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ASSESSMENT OF DIGITAL EDUCATION AND CAPACITY BUILDING THROUGH INTERDISCIPLINARY RESEARCH IN NIGERIAN TERTIARY INSTITUTIONS

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Abstract

The advent of digital technology has transformed educational landscapes globally, and Nigeria is no exception. This paper explores the transformative potential and practical challenges of integrating Artificial Intelligence (AI) into the Nigerian educational landscape, aimed at addressing systemic hurdles such as the estimated 18.5 million out-of-school children and high illiteracy rates. By analyzing the uses and impact of AI on teaching and reading, the study highlights the significance of digital education through Personalized and Adaptive Learning (PAL), which offers scalable solutions to overcrowded classrooms and uneven teacher distribution. The research advocates for a "hybrid human-AI" capacity-building model, where educators transition from primary content providers to facilitators, leveraging "virtual tutors" and automated assessment tools to enhance engagement and efficiency. Among the findings from the assessment reveal a paradox of high readiness versus low infrastructural capability. While Nigerian teacher educators demonstrate a strong positive perception of AI (Mean score 3.35) and a high willingness for training (87.1%), adoption is critically hampered by financial constraints (42.3%) and infrastructural deficiencies (25%), including unstable electricity and low internet penetration Significant gaps identified include a "digital divide" that restricts AI access to privileged institutions and a "sociolinguistic mismatch" where global AI tools lack local cultural and linguistic context. Furthermore, the study underscores ethical risks such as "metacognitive laziness" and data privacy concerns. The paper concludes that achieving equitable scale requires prioritizing government investment in basic infrastructure (Pillar 3 of NDEPS), mandating culturally relevant AI tools, and implementing robust ethical frameworks to ensure AI complements rather than replaces human pedagogy.

keywords: Artificial Intelligence (AI), Digital Education, Capacity Building, Learning Divide

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Introduction

The integration of technology into the processes of teaching and learning is no longer optional for Nigerian tertiary institutions (TIs), driven by twin imperatives: the need to expand access to a burgeoning student population and the global market demand for digitally literate graduates (Okorie & Nwafor, 2023). The onset of the COVID-19 pandemic served as a critical accelerant, exposing the deficiencies of traditional, physical-setting educational models and compelling an urgent, albeit often under-resourced, shift toward technology-mediated instruction (Akaeze & Akaeze, 2024). The transition is governed by ambitious policy frameworks, which mandate the development of infrastructure and digital competence across TIs (FME, 2022). However, institutional frameworks often exhibited significant resistance to change prior to the pandemic, compounding the challenge of achieving effective digital integration (Afolabi, 2023). The move to digital education is thus both a reactive response to disruption and an ambitious long-term goal for achieving global competitiveness.

To ensure that technology integration moves beyond mere administration and genuinely improves instructional quality, a structured assessment of the digital ecosystem is imperative (Moore & Kearsley, 2012). This paper aims to assess the major infrastructural, human, and policy challenges impeding effective digital education in Nigerian TIs. Evaluate the efficacy of current capacity building and funding interventions (TET Fund). Propose a holistic, Interdisciplinary Research (IR) model as a mechanism for achieving sustainable and context-specific digital transformation.

Conceptual Clarifications

Digital education refers to the use of digital technologies to facilitate learning and teaching processes. In Nigeria, the adoption of digital education has been slow, primarily due to infrastructural deficits, socio-economic challenges, and a lack of trained personnel (Adebayo,

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2020). However, the potential benefits of digital education, such as increased accessibility, flexibility, and the ability to cater to diverse learning needs, have been widely documented (Ogunleye, 2019).

Capacity building, on the other hand, involves developing skills, knowledge, and competencies to improve individual and organizational performance. In the context of education, capacity building is essential for equipping educators and learners with the necessary tools to thrive in a digital age (Ibrahim & Olatunji, 2021).

Interdisciplinary research, which combines insights from various fields, can play a crucial role in addressing the multifaceted challenges of digital education in Nigeria (Nwafor, 2022). Interdisciplinary research is the process of integrating knowledge and methods from different disciplines to address a complex issue. It involves collaboration between researchers from various fields to provide a holistic solution. In the Nigerian context, interdisciplinary research has proven to be successful in tackling the challenges faced in the education sector, mainly related to digital education and capacity building (Adebayo, 2020).

One of the main benefits of interdisciplinary research in digital education and capacity building is that it brings together diverse perspectives and expertise. Nigeria is a country with a rich cultural and linguistic diversity, and this is reflected in the education system. Therefore, interdisciplinary research helps to bridge the gap between different subject areas and encourages a more interdisciplinary approach to teaching, which can enhance the learning experience for students (Adebayo, 2020).

