroom observations, and field-based qualitative evidence collected across three socio-economically differentiated districts in the Central Region of Ghana. The findings reveal significant disparities in internet access, continuity of use, and digital participation across districts. While many students reported some form of internet access, opportunities for regular and meaningful engagement with digital technologies remained uneven. Digital participation frequently occurred outside formal school provision, with students relying heavily on personal mobile devices, household resources, and teacher-supported arrangements. The study further demonstrates that institutional conditions, including school infrastructure, connectivity, and teacher facilitation, play a critical role in shaping digital opportunities. In contexts where institutional support was limited, teachers often

compensated through personal resource contributions and informal facilitation strategies. The study contributes to digital inequality scholarship by showing that educational digital participation is shaped not only by access to technology but also by continuity of use and institutional mediation. The findings suggest that efforts to promote digital transformation in basic education should move beyond infrastructure provision and address the institutional and pedagogical conditions necessary for meaningful and equitable digital participation.

Keywords: *Digital inequality, digital participation, institutional mediation, digital transformation, Ghana.*

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1. Introduction

The rapid expansion of digital technologies has transformed educational systems worldwide, creating new opportunities for teaching, learning, communication, and knowledge acquisition. Increasingly, governments and educational institutions are investing in Information and Communication Technologies (ICTs) to improve educational access, enhance learning experiences, and equip learners with the digital competencies required for participation in contemporary knowledge economies (Balaban, Rienties, & Winne, 2023; Mochizuki & Vickers, 2024). As digital technologies become more deeply integrated into everyday life, access to digital resources and opportunities has become an increasingly important determinant of educational participation and future human capital development.

Despite significant advances in digitalisation globally, access to digital technologies and opportunities for meaningful digital participation remain unevenly distributed. These inequalities are particularly pronounced in many developing countries, where disparities in infrastructure, connectivity, affordability, and institutional capacity continue to shape educational experiences (Myovella et al., 2020; Asongu, Odhiambo, & Rahman, 2024). While considerable policy attention has focused on expanding access to digital technologies, emerging evidence suggests that access alone does not guarantee meaningful participation or educational benefit. Students may possess some level of connectivity but still face significant barriers related to the quality, continuity, and educational relevance of their digital engagement.

These concerns have become increasingly important within basic education systems. The basic education level plays a foundational role in developing literacy, numeracy, problem-solving abilities, and the digital competencies necessary for lifelong learning and participation in modern societies (Chandra, 2023; Dyussenov, Ibadildin & Hwang, 2025a). Consequently, improving opportunities for digital participation during the early years of schooling has become a major policy priority across many countries. Effective integration of digital technologies within basic education has been associated with enhanced access to information, improved learning opportunities, greater educational engagement, and the development of critical twenty-first-century skills (Nouri et al., 2020; Ozdamli & Karagozlu, 2022). However, these benefits

depend heavily on the availability of supportive institutional environments capable of facilitating meaningful digital engagement.

Ghana reflects many of the opportunities and challenges associated with educational digitalisation. Over the past decade, the Government of Ghana has introduced numerous initiatives aimed at promoting ICT integration within the education sector, including the One Laptop Per Child initiative, Ghana Learning TV, the Ghana Investment Fund for Electronic Communications (GIFEC), the e-Transform Ghana Project, and more recently the introduction of coding and robotics programmes within selected schools (Adarkwah, 2021). These initiatives reflect a broader national commitment to leveraging digital technologies to improve educational quality and prepare young people for participation in an increasingly digital economy.

Despite these efforts, significant inequalities remain. Recent evidence from the Ghana Statistical Service indicates that millions of school-aged children continue to experience limited access to ICT devices and digital learning opportunities, with rural communities facing particularly severe challenges (GSS, 2023). Many rural schools continue to operate under conditions characterised by inadequate ICT infrastructure, unreliable internet connectivity, limited electricity supply, insufficient technological resources, and shortages of teachers with appropriate digital competencies (Agyekum, 2023; Baako, Gidisu, & Umar, 2023). These constraints limit opportunities for meaningful digital participation and contribute to persistent educational inequalities between rural and urban communities. Importantly, the challenge extends beyond questions of access alone. Existing research increasingly suggests that digital inequality operates across multiple dimensions, including access, frequency of use, continuity of engagement, digital skills, and the ability to derive meaningful benefits from digital technologies (van Dijk, 2005; Hargittai, 2002). Students may have intermittent access to digital technologies but lack opportunities for sustained engagement or meaningful educational use. Similarly, schools may possess ICT resources but lack the institutional capacity to support effective integration into teaching and learning. Understanding digital participation therefore requires attention not only to technological access but also to the institutional conditions that shape how digital opportunities are experienced.

The concept of institutional mediation is particularly relevant in this regard. Schools serve as critical mediating institutions that can facilitate or constrain students' digital participation through the provision of infrastructure, connectivity, policies, pedagogical practices, and technological support (Warschauer, 2003; Selwyn, 2002). Within resource-constrained educational settings, teachers frequently play important mediating roles by creating opportunities for digital engagement, compensating for infrastructural limitations, and facilitating access to technological resources. Consequently, digital participation is often shaped not only by the availability of technology but also by the institutional and pedagogical environments within which learning occurs.

Although Ghana's digital divide has attracted increasing scholarly attention, much of the existing literature has focused on access to ICT infrastructure, technology adoption, digital literacy, or policy implementation (Aikins & Arthur-Nyarko, 2019; Agyei, 2021; Baako, Gidisu, & Umar, 2023). Comparatively limited attention has been devoted to understanding how district-level inequalities, continuity of internet use, and institutional mediation interact to shape students' opportunities for digital participation within rural basic schools. This represents an important gap, particularly given growing investments in educational digitalisation and ongoing concerns regarding educational inequality.

This study addresses this gap by examining patterns of internet access, continuity of use, digital participation, and institutional mediation among Basic 8 students in rural Ghana. Drawing on a mixed-methods design that combines survey data, interviews, and classroom observations, the study explores how infrastructural inequalities influence students' digital experiences and how schools and teachers mediate opportunities for digital engagement.

The study is guided by four research questions:

RQ1: How do patterns of internet access and continuity of use differ across socio-economically differentiated districts in rural Ghana?

RQ2: What forms of digital engagement do students undertake when internet access is available?

RQ3: How do institutional conditions within schools mediate students' opportunities for digital participation and learning?

RQ4: What role do teachers play in facilitating digital engagement in contexts characterised by infrastructural constraints?

By addressing these questions, the study contributes to scholarship on digital inequality, educational technology, and digital inclusion by demonstrating how access, continuity of use, and institutional mediation interact to shape digital participation in resource-constrained educational settings. The findings also provide evidence relevant to ongoing efforts to promote equitable digital transformation within Ghana's basic education system.

The remainder of the paper is organised as follows. The next section reviews the literature on digital inequality, continuity of internet use, institutional mediation, and educational participation. This is followed by the theoretical framework, methodology, findings, discussion, and conclusion.

2. Literature Review

2.1 Digital Inequality and Educational Access

The rapid expansion of digital technologies has generated significant optimism regarding their potential to improve educational access, learning opportunities, and human capital development. However, access to digital technologies remains highly uneven both within and between countries. This phenomenon is commonly described as the digital divide and refers to disparities in access to information and communication technologies, internet connectivity, digital skills, and the benefits derived from technology use (van Dijk, 2005).

While early studies conceptualised the digital divide primarily in terms of physical access to computers and internet connectivity, contemporary scholarship recognises digital inequality as a multidimensional phenomenon extending beyond simple access (Hargittai, 2002; van Dijk, 2020). Educational researchers increasingly argue that unequal access to digital technologies can reinforce existing social and educational inequalities by limiting opportunities for learning, information acquisition, and skill development (Warschauer, 2003).

These inequalities are particularly pronounced in developing countries, where infrastructural deficits, affordability constraints, unreliable electricity supply, and limited institutional capacity continue to hinder equitable access to digital technologies (Myovella, Karacuka, & Haucap, 2021). Across Sub-Saharan Africa, significant disparities persist between urban and rural communities, with learners in rural areas often facing greater barriers to connectivity and digital participation (Asongu, Odhiambo, & Rahman, 2024; Dlamini & Dewa, 2021).

The Ghanaian context reflects many of these broader challenges. Although national investments in ICT infrastructure and educational technology have expanded opportunities for digital learning, substantial disparities remain across regions and school types (Aikins & Arthur-Nyarko, 2019; Baako, Gidisu, & Umar, 2023). Rural schools frequently operate with limited technological resources, inadequate internet connectivity, and insufficient ICT support, constraining students' opportunities to engage meaningfully with digital technologies. Consequently, understanding educational digital inequality requires attention not only to whether technology is available but also to how access is distributed across different educational contexts.

