CHALLENGES AND OPPORTUNITIES OF INTEGRATING ARTIFICIAL INTELLIGENCE INTO TEACHER EDUCATION DEVELOPMENT IN NIGERIA: A CONCEPTUAL REVIEW.

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Abstract

The rapid advancement of artificial intelligence (AI) is currently reshaping global education, fundamentally altering how knowledge is created, shared, and assessed. In the Nigerian context, the integration of AI into teacher education programs offers a pivotal opportunity to enhance the quality, effectiveness, and inclusivity of future educators; however, this potential remains largely untapped due to systemic barriers. This paper explores the current state of AI adoption within Nigerian teacher education institutions. It seeks to identify the specific opportunities AI presents for teacher preparation while critically analysing the multifaceted challenges that impede its successful implementation. Adopting a conceptual review approach, this paper synthesises current literature, drawing on peer-reviewed journal articles, policy documents and authoritative reports published between 2019 and 2025 to examine the intersection of AI and pedagogical training. It evaluates the socio-technical environment of Nigerian tertiary institutions to assess their readiness for technological integration. The study reveals that while AI is essential for modernising teacher education, its implementation is significantly constrained by infrastructure deficits, limited human capacity, inadequate policy framework and cultural resistance. The paper asserts that while AI is transformative, its benefits can only be realised through deliberate, policy-backed strategies. It concludes by recommending that policymakers and regulatory bodies prioritise the development of comprehensive national guidelines for AI in teacher education to ensure a sustainable and equitable transition.

Keywords: Artificial Intelligence, Teacher Education, Challenges, Opportunities

Introduction

The swift adoption of Artificial Intelligence (AI) across various sectors, including healthcare, finance, and manufacturing, has significantly reshaped the course of modern society. As a primary driver of innovation, AI is increasingly recognised as a transformative force in education, signalling a shift in how teaching, learning, and assessment are conceptualised (Chen et al., 2020). Globally, educational systems are implementing AI initiatives as a strategic response to prepare students for a technologically advanced future, ensuring they possess the essential skills required for a changing labour market. The landscape of AI in Education (AIED) is broad, encompassing various technological applications such as adaptive learning platforms (e.g., DreamBox, Knewton Alta), language learning tools (e.g., Duolingo), and intelligent tutoring systems (Wang, 2024). Furthermore, AI-driven administrative tools, such as classroom management software (Classcraft, LanSchool) and performance analytics systems (Google Classroom, PowerSchool), are revolutionising the educational environment by automating routine tasks and providing educators with data-driven insights into student progress (Balarabe, 2025; Wang, 2024).

In Nigeria, the teacher remains the cornerstone of educational success; it is widely accepted that no education system can rise above the quality of its teachers. Consequently, teacher education programs must evolve to incorporate emerging technological methodologies. As society becomes increasingly reliant on intelligent devices, AI literacy has transitioned from a specialised skill to a fundamental necessity for both pre-service and in-service teachers (Balarabe, 2025). Designing and implementing a robust AI curriculum is no longer optional; it is a critical mandate to ensure that teachers possess the competencies required to leverage AI effectively (Ali, 2025; Panagou et al., 2025). However, the rapid expansion of AI is a double-edged sword, presenting both profound opportunities for personalised learning and significant challenges, including ethical concerns and implementation barriers (Remain, 2019; Luan et al., 2020). While Generative AI has advanced machine learning capabilities, its successful adoption in Nigeria depends on overcoming infrastructure, policy, and training hurdles (Ayanwale et al., 2022).

This article intends to critically examine the integration of AI within the Nigerian teacher education program by analysing the current state of AI literacy among teachers, required to enhance instruction, identifying the challenges and barriers that hinder the effective implementation and proposing strategic recommendations for policymakers and curriculum developers to design a curriculum that integrates effective use of AI in Nigerian schools.

This paper, therefore, examines the opportunities and challenges of integrating AI into teacher education programmes in Nigeria and proposes strategic pathways for effective implementation.