Furthermore, interdisciplinary research helps to develop critical thinking skills, which are essential for the 21st-century workforce. In a country like Nigeria, where the job market is rapidly evolving,

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individuals need to possess the ability to think critically and adapt to new technologies and industries. Through interdisciplinary research, students are encouraged to approach problems from different angles, leading to the development of analytical and problem-solving skills.

This transformative potential is best realized through interdisciplinary collaboration, combining the expertise of technologists, educators, and social scientists. Such synergy yields targeted, contextually relevant solutions. For example, in Technology and Pedagogy, the World Bank-supported pilot project exemplifies this, demonstrating the efficacy of using Generative AI (an output of computer science) as an instructional assistant in collaboration with human teachers (pedagogy). This approach resulted in enhanced student performance in English language learning, with the AI providing instant, personalized feedback on grammar and writing.

AI & Local Context (Linguistics/Cultural Studies): The DSN AI Innovations project is a powerful illustration of blending AI development with local content creation. It leverages GPT models and text-to-video AI to create personalized STEM video lessons that deliberately integrate local contexts and nuances, making complex subjects more comprehensible for Nigerian students, especially those in rural areas.

Computer Science & Linguistics: To overcome the existing sociolinguistic mismatch of global AI tools, interdisciplinary research is critical. Projects like the N-ATLAS initiative focus on digitizing local languages and generating rich, contextually relevant datasets. This effort, driven by computational linguistics, is essential to ensure that AI tools are culturally appropriate and socio-linguistically relevant to the Nigerian curriculum. This concerted approach ensures that AI is developed and deployed to meet Nigeria’s unique educational and cultural needs.

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In today's digital age, the need for quality education and a skilled workforce is more crucial than ever. With the constant advancements in technology and the ever-changing job market, it is essential for countries to invest in digital education and capacity building. In this regard, interdisciplinary research has emerged as a powerful tool in Nigeria to address the gaps in the country's education system and to equip individuals with the necessary skills for the future (Ogunode & Olaitan, 2023).

Rationale for Assessing the Digital Education Ecosystem

To ensure that technology integration moves beyond mere administration and genuinely improves the quality of teaching, learning, and research, a structured assessment of the digital ecosystem is imperative (Ibrahim & Olatunji, 2021). Such an evaluation is necessary to measure institutional readiness, determine the efficacy of government-led capacity-building interventions, and evaluate their long-term impact on instructional quality and institutional resilience (Nwafor, 2022). The analysis is essential to address the recognized wide disparity between ambitious policy mandates and the constrained realities of implementation, which are often dictated by chronic challenges related to funding, infrastructure, and capacity development across the tertiary landscape (Ogunleye, & Adebayo, 2021).

The assessment of AI adoption in Nigerian education will influence policy and implementation strategies in the following two major ways which include prioritizing Infrastructure Investment, as the the primary barriers to AI adoption are Financial Constraints (42.3%) and Infrastructural Deficiencies (25.0%) will force a shift in policy focus. Policy Influence rather than allocating substantial funds to acquiring advanced AI software (which is currently inaccessible to the majority), policy will be compelled to prioritize "Pillar 3" (Critical Infrastructure). This means dedicating budgetary resources to foundational necessities like ensuring stable electricity,

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procuring affordable hardware, and expanding internet connectivity especially in rural public schools. Also, implementation Strategies will focus on "low-bandwidth, offline-capable" AI solutions and public-private partnerships to close the digital divide, ensuring that implementation starts from the ground up rather than focusing solely on urban centers.

Secondly, Policy will be shaped to mandate that educational AI tools must be culturally and linguistically relevant. This will drive investment and collaboration in initiatives like N-ATLAS to generate local language data, ensuring AI applications are effective for Nigerian students. Furthermore, policies will require ethical guidelines to manage data privacy and specifically counter the risk of "metacognitive laziness. Strategies should pivot from basic ICT training to specialized Capacity Building focused on the hybrid human-AI model. This involves compulsory professional development for teachers in prompt engineering and data management, turning educators into skilled supervisors of AI tools, which is necessary for effective and ethical deployment.

Infrastructural Deficits and the Digital Divide

The most pronounced impediment to digital education in Nigeria is the chronic infrastructure deficit (Haruna, 2018). Studies consistently highlight three major infrastructural barriers, unstable power supply (electricity), unreliable and low-speed internet connectivity, and the high cost of data for both faculty and students (Akaeze & Akaeze, 2024).

i. Power Supply: Digital learning systems cannot function without a reliable power source, yet TIs and student residences frequently suffer from erratic electricity, forcing reliance on expensive generators (Haruna, 2018).
ii. Connectivity and Cost: Poor network connectivity and limited bandwidth hinder the successful deployment of resource-intensive platforms like Learning Management Systems

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(LMS) and Virtual Learning Environments (VLE) (Nwabufo, 2021). Furthermore, the high cost of data exacerbates the digital divide, creating significant socio-economic and regional disparities in access, thus undermining the national goal of equitable quality education (Afolabi, 2023). Studies investigating AI adoption among academic staff at institutions like the Federal University of Technology, Akoka. (2024) provide quantified metrics detailing these constraints.