2.2 Continuity of Internet Use and Digital Participation

Access to digital technologies does not necessarily guarantee meaningful participation in digital environments. Increasingly, scholars argue that continuity and frequency of internet use are equally important dimensions of digital inclusion (van Deursen & Helsper, 2015). Students may have occasional access to digital technologies yet lack opportunities for sustained engagement that would allow them to develop digital competencies and derive educational benefits.

Continuity of use refers to the extent to which individuals can access and utilise digital technologies consistently over time. Research suggests that irregular or intermittent access often limits the development of digital skills and reduces opportunities for educational engagement (Scheerder, van Deursen, & van Dijk, 2019). In educational settings, continuity of internet use influences learners' ability to access digital resources, complete assignments, participate in online learning activities, and develop confidence in using technology.

Recent studies indicate that meaningful digital participation depends not only on whether learners have internet access but also on the quality, frequency, and purpose of their engagement (Gui, Parma, & Comi, 2018; Sart et al., 2022). Students who engage regularly with digital technologies for educational purposes tend to demonstrate stronger digital competencies and greater academic engagement than those whose access is sporadic or primarily recreational.

Within many developing-country contexts, continuity of internet use remains constrained by affordability, unstable connectivity, limited device ownership, and infrastructural challenges (Chomunorwa, Mashonganyika, & Marevesa, 2023). Consequently, examining continuity of use provides a more nuanced understanding of digital participation than access indicators alone.

2.3 Institutional Mediation and Digital Participation

Although digital participation is often discussed in relation to individual access and skills, schools play a critical role in shaping how students experience digital technologies. Educational institutions function as mediating environments that influence the extent to which learners can translate access into meaningful educational opportunities (Warschauer, 2003).

The concept of institutional mediation emphasises the role of schools, educational policies, infrastructure, organisational support systems, and pedagogical practices in facilitating or constraining digital participation. Access to digital technologies alone does not guarantee meaningful learning outcomes if schools lack the resources and institutional capacity necessary to support effective integration into teaching and learning processes (Selwyn, 2002).

Research consistently demonstrates that schools with adequate ICT infrastructure, reliable internet connectivity, supportive leadership, and digitally competent teachers are better positioned to facilitate meaningful digital engagement among students (Tondeur et al., 2016). Conversely, schools operating under conditions of infrastructural scarcity often struggle to provide sustained opportunities for technology-enhanced learning. Teacher facilitation represents an important component of institutional mediation. Teachers influence students' digital experiences through instructional practices, technological support, resource provision, and the integration of digital tools into classroom activities (Flores-Tena, Ortega-Navas, & Sousa-Reis, 2021). In resource-constrained settings, teachers frequently act as critical intermediaries who compensate for institutional deficiencies by providing alternative pathways to digital participation.

Evidence from developing countries suggests that institutional factors often exert as much influence on digital participation as technological access itself (Ciuriak & Ptashkina, 2019; Sepúlveda, 2020). Recent studies on educational digital transformation further demonstrate that investments in infrastructure alone are insufficient unless accompanied by institutional support, teacher development, and governance structures capable of supporting meaningful digital engagement (Chomunorwa et al., 2023; Dyussenov, Ibadildin & Hwang, 2025b).

The concept of institutional mediation is particularly relevant in rural educational contexts where students frequently encounter multiple barriers to digital participation. Understanding how schools and teachers mediate digital opportunities is therefore essential for explaining variations in students' experiences of digital engagement.

2.4 Theoretical Framework

This study is informed by three complementary theoretical perspectives: the multi-level digital divide framework (van Dijk, 2005), second-level digital divide theory (Hargittai, 2002), and Sen's Capability Approach (Sen, 1999). The multi-level digital divide framework conceptualises digital inequality as extending beyond physical access to include differences in skills, patterns of use, and outcomes. First-level digital divides refer to inequalities in access to ICT infrastructure and connectivity, while second-level divides concern differences in the frequency, quality, and effectiveness of technology use. These perspectives are particularly relevant in rural educational contexts where access remains uneven and opportunities for meaningful digital participation vary substantially.

The Capability Approach provides a complementary lens by emphasising individuals' ability to convert resources into valued functionings. From this perspective, internet connectivity alone does not guarantee educational benefits. Rather, institutional environments, teacher support, and available infrastructure influence whether students can transform digital access into meaningful educational opportunities.

Building on Warschauer (2003) and Selwyn (2002), this study further introduces institutional mediation as the processes through which schools facilitate or constrain students' digital participation through infrastructure, policies, pedagogical practices, and resource allocation. Teacher mediation is conceptualised more narrowly as the actions undertaken by teachers to facilitate digital learning through instruction, resource provision, and technological support.

These frameworks provide an integrated analytical lens for examining how access, continuity of use, and institutional conditions interact to shape digital participation among students in rural Ghana.

3. Methodology

3.1 Research Design

This study adopted a concurrent mixed-methods design to investigate patterns of digital participation among Basic 8 students in public basic schools in Ghana's Central Region. Quantitative and qualitative evidence were collected during the same period and subsequently integrated during interpretation to develop a comprehensive understanding of digital inequality within school contexts. The quantitative component generated descriptive evidence on students' internet access, continuity of use, and online activities across districts, whereas qualitative interviews and classroom observations provided contextual explanations for the institutional, infrastructural, and pedagogical factors influencing these patterns. Integrating the two strands enabled the study to move beyond describing digital participation to explaining how educational environments shape students' opportunities to engage with digital technologies.

3.2 Study Context and Site Selection

Fieldwork was conducted between October and November 2024 in three districts within Ghana's Central Region: Cape Coast Metropolitan (CCM), Komenda-Edina-Eguafo-Abrem (KEEA) Municipality, and Ekumfi District (EKD). The study sites were selected purposively to capture variation in socio-economic conditions and educational infrastructure. Selection was informed by the Ghana Statistical Service's poverty mapping framework, which categorises districts according to relative levels of socio-economic endowment (GSS, 2015). Within this classification, Cape Coast Metropolitan represented a relatively well-resourced district, KEEA represented an intermediate context, while Ekumfi reflected comparatively lower levels of socio-economic development.

Selecting districts with contrasting socio-economic characteristics provided an opportunity to examine how contextual differences influence students' access to digital technologies and opportunities for educational internet use. Across the three districts, twenty-four public basic schools (eight from each district) were included in the study. Schools were identified in collaboration with district education authorities to ensure variation in geographical location, infrastructure, and ICT resource

availability. Concentrating on public schools allowed the study to examine digital participation within mainstream educational settings where disparities in technological resources are often most visible.

3.3 Study Population and Participant Selection

The study involved both student and teacher participants to capture multiple perspectives on digital participation within schools. The quantitative component focused on Basic 8 students because learners at this stage are increasingly expected to engage independently with digital technologies while simultaneously preparing for more advanced academic work requiring ICT competencies. Students who were enrolled in Basic 8, present during data collection, and had obtained the necessary institutional and parental or guardian consent were eligible to participate. A total of 854 students completed the survey.

To complement the survey findings, qualitative data were obtained from twelve students and ten teachers selected through purposive sampling. Student participants were chosen to reflect variation in gender, district, reported internet access, and observed patterns of digital engagement. Teacher participants were selected based on their involvement in ICT instruction, experience with integrating digital technologies into classroom practice, or familiarity with school-level ICT infrastructure. Rather than seeking statistical representation, the qualitative sample was intended to generate in-depth insights into the institutional and pedagogical processes underpinning students' experiences of digital participation. Classroom observations further enriched these accounts by documenting how technology was used within everyday teaching and learning environments.

3.4 Quantitative Data Collection

Data for the quantitative component were collected using a structured questionnaire designed to capture key dimensions of students' digital participation, including internet access, recency and frequency of internet use, locations of access, online learning activities, recreational internet use, and selected indicators of digital content creation. Questionnaire items were adapted from established literature on digital inequality and educational technology, with additional guidance drawn from the UNESCO Institute for Statistics' *Practical Guide to Implementing Surveys in ICT for Primary and Secondary Schools*. Prior to the main survey, the instrument was piloted in a school outside the study area to assess clarity, relevance, and age appropriateness. Feedback from the pilot informed revisions to item wording, sequencing, and administration procedures.

Although the questionnaire was originally developed for online administration using Microsoft Forms, preliminary field visits revealed substantial limitations in computer availability and internet connectivity across participating schools. Consequently, paper-based questionnaires were used throughout the study. Students who were able to complete the questionnaire independently did so through self-administration, while researcher-assisted administration was provided where clarification was necessary. Completed questionnaires were checked immediately after administration to identify missing responses before being digitised and imported into Stata for analysis.

3.5 Qualitative Data Collection

Interviews

Qualitative interviews were undertaken to gain a deeper understanding of the institutional and interpersonal factors shaping students' digital participation beyond what could be captured through the survey. Semi-structured interviews were conducted with twelve students and ten teachers drawn from the participating schools. Interview questions explored experiences of internet accessibility, the adequacy of school ICT infrastructure, instructional use of digital technologies, teacher support for technology-mediated learning, and challenges affecting students' engagement with online resources.

The semi-structured format allowed participants to discuss issues that were particularly relevant to their experiences while ensuring consistency across interviews. Individual interviews lasted approximately 20 to 40 minutes and were conducted in locations approved by school authorities to provide a quiet and comfortable environment for discussion. With participants' consent, detailed field notes were taken throughout the interviews, and where audio recording was impracticable, comprehensive notes were expanded immediately after each session to preserve participants' views and contextual information.

Classroom Observations

To complement interview and survey data, non-participant classroom observations were undertaken during ICT-related instructional activities. The observations focused on how digital technologies were incorporated into classroom teaching, the availability and functionality of ICT resources, patterns of student participation, teacher facilitation strategies, and the practical constraints encountered during technology-supported lessons.

A structured observation guide was used to ensure consistency across schools while allowing sufficient flexibility to document contextual issues unique to each setting. Observation records included descriptive accounts of classroom interactions, technology use, infrastructure availability, and interruptions arising from limited connectivity or equipment shortages. Recording these naturally occurring classroom practices provided an important means of comparing reported experiences with actual instructional practice and strengthened the contextual interpretation of the quantitative findings.

3.6 Analytical Procedures

Quantitative Analysis

Following data collection, completed questionnaires were digitised, verified, and imported into Stata for statistical analysis. Given the descriptive objectives of the study and the purposive selection of participating districts, the analysis focused on identifying patterns of digital participation rather than testing causal relationships. Descriptive statistics, including frequencies and percentages, were generated to summarise students' internet access, continuity of use, locations of access, and online activities. Cross-tabulations were subsequently employed to compare these indicators across districts, thereby highlighting spatial variations in digital participation associated with differing socio-economic contexts.

Qualitative Analysis

Qualitative data derived from interviews and classroom observations were analysed using thematic analysis. The analytical process commenced with repeated reading of interview notes and observation records to achieve familiarity with the data. Open coding was then undertaken to identify recurring concepts relating to internet accessibility, school infrastructure, teacher support, institutional constraints, continuity of internet use, and patterns of digital engagement.

As analysis progressed, related codes were consolidated into broader themes that captured the principal institutional and pedagogical influences on students' digital participation. These themes were subsequently compared with the quantitative findings to identify areas where the different forms of evidence converged or diverged. Integrating qualitative and quantitative evidence during interpretation enabled the study to provide richer explanations for observed district-level differences and strengthened the overall coherence of the findings.

3.7 Quality Assurance and Trustworthiness

The credibility of the study was enhanced through methodological triangulation, whereby evidence was drawn from three complementary sources: student surveys, semi-structured interviews, and classroom observations. Using multiple methods allowed the study to compare findings across different forms of evidence and reduced reliance on a single source of data. The integration of quantitative and qualitative findings during interpretation strengthened the robustness of the conclusions by enabling the identification of both convergent and divergent patterns.

Several procedures were implemented to improve the quality of the quantitative data. The survey instrument was piloted before the main fieldwork to assess clarity, relevance, and suitability for the target population. During data collection, questionnaires were administered using standardised procedures, with researcher assistance provided only where clarification was required. Completed questionnaires were reviewed immediately after administration to identify missing responses before digitization, thereby minimizing data entry errors and incomplete records.

The trustworthiness of the qualitative component was supported through systematic documentation of interviews and classroom observations. Interview notes were expanded immediately after each session to preserve contextual details and participants' perspectives, while observation records followed a structured guide to ensure consistency across schools. Throughout the analytical process, emerging themes were continually compared across interviews, observations, and survey findings to ensure that interpretations remained grounded in the empirical evidence.

3.8 Ethical Considerations

Ethical clearance for the study was obtained through the appropriate institutional approval processes before the commencement of fieldwork. Administrative permission was subsequently secured from the Ghana Education Service district education directorates, and the heads of participating schools before data collection began.

Given that the study involved minors, particular emphasis was placed on safeguarding participants' rights and welfare. Information explaining the purpose of the research, participation requirements, and data management procedures was

provided to school authorities, teachers, and participating students. Participation was entirely voluntary, and respondents were informed that they could decline participation or withdraw from the study at any stage without adverse consequences.

Confidentiality and anonymity were maintained throughout the research process. No personal identifiers were collected that could reveal the identity of participants or their schools in published reports. Interview notes, observation records, and survey data were securely stored and accessed only for research purposes. During analysis and reporting, all qualitative extracts were anonymised to protect the privacy of participants and ensure compliance with accepted ethical standards for educational research.

3.9 Conceptualisation of Key Constructs

To facilitate interpretation of the findings, two contextual constructs are used throughout this study.

Institutional mediation refers to the ways in which school-level policies, organisational practices, physical infrastructure, and the availability of educational resources shape students' opportunities to access and use digital technologies for learning. Within this study, institutional mediation encompasses factors such as ICT facilities, internet connectivity, electricity reliability, administrative support, and the broader learning environment that either enables or constrains digital participation.

Teacher mediation describes the instructional and supportive roles played by teachers in facilitating students' engagement with digital technologies. These roles include classroom instruction, guidance on the educational use of digital resources, supervision of technology-based activities, provision of alternative learning resources where digital infrastructure is inadequate, and other forms of pedagogical support that influence students' digital experiences.

Neither institutional mediation nor teacher mediation was operationalised as a quantitative variable within the survey. Instead, both constructs emerged inductively from interview narratives and classroom observations and are therefore employed as interpretive concepts to explain patterns identified in the quantitative analysis rather than as statistically tested predictors.

3.10 Researcher Reflexivity

The researcher's direct involvement in administering the survey, conducting interviews, and undertaking classroom observations provided valuable familiarity with the educational contexts in which the study was conducted. This close engagement facilitated rapport with participants and enhanced the interpretation of contextual factors that may not have been apparent through quantitative data alone. At the same time, the researcher's proximity to the field created the potential for subjective interpretation during data collection and analysis.

To minimise this possibility, several reflexive strategies were adopted throughout the study. Observation records distinguished clearly between descriptive accounts of events and the researcher's interpretations, thereby reducing the risk of conflating observation with inference. Interview findings were continuously compared with survey results and classroom observations to ensure that emerging interpretations were supported by multiple sources of evidence. In addition, analytic decisions were

revisited throughout the coding process to maintain consistency and ensure that conclusions remained firmly grounded in the data rather than in prior assumptions.

4. Results

4.1 District-Level Inequalities in Internet Access

Differential Access Across Districts (First-Level Divide)

Substantial district-level disparities in internet access were observed. While 70.2% of students in Cape Coast Metropolitan (CCM) reported ever using the internet, the proportion declined to 50.6% in Ekumfi District (EKD) and 57.7% in Komenda Edina Eguafo Abrem (KEEA) (Table 1). These patterns correspond with CCM's urban status, stronger ICT infrastructure, and institutional density.

These findings are consistent with first-level digital divide theory, which conceptualises inequality primarily as differential access to infrastructure (van Dijk, 2005). In EKD, where some communities and schools lack stable mobile network connectivity, digital exclusion appears infrastructural rather than motivational.

Continuity and Recency of Use (Second-Level Divide)

Among students who had ever accessed the internet, 65.9% reported doing so within the past three months. However, 20.4% indicated their last use occurred more than 12 months prior. Notably, the proportion of students reporting over 12 months since last use was nearly twice as high in EKD and KEEA as in CCM. Additionally, 40.6% of students reported no internet use within the three months preceding the survey. These findings suggest layered inequalities beyond initial access. Variations in frequency, continuity, and recency of engagement align with second-level digital divide theory, which emphasises differences in usage intensity and skill development (Hargittai, 2002).

Table 1: Frequency of use of the Internet among students

Description	CCM	EKD	KEEA	Total
Ever used the internet from any location	70.2	50.6	57.7	
Last internet usage				
<i>Between 3 and 12 months</i>	11.4	9.7	17.6	13.7
<i>Less than 3 months</i>	75.1	66.2	58.0	65.9
<i>More than 12 months</i>	13.6	24.0	24.4	20.4
Where internet was used most				
<i>Another person's home</i>	8.1	9.6	13.6	10.8
<i>At home</i>	78.7	68.5	64.1	70.2
<i>At school</i>	8.1	21.2	18.4	15.2
<i>Internet Café</i>	4.8	0.7	3.3	3.3
<i>Other</i>	0.4	0.0	0.6	0.4

How often was the internet used in the last 3 months?

<i>At least once a day</i>	4.3	15.3	18.6	13.0
<i>At least once a week</i>	56.7	29.4	35.0	41.3
<i>Less than once a week</i>	3.9	9.4	4.0	5.1
<i>Never</i>	35.1	45.9	42.3	40.6

Source: Authors' computation from field data

CCM: Cape Coast Metropolitan; EKD: Ekumfi District, KEEA: Komenda Edina Eguafo Abirem

4.2 Spatial Distribution of Access: Home Dominance and School Marginality

Privatised Access Patterns

Internet access was predominantly home-based. Approximately 70.2% of students reported accessing the internet primarily at their own homes, and 10.8% at another person's home (Table 1). In contrast, only 15.2% identified school as their primary access location. Across all study sites, only two schools possessed functional computer laboratories with internet connectivity. This spatial pattern indicates a shift from institutional to household-based connectivity, effectively privatising digital opportunity.