Table 1: Quantified Barriers to AI Adoption in Nigerian Educational Institutions

Barrier Category	Specific Challenge	Percentage of Respondents
Financial	Inadequate Funding/High Costs	42.3%
Infrastructural	Deficiencies (Internet, Electricity, Hardware)	25.0%
Human Capital	Limited Technical Expertise	15.4%
Policy/Cultural	Resistance to Change (Traditional Norms)	persistent challenge

Source: (Federal University of Technology, Akoka, 2024)

Policy Implementation and Funding Interventions

The Tertiary Education Trust Fund (TET Fund) is the primary government agency mandated to intervene in the funding and development of public TIs. TET Fund's ICT Support intervention is designed to procure physical ICT facilities, provide institutional bandwidth, and sponsor staff capacity development (Ogunode & Ade, 2023). While TET Fund has demonstrably contributed to the construction of ICT centers and the procurement of hardware (Jasper & Aliyu, 2021), the assessment reveals significant implementation bottlenecks.

1. Utilization Gaps: Infrastructure is often underutilized due to maintenance issues or lack of complementary skills (Ogunode & Ade, 2023).

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2. Focus on Hardware: The intervention tends to prioritize physical infrastructure over the necessary pedagogical transformation required for effective e-learning integration (Ogunode & Olaitan, 2023).
3. Policy Fidelity: Despite NUC and FME policies, implementation fidelity at the institutional level remains low, often due to a lack of institutional-specific policies, inadequate technical support, and poor monitoring (Okorie & Nwafor, 2023).

The positive outcomes of a large-scale pilot project such as World Bank-supported pilot project utilizing Generative AI (ChatGPT), English language learning, specifically grammar and writing. Teachers adopted the role of facilitators, while the AI chatbot functioned as an instructional assistant. The AI provided instant feedback on grammatical errors, vocabulary, and coherence. The project demonstrated the efficacy of a hybrid human-AI regulation model. Also, the use of prompt engineering by teachers was instrumental in making the AI's responses more useful and relevant by generating examples linked to the local context and environment. The collaboration confirmed that AI excels when human educators actively manage its deployment and tailor its output, leading to enhanced academic outcomes. While highly effective, it was noted that AI use in general is unevenly distributed, primarily benefiting privileged public schools, top-rated private schools, or mission schools. The fundamental barriers of high costs (42.3%) and infrastructural deficiencies (25.0%) mean that successful small-scale implementations like this often fail to achieve true national scale.

Sustainable Digital Transformation

The problems identified infrastructural decay, policy-reality gaps, and human capacity deficits are systemic and interconnected. A purely technical, purely pedagogical, or purely administrative

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approach will fail to provide sustainable solutions (Moeenian, Sowa, & Adebayo, 2022). The Sustainable transformation in Nigeria's educational sector through AI is fundamentally a question of political economy and targeted investment, not merely technological adoption. The high readiness and positive attitude of Nigerian teacher educators, evidenced by a total mean of 3.35 in positive perception and 87.1% willingness for training, demonstrate that cultural resistance is minimal. However, achieving equitable and national scale is impossible without first overcoming the dominant systemic barriers that constitute the digital divide (Afolabi, 2023). The government must prioritize massive investment in reliable electricity, hardware procurement, and high-speed internet penetration which aligns with Pillar 3 of the National Digital Economy Policy and Strategy (NDEPS) (Akinola,2023). Addressing the financial gap (42.3%) and infrastructural deficiencies (25.0%) is the essential prerequisite for moving AI beyond small, controlled pilots toward a durable and widely accessible system that truly combats the high out-of-school population (Akaeze, & Akaeze, 2024).

The second pillar of sustainable transformation rests on pedagogical evolution and ethical governance to ensure AI complements, rather than replaces, the essential human elements of teaching and learning. Sustainability requires institutionalizing the hybrid human-AI regulation model. Educators must undergo compulsory and customized training to shift their role from primary content provider to a facilitator and mentor, effectively supervising AI deployment and utilizing prompt engineering to tailor its output. Furthermore, transformation must be socio-linguistically sustainable; policymakers must mandate the adoption of AI tools that are culturally appropriate and contextually relevant to mitigate the limitations of standardized global tools (Afolabi, 2023). Finally, robust ethical policies must be developed to cover data privacy and algorithmic transparency, and, critically, to integrate ethical AI literacy into the national

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curriculum to prevent pedagogical risks such as "metacognitive laziness" from over-reliance on Gen-AI.