Classroom-Level Evidence of Institutional Deficit

Qualitative classroom observations reinforce this pattern. During one ICT lesson:

"The lesson for the day required the use of the internet... she connected her personal mobile hotspot to access the internet as the school had none. After nearly five minutes of no action, the researcher offered to make his personal data available to facilitate the lesson."

Similarly, a teacher from KEEA reported:

"I use my own data, my own laptop to teach. Nobody pays for the data, but I am fine. It helps me teach the students better... Sometimes I connect my hotspot to my laptop and the students come around in groups to see specific activities that I am performing online."

These excerpts demonstrate that internet-enabled instruction is contingent upon teacher improvisation rather than institutional provisioning.

Digital instruction was thus contingent upon teacher-owned devices and privately funded data. This description reveals two structural dynamics: financial externalisation of ICT costs onto teachers and group-based observational learning due to limited bandwidth and devices.

Another teacher highlighted network instability:

"I wish it was possible to download specific videos before the class because sometimes the internet is very unstable and ends up delaying the lesson."

These accounts collectively demonstrate that digital pedagogy is improvised rather than institutionalised.

4.3 Patterns of Internet Use

Media-Oriented and Informational Uses

The most frequently reported activity was watching videos, movies, or TV series (75.7%), particularly in CCM (83.6%) (Table 2¹). Additional activities included: reading or watching news (67.5%); social media use (63.6%); and sharing texts or images (59.4%). These patterns indicate substantial engagement with entertainment and communication-oriented digital platforms.

Academic and Productive Uses

Students also reported considerable educational engagement: 72.1% completed assignments online; 69.8% completed homework; 58.9% conducted school research; 43.4% studied for tests; 40.9% took tests online; 67.4% learned how to do something new online, 31.1% created a game, application, or computer program. These findings indicate that when access is available, students engage in both consumption and production-oriented digital practices.

Table 2: Patterns of Internet use

Description	CCM	EKD	KEEA	Total
Looked up information out of curiosity?	65.8	42.4	40.7	49.8
Watched video clips, shows, movies or a TV series	83.6	76.3	69.3	75.7
Shared texts, images or videos	68.3	52.9	55.4	59.4
Read or watched the news	66.3	77.1	64	67.5
Used instant messaging	61.7	58.6	41	51.9
Posted texts, images or videos you created	54.3	43.2	37	44.3
Used maps	24.7	35.3	27.7	28.3
Used social media, e.g. WhatsApp, Facebook, Instagram, Twitter	71.3	58.2	60.2	63.6
Learned to do something you did not know how to do	75.4	56.5	66.3	67.4
Taught other people to do something they did not know how to do	46	41.2	41.7	43.1
Created a game, application or computer program	32.1	32	29.9	31.1
Read a book or an e-book	60.9	51.5	53.8	55.8
Done an assignment (individual or group)	70.1	72.9	73.2	72.1
Done homework or exercises assigned by the teacher	73.1	64.7	69.7	69.8
Done school research	69.8	47.7	55.7	58.9

¹ Portions of Table 2 has been published in Ayerakwa et al., 2026

Done presentations to classmates	31.9	43.8	38.7	37.4
Played educational electronic games	51.8	50.3	36.7	44.8
Communicated with your teachers online	23.8	18.9	27	24.2
Taken part in online courses	29.2	18.8	30.5	27.6
Studied for a test	47.9	26.6	47.8	43.4
Researched on class topics	68	51.8	55.2	58.9
Shared school projects	26	16.5	27.6	24.7
Taken tests	43.1	30.2	44.4	40.9
Done school projects with classmates	42.2	40.6	46	43.5

Source: Authors' computation from field data

CCM: Cape Coast Metropolitan; EKD: Ekumfi District, KEEA: Komenda Edina Eguafo Abirem

4.4 Teacher Mediation and Participation Constraints

Teachers functioned as key mediators of digital learning. They provided personal laptops and smartphones, financed mobile data, curated online resources, and demonstrated digital processes in real time. However, participation was often constrained. In one observed ICT lesson, only two students practised sending emails while others looked on as passive observers due to limited devices and unstable connectivity. Another teacher remarked:

"I wish it were possible to have the requisite ICT gadgets that one can connect with and share videos with the students in class, but this is not possible, and when you want to use your own devices too, the connectivity is very bad".

These findings illustrate infrastructural fragility and the predominance of demonstration-based rather than participatory digital instruction.

4.5 Triangulation of Quantitative and Qualitative Findings

The integration of quantitative and qualitative evidence revealed both convergence and divergence across data sources. A clear area of convergence emerged regarding the limited role of schools in providing internet access. Quantitative findings showed that only 15.2% of students reported accessing the internet primarily through their schools. This pattern was strongly corroborated by interviews and classroom observations, which revealed widespread dependence on teacher-provided devices, personal mobile hotspots, and self-funded data subscriptions. Together, these findings indicate that digital participation in the study districts is largely dependent on household and individual teacher resources rather than institutional provision.

Another area of convergence concerned district-level inequalities in access and continuity of internet use. Students in the less-resourced districts reported lower levels of internet access and longer periods since their last online activity. These findings aligned closely with teacher accounts describing unstable network coverage, inadequate ICT infrastructure, and limited availability of digital devices.

A notable divergence emerged in relation to educational uses of the internet. Survey results suggested relatively high levels of engagement in online assignments, homework completion, and school-related research. However, classroom

observations indicated that students often participated in digital lessons indirectly through observation rather than hands-on interaction because of limited devices and unreliable connectivity. This suggests that while students may engage with educational technologies outside school settings, opportunities for active digital participation within classroom environments remain constrained.

5. Discussion

5.1 Digital Access and Continuity of Use in Rural Educational Contexts

The findings reveal substantial inequalities in students' access to and continuity of internet use across the study districts. Although a majority of students reported having used the internet at some point, levels of regular access and recent internet use varied considerably. These findings suggest that digital participation among students in rural Ghana remains uneven despite broader national efforts to expand connectivity and digital inclusion.

From the perspective of Digital Divide Theory, these findings illustrate the persistence of first-level digital divides characterised by unequal access to digital infrastructure and internet connectivity (van Dijk, 2005). While mobile technologies have expanded opportunities for internet access, significant disparities remain in students' ability to connect regularly and reliably. Access therefore remains an important determinant of digital participation, particularly in rural and resource-constrained educational environments.

The observed disparities are consistent with evidence from other Sub-Saharan African countries. Studies from South Africa, Kenya, Tanzania, and Zimbabwe similarly report that rural learners continue to face infrastructural barriers despite increasing national investments in digital technologies (Myovella et al., 2021). Across many African educational systems, unreliable connectivity, limited ICT infrastructure, and high data costs continue to constrain meaningful participation in digital learning. The Ghanaian experience therefore reflects broader regional patterns in which access has improved but remains unevenly distributed.

The findings further suggest that digital participation cannot be understood solely in terms of whether students possess internet access. Continuity of use emerged as an equally important dimension. Students who experienced more regular internet access were also more likely to report educational uses of digital technologies. This supports arguments that meaningful digital inclusion requires not only connectivity but also sustained opportunities to engage with digital resources over time.

5.2 Digital Participation Beyond School Infrastructure

One of the most significant findings of the study is that digital participation frequently occurred outside formal institutional provision. Survey results indicated that relatively few students accessed the internet primarily through school infrastructure. Instead, access was commonly facilitated through personal mobile devices, family-owned smartphones, community networks, and teacher-supported arrangements.

The triangulation of quantitative and qualitative evidence provides strong support for this finding. Survey data showed that only a small proportion of students identified schools as their primary source of internet access. This pattern was corroborated by interviews and classroom observations, which revealed that many schools lacked

adequate connectivity, functioning ICT laboratories, or sufficient digital devices. Students therefore relied heavily on household and community resources to participate in digital activities.

This finding extends current understandings of digital participation by highlighting the importance of non-institutional pathways through which learners access digital opportunities. While educational technology policies often assume that schools function as the primary gateway to digital learning, the evidence suggests that students frequently develop digital experiences through arrangements that exist outside formal educational provision. Digital participation in these contexts is therefore shaped not only by educational institutions but also by household resources, social networks, and community-level opportunities.

5.3 Institutional Mediation and Teacher Facilitation

The study demonstrates that institutional conditions play a critical role in shaping students' opportunities for digital participation. Significant differences in digital engagement were observed across schools and districts, reflecting variations in infrastructure, connectivity, and access to technological resources.

Drawing on Warschauer (2003) and Selwyn (2002), these findings highlight the importance of institutional mediation in determining how digital opportunities are experienced. Institutional mediation refers to how schools facilitate or constrain digital participation through infrastructure provision, resource allocation, organisational support, and educational policies. Access to digital technologies alone does not guarantee meaningful educational participation; rather, students' ability to benefit from digital opportunities depends heavily on the institutional environments within which learning occurs.

The findings indicate that many schools lacked the resources required to support sustained digital engagement. In several instances, digital participation was dependent upon the initiative of individual teachers who used personal devices, personal internet subscriptions, or informal arrangements to support students' learning.

This distinction between institutional mediation and teacher mediation is important. While institutional mediation reflects broader organisational capacities and structures, teacher mediation refers to the direct actions undertaken by teachers to facilitate students' engagement with digital technologies. The findings suggest that where institutional support was weak, teacher agency often served as a compensatory mechanism. However, reliance on individual teachers is unlikely to provide a sustainable basis for digital inclusion, particularly in under-resourced schools.

From a Capability Approach perspective (Sen, 1999), these findings illustrate that digital technologies represent resources whose educational value depends on the presence of enabling conditions. Schools and teachers function as conversion factors that influence students' ability to transform digital access into meaningful educational opportunities. Consequently, improving infrastructure alone may be insufficient if institutional and pedagogical capacities remain underdeveloped.

5.4 Educational Engagement and the Second-Level Digital Divide

The study further reveals important differences in how students use digital technologies for educational purposes. Although many students reported using the internet for assignments, information searches, and school-related activities, qualitative evidence suggested that opportunities for active digital engagement remained constrained.

A notable example of triangulation emerged in relation to educational internet use. Survey findings suggested relatively high levels of engagement in online educational activities. However, classroom observations indicated that many students participated in digital lessons indirectly through observation rather than direct interaction because of limited devices and unstable connectivity. This divergence highlights the importance of combining quantitative and qualitative evidence when examining digital participation.

These findings align closely with second-level digital divide theory (Hargittai, 2002), which emphasises inequalities in digital skills, patterns of use, and the ability to derive meaningful benefits from technology. Possessing internet access does not necessarily translate into effective educational participation. Rather, differences in the quality, frequency, and purpose of digital engagement contribute to unequal educational outcomes.

The findings therefore suggest that educational inequalities increasingly reflect differences not only in access but also in opportunities for meaningful digital participation. Students who possess greater opportunities to engage actively with digital technologies are likely to acquire stronger digital competencies and derive greater educational benefits than students whose engagement remains intermittent or largely observational.

5.5 Implications for Digital Inclusion and Human Capital Development

The findings have important implications for digital inclusion and human capital development within Ghana's education system. The evidence suggests that expanding connectivity alone is unlikely to achieve the transformative educational outcomes often associated with digital technologies. Instead, meaningful digital inclusion requires simultaneous investments in infrastructure, institutional capacity, teacher support, and opportunities for active student engagement.

The study contributes to digital divide scholarship by demonstrating that digital inequality in rural educational settings operates simultaneously at access, continuity, and institutional levels. The findings extend existing research by showing how institutional mediation influences students' ability to convert digital resources into educational opportunities. In this regard, the study shifts attention from simple measures of connectivity towards broader questions concerning the quality of digital participation and the institutional conditions that support it.

Overall, the findings suggest that sustainable digital transformation in education requires more than technology deployment. It requires the development of enabling institutional environments capable of supporting equitable, meaningful, and continuous digital participation among learners.

6. Conclusion

This study examined patterns of digital participation among Basic 8 students in rural Ghana and explored how internet access, continuity of use, and institutional conditions shape opportunities for digital engagement. Drawing on survey data, interviews, and classroom observations, the study provides evidence that digital participation remains highly uneven despite broader efforts to expand digital connectivity within Ghana's education sector.

The findings reveal that significant disparities persist in students' access to and continuity of internet use across districts and schools. While many students reported some level of internet access, opportunities for regular and meaningful engagement with digital technologies varied considerably. Importantly, the study demonstrates that digital participation frequently occurs outside formal institutional provision, with students relying heavily on personal mobile devices, household resources, community networks, and teacher-supported arrangements rather than school-based infrastructure.

The study further highlights the critical role of institutional mediation in shaping digital opportunities. Schools with limited connectivity, inadequate ICT infrastructure, and constrained technological resources were less able to support sustained student engagement with digital technologies. In many instances, individual teachers acted as important facilitators of digital participation by providing access to devices, internet connectivity, and learning support. These findings suggest that digital inclusion in educational settings depends not only on technological access but also on the institutional and pedagogical conditions that enable students to transform digital resources into meaningful learning opportunities.

Theoretically, the study contributes to digital divide scholarship by demonstrating that digital inequality in rural educational contexts operates across multiple dimensions, including access, continuity of use, and institutional support. By integrating Digital Divide Theory and the Capability Approach, the study shows that internet connectivity alone is insufficient for meaningful participation. Rather, the educational benefits of digital technologies depend on the extent to which learners can convert access into valued educational outcomes through supportive institutional environments and effective teacher facilitation.

The findings carry important implications for educational policy and digital transformation initiatives in Ghana. Efforts to promote digital inclusion should move beyond a narrow emphasis on infrastructure provision and address broader institutional constraints that limit meaningful participation. Investments in school connectivity, ICT infrastructure, teacher professional development, and digital learning resources remain essential if digital technologies are to contribute effectively to human capital development. Policies should also recognise the important role that households and communities currently play in supporting students' digital engagement and seek to strengthen these complementary pathways.

Several limitations should be acknowledged. The study focused on selected districts within one region of Ghana and therefore may not fully capture patterns of digital participation across the country. In addition, the cross-sectional design limits the ability to examine changes in digital participation over time. Future research could employ longitudinal approaches to investigate how digital engagement evolves as connectivity expands and could examine institutional mediation across different educational levels and geographical contexts.

Overall, the study demonstrates that the challenge facing educational digital transformation in rural Ghana is not simply one of expanding access, but of creating the institutional, pedagogical, and infrastructural conditions necessary for meaningful and equitable digital participation. Sustainable digital inclusion requires more than connectivity; it requires educational systems capable of converting digital opportunities into genuine learning and human development outcomes.

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Decarbonising Higher Education in the Global South: Assessing the Carbon Mitigation Potential of Open and Distance Learning in Nigeria

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ABSTRACT

As global concerns regarding climate change intensify, the environmental impact of traditional higher education, characterised by massive paper consumption and daily commutes of students and staff, demands urgent attention. This paper explores the "green" potential of Open and Distance Learning (ODL) in Nigeria, focusing on the National Open University of Nigeria (NOUN) as a case study. By transitioning to a digital-first instructional model, ODL inherently reduces carbon emissions associated with physical campus operations. This study utilises primary data collected from a survey of 157 NOUN students to model the carbon savings achieved through the ODL framework. Findings indicate that while traditional campus models require students to commute an average of 4.2 days per week, ODL students visit study centres only 1.8 times per month, resulting in an average of 15 avoided trips per student monthly. Based on a Nigerian transport emission factor of 118g of CO₂ per km, this reduction prevents approximately 17.7 kg of CO₂ emissions per student each month. Furthermore, the research assesses how ODL facilitates Nigeria's climate goals under the 2021 Updated Nationally Determined Contributions (NDC) to the Paris Agreement, specifically regarding emission reductions in the transport and forestry sectors. The study concludes with recommendations for adopting solar-powered study centres to maximise ODL's environmental benefits.

Keywords: *Green Education, Carbon Footprint, ODL Nigeria, Sustainability, Paperless Learning.*

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Introduction

The global climate crisis necessitates an urgent paradigm shift across all sectors of human activity to drastically reduce greenhouse gas (GHG) emissions (IPCC, 2023). While industrial and manufacturing sectors dominate global sustainability discourse, higher education systems globally are increasingly recognised as significant institutional carbon emitters. In the Global North, universities have begun systemic tracking of their environmental impact, identifying that "Scope 3" emissions, specifically indirect emissions resulting from student and staff commuting, frequently account for over 60% of an institution's total carbon footprint (Roy et al., 2008). However, in the Global South, and within sub-Saharan Africa specifically, this academic carbon cycle is heavily exacerbated by acute structural deficits, including reliance on highly inefficient transport networks and decentralised fossil-fuel power generation.

The higher education sector in Nigeria, traditionally characterised by brick-and-mortar conventional campuses, contributes substantially to this national carbon trajectory. This footprint is driven by high physical administrative dependencies, massive paper-based resource consumption, and the daily long-distance commuting of thousands of students and staff. As Nigeria endeavours to meet its obligations under the 2021 Updated Nationally Determined Contributions (NDC) to the Paris Agreement, committing to an unconditional 20% reduction in economy-wide emissions by 2030, the decarbonisation of institutional transport and energy domains becomes imperative.