Components of the Interdisciplinary Research Model

The IR model proposes collaboration between three core disciplines to co-create context-specific solutions (Sowa, Adebayo & Okonkwo, 2024):

a) **Technical Engineering and ICT Science:** Focuses on optimizing infrastructure, ensuring network resilience, developing context-appropriate digital tools, and implementing preventive maintenance protocols (Haruna, 2018).
b) **Pedagogical Science and Education Management:** Focuses on instructional design, developing new digital curricula, assessing the efficacy of e-learning tools, and creating specialized, domain-specific digital pedagogy training for faculty (Bates, 2020).
c) **Socio-Economic Analysis and Public Policy:** Focuses on mapping the digital divide, analyzing the cost-benefit of different interventions, recommending policy adjustments, and developing mechanisms for subsidized access for low-income populations (Afolabi, 2023).

Capacity Building and Digital Illiteracy among Faculty

Effective digital education hinges on the digital literacy of academic staff (Jongsermtrakoon & Nasongkhla, 2015). A significant gap exists between the digital competency required for modern pedagogy (e.g., using mobile learning, AI tools, and VLEs) and the current skills possessed by many faculty members in Nigeria (Amuche, 2022). Capacity building (CB) interventions, often sponsored by TET Fund, have been initiated to address this (Akinola et al, 2023).

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However, training programs frequently suffer from a lack of specialization, focusing on generic ICT skills rather than advanced, domain-specific digital pedagogy, the art of teaching effectively with technology (Borthwick & Hansen, 2017). This low faculty expertise means that even when infrastructure is available, lecturers struggle to transfer traditional teaching methods effectively to digital platforms, limiting the adoption of innovative instructional practices (Bates, 2020).

Mechanism for Enhanced Implementation Fidelity

The interdisciplinary research model provides a pathway for enhancing implementation fidelity:

Contextualization: I R ensures that ICT solutions are not merely imported but are indigenously adapted to the realities of Nigerian power, connectivity, and socio-cultural environment.

Capacity Integration: Training programs developed by the Pedagogical arm are informed by the infrastructural capacity limits identified by the technical arm, ensuring those faculties are trained on tools that the university can reliably support.

Sustained Monitoring: By integrating Engineering and Policy analysis, IR facilitates the development of robust monitoring and evaluation frameworks to track the utilization, maintenance, and educational impact of digital assets over time (Ogunode et al., 2023).

The stakeholders include Federal and State Ministries of Education, Ministry of Communications and Digital Economy, Nigerian Communications Commission (NCC), Global tech firms (e.g., MTN, Glo, Airtel), and International Development Partners (e.g., World Bank, UNICEF) should consider the following practical steps:

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i. Convene a National AI in Education Infrastructure Summit to commit resources specifically to Pillar 3 of NDEPS (Critical Infrastructure).
ii. Form Public-Private Partnerships (PPPs) with telecoms and ISPs (Internet Service Providers) to secure subsidized, reliable, and solar-powered broadband connectivity for public schools, particularly in underserved rural areas.
iii. Establish a National Device Procurement Fund (e.g., subsidized tablets/laptops) supported by development banks to overcome the high cost of hardware access for low-income schools and students.

Conclusions

In conclusion, interdisciplinary research has emerged as a powerful means to promote digital education and capacity building in Nigeria. By bringing together diverse perspectives and expertise, it has the potential to address the challenges faced by the education system and equip individuals with the necessary skills for the future workforce. However, to fully harness the benefits of interdisciplinary research, there is a need for increased collaboration and support from all stakeholders in the education sector. With a holistic and interdisciplinary approach, Nigeria can pave the way for a brighter and more digitally equipped future for its citizens. The assessment confirms that digital education in Nigerian tertiary institutions is constrained by critical infrastructural shortfalls, a persistent digital divide, and disconnect between funding interventions and actual pedagogical transformation. To bridge the significant gap between policy intentions and operational reality, a fundamental shift in approach is required.

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Suggestions/Way forward

1. Adopt the Interdisciplinary Research (IR) Model: University management and funding agencies (TET Fund) should mandate and fund interdisciplinary research clusters composed of ICT Engineers, Educational Psychologists, and Public Policy experts. These clusters must collaboratively design and evaluate all future digital education projects.
2. Prioritize Digital Pedagogy CB: Capacity building must shift decisively from generic ICT literacy to specialized, domain-specific digital pedagogy and foundational competence in emerging technologies like Artificial Intelligence (AI) (Borthwick & Hansen, 2017).
3. Address the Access Divide: Government agencies must implement mechanisms, in conjunction with Public-Private Partnerships (PPP), for subsidized internet access and affordable digital devices to combat the severe socio-economic and regional digital divide (Afolabi, 2023).

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