Open and Distance Learning (ODL) presents a transformative, technological strategy to alleviate these environmental burdens, fundamentally validating the "green" modernisation principles regarding the sustainability potential of digital learning platforms (Isaias & Issa, 2013). By pivoting toward a digital-first instructional architecture, single-mode ODL frameworks possess the structural capacity to "decouple" educational expansion from carbon intensification. Furthermore, evaluating these shifts through established climate metrics (Wals & Benavot, 2017) underscores how structural adjustments in higher education delivery can yield macro-environmental benefits equivalent to active environmental conservation.

While a substantial body of literature examines the pedagogical and socio-economic access advantages of ODL in developing nations, there remains an empirical gap regarding its quantified environmental utility in sub-Saharan Africa. Most existing regional studies remain descriptive, failing to map behavioural student logistics directly onto automotive and lifecycle carbon emission factors.

To address this gap, this study establishes a clear empirical rationale by evaluating the carbon mitigation capacity of the National Open University of Nigeria (NOUN). The primary objective of this research is twofold: first, to quantify the net variance in carbon emissions (CO₂) achieved when transitioning from traditional campus-based commuting to an ODL framework; and second, to model the lifecycle environmental savings realised through the substitution of physical print materials with digital e-Courseware. By establishing this localised empirical baseline, the paper provides a scalable framework demonstrating how

flexible higher education models can actively drive national climate mitigation policies in the Global South.

Theoretical Framework and Context

Contextual Evolution of Distance Education in Nigeria

In 1977, the Nigerian government's National Policy on Education (NPE) emphasised integrating individuals into effective citizenship (Ayo et al., 2014). Since independence in 1960, Nigeria has made significant progress in education, establishing various institutions and policies aimed at improving access and quality. The 1977 NPE set the foundation for a robust educational framework; however, implementation has historically faced challenges due to systemic funding limitations and infrastructure deficits (Eheazu, 2014).

The introduction of Open and Distance Learning (ODL) aimed to directly alleviate these constraints and enhance educational access, particularly for marginalised populations and working adults unable to attend conventional institutions. The National Open University of Nigeria (NOUN), founded in 2002, exemplifies this initiative. With ODL, Nigeria can provide flexible educational opportunities that cater to diverse learning needs and schedules (Ayo et al., 2014). The evolution of ODL reflects global trends toward inclusivity and accessibility in education, enabling learners to engage in their studies without the constraints of physical location.

Despite its analytical utility in explaining this transition, applying Ecological Modernisation Theory (EMT) within an African context introduces critical, contested conceptual boundaries that must be acknowledged. Critics of EMT argue that the theory inherently reflects a Western, highly industrialised worldview which presumes the existence of robust, baseline technological infrastructures and stable state regulatory frameworks (York et al., 2003). In developing economies like Nigeria, the presumption that technological innovation smoothly drives institutional greening is challenged by systemic infrastructure deficits such as an unreliable national power grid and unequal digital access. This creates an "incomplete modernisation" or an "Energy Paradox," where the transition to digital tools accidentally shifts the carbon burden from a centralised grid to inefficient, decentralised domestic petrol or diesel generators. Furthermore, EMT has been critiqued for failing to account for how a digital structural reform might affect student motivation or exacerbate the digital divide among marginalised populations. Rather than invalidating the theory, these localised frictions require a contextualised, reflexive application of EMT, one that views modernisation not as a seamless technological triumph, but as an ongoing socio-technical negotiation wrapped in regional structural realities.

Environmental Sustainability and ODL as a Carbon Mitigation Strategy

Environmental sustainability within higher education refers to institutional practices aimed at fostering ecological awareness, promoting sustainable development, and equipping individuals with the knowledge needed to address macro-ecological challenges. This imperative aligns directly with Sustainable Development Goal 4 (SDG 4), which advocates for inclusive and equitable quality education (Eheazu, 2014). The role of higher education in achieving sustainability cannot be overstated; institutions of higher learning are uniquely positioned to influence societal values and behaviours, shaping a generation of environmentally literate citizens (Ifegbesan et al., 2017). By embedding sustainability

principles into delivery frameworks, higher education institutions can contribute significantly to building a low-carbon economy and mitigating the impacts of climate change.

Within this framework, Open and Distance Learning (ODL) emerges as a critical operational strategy for driving environmental sustainability within the Nigerian higher education sector. It directly addresses several key environmental challenges faced by traditional educational models, including the intensive carbon emissions associated with physical commuting and paper resource consumption (Roy, Potter, & Yarrow, 2008). ODL minimises the need for extensive physical campus infrastructures, thereby reducing baseline energy demands and the associated corporate carbon footprint.

Additionally, ODL leverages digital technologies to optimise learning delivery, facilitating the development and dissemination of interactive e-Courseware that completely eliminates the need for printed materials. This shift toward digital content delivery not only reduces paper consumption but also promotes a structurally sustainable approach to mass education, aligning institutional objectives with the broader principles of national environmental stewardship (Tunmibi et al., 2015).

Literature Review and Empirical Synthesis

Global Perspectives on Higher Education Carbon Footprints

The quantification of institutional carbon footprints has emerged as a critical domain within sustainability literature, driven by the realisation that higher education institutions operate as macro-consumers of energy and resources. Early seminal work in the Global North established that university emissions are not confined merely to campus electricity use (Scope 1 and Scope 2), but are heavily driven by indirect Scope 3 emissions, specifically student and staff commuting logistics (Roy et al., 2008). In a comprehensive lifecycle assessment of higher education delivery models across Europe, researchers demonstrated that distance learning models reduce energy consumption by 90% and cut carbon emissions by 85% compared to conventional brick-and-mortar campus architectures.

More recent global scholarship has expanded on these frameworks by integrating advanced lifecycle analysis (LCA) software to track digital transitions. For instance, Caeiro et al. (2020) evaluated virtual learning environments in conventional universities, noting that while paper reductions provide minimal macro-level impact, the elimination of daily urban transit provides profound carbon mitigation benefits. Similarly, Versteijlen et al. (2017) highlighted that the environmental advantage of distance learning is a dynamic variable, heavily contingent on whether digital infrastructures run on renewable grids or fossil-fuel baseloads. These global assessments, however, rely on highly centralised municipal public transport data and stable national electricity configurations characteristic of developed economies, leaving a significant empirical blind spot regarding how these models behave under volatile infrastructural conditions.

The Sub-Saharan African Context and Institutional Realities

When shifting the analytical lens to sub-Saharan Africa, the socio-technical landscape of institutional carbon accumulation changes drastically. In Nigeria, conventional higher education institutions place an immense burden on regional transport and power

infrastructures. Because conventional universities rely on highly centralised physical lecture systems, thousands of students and staff are forced into daily commuting patterns using inefficient, low-occupancy automotive transport within congested urban grids (Ayo et al., 2014). This physical administrative dependency is further compounded by a historical reliance on massive paper-based resource distribution and textbook printing, which deepens institutional carbon intensity (Osaat & Nsereka, 2012).

Compounding this transport burden is the regional power infrastructure crisis. Conventional Nigerian campuses operate as heavy emitters due to their reliance on high-capacity industrial diesel generators to maintain administrative and residential operations during systemic national grid failures (Akeel et al., 2019). While Open and Distance Learning (ODL) models have been widely studied in Nigeria for their capacity to democratise educational access and bypass physical capacity constraints (Olufunke & Adegun, 2014), their environmental metrics remain severely under-researched. Regional literature has historically remained localised and descriptive, focusing on qualitative perceptions of e-learning readiness rather than the empirical calculation of avoided emissions.

Emerging Frontiers: Artificial Intelligence (AI) and Digital Optimisation

A rapidly evolving dimension within global ODL sustainability frameworks is the strategic integration of Artificial Intelligence (AI) to optimise digital instructional delivery and minimise resource expenditures. Current international scholarship demonstrates that AI-driven learning management systems (LMS) can significantly streamline data centre processing loads through predictive server allocation, reducing the indirect energy footprint of cloud computing architectures (Leal Filho et al., 2025). Furthermore, AI-powered adaptive learning engines enable personalised e-Courseware pathways that reduce student online session durations while maintaining pedagogical efficacy, implicitly lowering the domestic hardware charging cycles required by the learner. Within the African ODL landscape, the potential for AI to optimise resource allocation represents a vital tool for environmental stewardship, offering a means to maximise server efficiencies and lower data transfer costs in an energy-constrained environment.

Synthesis of Empirical Gaps

A critical synthesis of the existing literature reveals three distinct empirical gaps that necessitate this study:

- 1. The Global-Local Methodological Mismatch:** While international studies utilise highly calibrated automotive and computing emission factors, they fail to account for the unique infrastructural frictions of the Global South, such as the localised "Energy Paradox" where digital learning shifts emission burdens onto domestic petrol generators.
- 2. Lack of Quantified Carbon Metrics in Regional ODL:** Existing sub-Saharan African research focuses almost exclusively on the pedagogical, economic, and social access dimensions of distance education, leaving the exact carbon mitigation capacity of regional institutions unquantified.
- 3. Boundary Clarification and Scope Constraints:** Prior regional studies often conflate total university operations with student-specific behavioural changes. To maintain structural precision, this study intentionally isolates its analytical boundary

to the carbon footprint of student commuting logistics and individual learning hardware/courseware utilisation. It explicitly excludes the carbon footprints of university administrative staff, non-academic personnel, and corporate institutional procurement, establishing a dedicated, high-fidelity baseline focused purely on the student-end technological shift.

Research Design

Research Approach, Design and Study Setting

This study employs a quantitative research approach characterised by deductive reasoning. This approach was chosen to empirically test the principles of Ecological Modernisation Theory (EMT) against carbon-footprint data within the Nigerian higher education sector. By progressing from the broader theoretical framework of institutional modernisation to specific observations of carbon savings, the study aims to validate the "decoupling" effect attributed to digital education. A descriptive-survey research design was utilised to evaluate the comparative environmental impact of Open and Distance Learning (ODL) versus traditional campus-based educational models. This design is particularly suitable as it facilitates the systematic collection of quantifiable data, encompassing variables such as commuting distances and hardware usage, while avoiding any manipulation of the natural environment or academic behaviours of participants. Consequently, this approach ensures that the observed carbon mitigation reflects genuine institutional efficiencies.

The study was conducted across selected study centres of the National Open University of Nigeria (NOUN). Established initially in 1983 and resuscitated in 2002, NOUN stands as Nigeria's premier and largest single-mode Open and Distance Learning institution, serving an expansive student body spread across geo-political zones. This institutional setting provides an ideal, information-rich environment for this research, as its digital-first infrastructure utilises e-Courseware, online tutor-marked assignments, and virtual portals designed intentionally to minimise physical human mobility and structural carbon accumulation.

Population, Sampling Technique, and Justification

The target population comprised active undergraduate and postgraduate students enrolled at NOUN. Primary data were collected using a non-probability purposive sampling technique to yield a final sample of 157 respondents.

a. Inclusion Criteria: To be included in the study, participants were required to be:

1. Currently registered students actively participating in academic semesters.
2. Utilising the university's digital e-Courseware portal as their primary means of accessing learning materials.
3. Commuting to institutional study centres exclusively for mandatory academic functions, such as examinations or physical facilitation sessions.

b. Exclusion Criteria: Students who deferred their semesters, relied entirely on third-party printed materials, or did not interact with the online student portal were excluded from the assessment.

- c. **Sample Estimation and Justification:** The justification for using purposive sampling lies in the highly specific operational criteria necessary for a precise environmental lifecycle assessment. To accurately quantify the "green" potential of the ODL model, it was imperative to select participants who actively engage with e-courseware and digital portals. A simple random sampling method could potentially include inactive or non-digitised students, thereby undermining the measurement of the intended technological shift. While a sample size of 157 restricts broad generalisability across the entire Nigerian university population, it serves as a scientifically rigorous "proof of concept" to model real-world carbon-saving behaviours within a specialised ODL framework.

Instrumentation, Validity, and Reliability

Data were collected via a structured electronic questionnaire designed with three core modules:

1. **Commuting Logistics:** This module tracks round-trip distances, primary modes of transport, and frequencies of campus/study centre visits.
2. **Hardware Utilisation:** This component identifies the primary learning devices used by students (e.g., desktops versus energy-efficient laptops) and secondary energy usage, specifically the runtime of decentralised petrol or diesel generators during grid outages.
3. **Resource Consumption:** This section assesses students' preferences for digital e-courseware compared to printed materials.
4. **Validity:** To establish face and content validity, the self-designed instrument was subjected to peer review by a panel of three experts in English Language Education and Educational Research Metrics to ensure item clarity, relevance, and alignment with the research objectives.
5. **Reliability:** The electronic instrument was pre-tested via a pilot study involving 20 students (who were excluded from the final sample). Internal consistency was determined using Cronbach's alpha, yielding a reliability coefficient of $\alpha = 0.82$, confirming the instrument's stability for quantitative collection.

Data Collection, Ethical Considerations, and Statistical Analysis

The survey was administered electronically via encrypted Google Forms over four weeks. Ethical clearance was obtained from institutional authorities prior to distribution. Participants were presented with an electronic informed consent form on the opening page of the survey; anonymity was strictly preserved, and participation was entirely voluntary with no academic or financial penalties for withdrawal.

Once collection concluded, the raw behavioural data were exported into Microsoft Excel and SPSS (Version 27) for processing. To translate behavioural travel and resource data into quantifiable carbon metrics, primary survey responses were integrated with localised and international emission factors. Avoided emissions were calculated using descriptive statistical matrices.

Transportation emissions were determined by computing individual Vehicle Kilometres Travelled (VKT) based on student commute routes and multiplying them by the baseline transport emission factor (118 g CO₂/km) established in the Federal Government of Nigeria’s (2021) Updated NDC. This empirical dataset was evaluated against a traditional brick-and-mortar baseline commute frequency of 4.2 days per week (Roy et al., 2008) to establish the net variance.

A comparative analysis of the primary data reveals a stark contrast between traditional commuting requirements and actual ODL attendance patterns (see Table 1). The empirical evidence indicates that the 157 students sampled collectively prevent the emission of approximately 2.78 metric tons of CO₂ every month.

Table 1: Commuting Patterns and Carbon Footprint Analysis (n=157)

Metric	Traditional (Hypothetical Baseline)	Model	ODL (Empirical Survey Data)	Model	Variance Absolute Savings	/
Average Commute Frequency	4.2 Days / Week		1.8 Days / Month		-90% frequency	
Total Monthly Trips (Aggregate)	2,637 Trips		283 Trips		2,354 Saved	Trips
Estimated Monthly VKT	26,370 km		2,830 km		23,540 Avoided	km
Monthly Emissions CO ₂	3,111.66 kg CO ₂		333.94 kg CO ₂		2,777.72 Saved	kg
Annual Footprint CO ₂	37,339.92 kg CO ₂		4,007.28 kg CO ₂		33,332.64 Saved	kg

Note: VKT = Vehicle Kilometres Travelled. Based on an average 10km round-trip and the FGN 2021 transport factor (118g/km). Source: Compiled by the Author (2026), based on primary survey data (n=157) and emission factors from the Federal Government of Nigeria [FGN] 2021 NDC Update.

Results and Discussion

Multi-Dimensional Sustainability Synthesis

The cumulative environmental benefit of the ODL model extends beyond transport, encompassing hardware efficiency and digitised resource management as summarised in Table 2. By synthesising primary survey data with international benchmarks from Gartner (2021) and Roy et al. (2008), the study identifies a total reduction in institutional environmental impact.

Table 2: Multi-Dimensional Carbon Savings Synthesis

Savings Category	Traditional Requirement	ODL Equivalent	Carbon Savings Logic
Transportation	Daily campus commute	Monthly study centre visit	2,778 kg CO₂ / Month (Based on survey VKT reduction; Roy et al., 2008)
Hardware	Desktop PC (High energy)	Laptop / Mobile Device	87% Reduction (Yin et al., 2022)
Learning Materials	Printed Textbooks (300pg)	e-Courseware (PDF)	3.6kg – 7.5 kg CO₂ saved per textbook (Bolanča Mirković & Bolanča, 2024)
Paper Use	2,000+ pages/semester	~12 printed pages/month	1.85kg CO₂ saved per 20 pages (Excluding domestic generator factor; Versteijlen & Janssen Groesbeek, 2024)

Source: *Synthesised by the Author (2026) from primary survey results and international lifecycle assessment (LCA) benchmarks (Bolanča Mirković & Bolanča, 2024; Roy et al., 2008; Versteijlen & Janssen Groesbeek, 2024).*

The data in Table 2 illustrates that the sustainability of the ODL model is not dependent on a single factor, but rather a synergistic reduction across critical operational domains: transportation logistics, hardware energy optimisation, and digital resource management. While the 2,778 kg of CO₂ monthly transport saving represents the most immediate decarbonisation of student logistics, the transition to mobile-first hardware and digital courseware addresses the hidden carbon costs of higher education delivery frameworks.

By utilising energy-efficient laptops or mobile devices rather than high-load traditional desktop systems, the student-end operational energy demand can be reconfigured efficiently within decentralised study environments (Yin et al., 2022). Furthermore, the shift to e-Courseware effectively eliminates the high-carbon lifecycle of physical textbook production, which can reach up to 7.5 kg CO₂ per unit volume (Bolanča Mirković & Bolanča, 2024). This multi-dimensional efficiency suggests that the single-mode ODL architecture serves as a comprehensive climate mitigation tool, capable of significantly lowering the indirect emissions that typically dominate the institutional footprint of traditional Nigerian universities (Versteijlen et al., 2017).

Comparative and Theoretical Discussion

The empirical findings established in this study provide crucial real-world validation for the core tenets of Ecological Modernisation Theory (EMT). According to EMT, environmental degradation can be effectively decoupled from economic and structural development through purposeful institutional modifications and technological substitution (Huber, 1982; York et al., 2003). The transition from a brick-and-mortar conventional university framework to the single-mode ODL model at the National Open University of Nigeria (NOUN) perfectly illustrates this structural decoupling. Rather than restricting educational access to achieve environmental preservation, the digital-first model expands academic opportunities across

the federation while simultaneously dropping automotive transport demands by 90% and aggregate paper consumption by 93%.

When situated within the broader global literature, the monthly mitigation of 2.78 metric tons of CO₂ across the 157 sampled students validates the Scope 3 commuting patterns observed in the Global North. For instance, our baseline transport saving of 17.7 kg of CO₂ per student each month strongly supports the foundational models of Roy et al. (2008) in Europe, which demonstrated that distance learning architectures reduce transport energy expenditure by approximately 85–90%.

However, a sharp comparative divergence emerges when analysing the resource consumption and hardware lifecycle dynamics. While global scholarship (e.g., Versteijlen & Janssen Groesbeek, 2024; Yin et al., 2022) argues that digital transitions yield a flawless, friction-free green path, our localised data uncovers an "Energy Paradox" or an "incomplete modernisation" specific to sub-Saharan Africa. The fact that 76% of the sampled Nigerian distance learners must rely on decentralised, low-capacity petrol or diesel generators introduces a structural carbon surcharge of 1.15 CO₂/kWh, nearly triple the emission intensity of a centralised municipal grid (0.42 CO₂/kWh).

Despite this localised energy overhead, the wholesale displacement of paper pulp manufacturing and physical material logistics (saving 3.6 kg to 7.5 kg of CO₂ per 300-page textbook, following (Bolanča Mirković & Bolanča, 2024) ensures that the net environmental balance remains profoundly positive. The digital transition still yields a clear, uncompromised lifecycle saving of 11.4 kg of CO₂ per student per semester. This proves empirically that technological innovation within an ODL framework can successfully absorb and overcome regional infrastructural inefficiencies, offering a resilient model for sustainable higher education in the Global South.

Socio-Technical Challenges and Implementation Framework

As noted during the empirical evaluation, the environmental optimisation of Open and Distance Learning is not an automatic technological outcome; rather, it is a complex socio-technical negotiation wrapped in regional structural constraints. To fully realise the carbon-mitigation potential of ODL across the Nigerian higher education sector, a series of deeply entrenched institutional and socio-cultural barriers must be systematically addressed.

1. Persistent Infrastructural Deficits and the Mindset Barrier

The primary operational challenge to sustainable ODL delivery remains the highly uneven distribution of digital infrastructure and stable internet connectivity across Nigeria's geopolitical zones. While the ODL model shifts the carbon burden away from centralised university campuses, it decentralises the energy requirement, placing a heavy technical and financial burden on individual students who must navigate erratic power supplies and exorbitant mobile data costs.

This infrastructural divide is further compounded by a persistent socio-cultural mindset that frequently discredits distance education as inferior to traditional face-to-face instruction. This historical bias drives resistance among certain academic labour unions and regulatory bodies, creating unnecessary pressure to preserve outdated, resource-heavy physical

administrative structures and physical verification cycles that counteract the institution's decarbonisation goals.

2. Multi-Agency Policy and Regulatory Realignment

Overcoming these systemic challenges requires an integrated, cross-sectoral governance approach. The implementation of a green educational framework cannot occur in isolation within the Ministry of Education; instead, it demands a coordinated policy realignment across multiple government ministries, departments, and regulatory agencies:

- i. **The National Universities Commission (NUC):** The regulatory benchmark for Nigerian higher education must transition away from models that evaluate institutional quality based on physical infrastructure, physical seat capacity, and printed volumes. The NUC must design modern, flexible accreditation standards that explicitly reward virtual learning environment (VLE) integration, digital portfolio development, and green institutional metrics.
- ii. **The Federal Ministry of Communications, Innovation and Digital Economy:** To mitigate the digital divide and reduce student dependence on domestic generators, this ministry must partner with telecommunications providers to establish subsidised, low-latency "Academic Data Bundles" and expand broadband fibre penetration to peri-urban and rural study hubs.
- iii. **The Federal Ministry of Environment:** In alignment with Nigeria's 2021 Updated Nationally Determined Contributions (NDC), the Ministry of Environment should formally integrate the higher education sector into the national carbon accounting framework. By recognising single-mode ODL institutions as active drivers of Scope 3 transport mitigation and forestry preservation, the government can unlock international climate finance and green bonds to fund regional solar-powered ODL study centres.
- iv. **The Federal Ministry of Power and Rural Electrification Agency (REA):** Targeted deployment of decentralised solar mini-grids must be prioritised for ODL study centres nationwide. By transforming these regional hubs into self-sustaining, renewable-energy clean spaces, the state can eliminate both the campus institutional carbon footprint and the student-end generator surcharge, cementing ODL as a flawless pillar of national sustainable development.

Conclusion

This study has empirically established and quantified the profound environmental utility of Open and Distance Learning (ODL) as a structural vehicle for carbon mitigation within the Nigerian higher education sector. Driven by dual research objectives, the investigation successfully mapped real-world behavioural student data from the National Open University of Nigeria (NOUN) onto localised and international environmental lifecycle metrics. Regarding the first objective, quantifying the net variance in transport-related carbon emissions CO₂ the empirical evidence demonstrates that the single-mode ODL framework cuts physical commuting frequencies by 90%, dropping trips from a traditional baseline of 4.2 days per week to a localised operational average of 1.8 days per month. This behavioural shift translates to an aggregate mitigation of 2.78 metric tons of CO₂ monthly across the 157 sampled students, preventing approximately 33.33 metric tons of atmospheric CO₂ accumulation annually. Concerning the second objective, modelling the lifecycle resource savings derived from digital e-Courseware substitution, the research

confirms that bypassing traditional paper pulp manufacturing and logistical book distribution yields a net lifecycle saving of 11.4 kg of CO₂ per student each semester. Cumulatively, these multi-dimensional metrics offer clear, undeniable proof that digital structural updates in higher education delivery can actively support national climate goals under the Federal Government of Nigeria's 2021 Updated Nationally Determined Contributions (NDC).

At a theoretical level, these empirical milestones significantly advance the contextual application of Ecological Modernisation Theory (EMT) within the unique socio-technical landscape of the Global South. This research provides a realistic, reflexive application of the theory by identifying and incorporating the regional "Energy Paradox" wherein 76% of distance learners must rely on decentralised, low-capacity domestic petrol generators due to national grid failures directly into the modernisation matrix. The final calculations prove that despite an environmental energy surcharge of 2.11 kg of CO₂ per month imposed by domestic fuel combustion, the technological efficiencies of the ODL model successfully absorb and overcome this localised carbon overhead. Consequently, this study demonstrates that institutional modernisation does not require a flawless national grid to achieve environmental utility; rather, structural technological transitions can successfully drive the "decoupling" of educational expansion from carbon intensification within unstable infrastructural environments.

Limitations

To ensure strict analytical precision and transparency, several institutional and methodological boundaries of this study must be explicitly stated:

- 1. Scope of the Analytical Boundary:** This research intentionally isolated its quantitative boundary to the carbon footprint generated directly by active student commuting logistics, individual learning hardware utilisation, and digital courseware resource consumption.
- 2. Exclusion Criteria:** It explicitly excluded the internal institutional carbon footprints generated by university administrative staff, non-academic personnel, corporate procurement cycles, and the physical building lifecycles of centralised university headquarters or regional study centres.
- 3. Sample Generalisability:** While the purposive sample size of 157 respondents provided a robust, data-rich "proof of concept" to model authentic carbon-saving behaviours at NOUN, it restricts broad statistical generalisability across the entire diverse landscape of Nigerian university students. The self-reported nature of the electronic survey data also relies on participant estimates of round-trip mileage and generator runtime, which introduces minor variance into the descriptive transport metrics.

Directions for Future Research

The boundaries and findings of this study open up critical avenues for subsequent academic inquiry:

1. **Expansion of Institutional Scope:** Future research should expand the analytical boundary to incorporate the behavioural logistics, transport modes, and workplace energy expenditures of academic and non-academic staff across single-mode ODL institutions to build a comprehensive, full-scale corporate carbon footprint analysis.
2. **Comparative Cross-Institutional Modelling:** Comparative empirical studies should be conducted between single-mode ODL institutions (like NOUN) and conventional brick-and-mortar Nigerian universities to map the net carbon variance across different institutional delivery models using identical localised emission factors.
3. **Advanced Lifecycle Evaluations:** Future investigations would benefit from utilising automated, GIS-mapped spatial tracking software to calculate real-world Vehicle Kilometres Travelled (VKT) and precise tailpipe emissions across varying urban transport modes.
4. **Empirical Modelling of Emerging Technologies:** Lastly, empirical research is urgently needed to model the precise carbon impact of integrating Artificial Intelligence (AI) and cloud-based Learning Management Systems (LMS) within regional distance education networks, specifically evaluating the net balance between data centre energy demands and the environmental savings achieved through optimised student screen time.

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