Literature Review

The concept of artificial intelligence: The term Artificial Intelligence is defined as the application of computational intelligence to enhance and transform teaching, learning and administrative processes (McCarthy,2024). In an academic context, it is not merely about using software but a trans-disciplinary field that integrates computer science, pedagogy and psychology to create adaptive, personalised learning environments. (Ali, 2025). Basically, AI is a broad field of computer science and technology focused on creating systems capable of performing tasks that typically require human intelligence, such as learning, reasoning, and problem-solving.

AI systems achieve their functions by combining data, algorithms, and significant computing power. In essence, AI aims to replicate human cognitive functions, allowing machines to automate tasks, provide insights from data, and solve complex problems across various industries, from healthcare to transportation and finance. Its key features include:

1. **Learning**: AI systems, particularly those using machine learning, acquire rules for using information through statistical analysis of large datasets, improving their performance over time without constant human coding.

2. **Reasoning and Problem Solving**: AI uses logical rules and algorithms to approximate human reasoning, devise solutions for specific issues, and make data-driven decisions.

3. **Natural Language Processing (NLP):** This subfield enables computers to understand, interpret, and generate human language, powering chatbots, translation services, and voice assistants.

4. **Perception (Computer Vision):** AI systems can interpret visual and audio inputs from the environment, allowing for facial recognition, object detection, and speech recognition.

Artificial Intelligence in Education

The reach of AI in education is undeniable as it is increasingly integrated into various technologies, such as the handheld devices that students use every day (smart phones, tablets, wearable devices and robotics (Annus, 2024). The integration of AI into education is more than a technological trend; it represents a fundamental paradigm shift in how we approach teaching and learning. The modern conception of AI in education (AIED) began with early explorations in intelligent tutoring systems and automated assessment tools. However, Annus further observed that the widespread accessibility of generative AI, particularly with the public release of large language models like ChatGPT, has accelerated this shift dramatically. While this paradigm shift brought about a number of key benefits and opportunities, the integration of AI in education is not without its challenges.

Opportunities for AI Integration in Teacher Education

AI literacy for future teachers is crucial for preparing them to effectively leverage AI tools in the classroom to foster personalised learning, innovation, and collaboration. AI offers tools that shift education from conventional techniques to customised, efficient, and engaging experiences (Ayanwale et al, 2022). As AI technology becomes more integrated into educational environments, it offers specific, impactful tools for teachers to enhance engagement, critical thinking, streamline tasks and personalise instruction (Panagou etal, 2025). Some of the concrete benefits of AI in education that showcase how artificial intelligence can support teaching and learning include the following.

1. Personalized Learning Experiences: The literature indicates that AI improves individualised learning and is based on constructivist learning theory, which emphasises

the active participation of learners in knowledge construction through their experiences and reflections (Panagou et a, 2025). Therefore, constructivism suggests that students build knowledge through active experience; however, teacher education in Nigeria often faces a high student-to-teacher ratio, making lecture halls and individual students' attention nearly impossible. Adaptive learning platforms, therefore, act as a scalable tutor–on–demand for Al technologies, such as adaptive learning platforms and intelligent tutoring systems, tailor instruction to each student's pace, preferences, and needs. These systems adhere to constructivist principles by establishing individualised learning trajectories that enable learners to interact profoundly with knowledge and enhance their comprehension over time (Ayeni et al., 2024). From this viewpoint, AI serves as a facilitator of learning rather than direct information.

2. Data-Driven Instructions: AI systems can assess enormous volumes of instructional data, enabling data-driven instruction. This approach reduces cognitive load by helping teachers better understand the material they offer to their pupils, improving retention and involvement. To provide teachers with real-time feedback and insights, AI technologies examine student performance and behaviour patterns, enabling tailored training (Luan et al., 2020). In addition, AI can alleviate unnecessary workloads by automating data collection and analysis, allowing teachers to concentrate on creating learning experiences that enhance understanding.

3. Automated Administrative Tasks. Another AI capacity that has been studied is the automation of administrative duties like scheduling, attendance tracking, and grading (Panagou et al., 2025). This competence emphasises the necessity of reducing time waste and optimising resources. By automating mundane chores, educators can devote more time to instructional preparation and student engagement, eventually improving teaching quality (Ali., 2025).

4. Interactive Virtual Environments. The advancement of AI-powered interactive virtual environments, according to Ahmad et al. (2022), provides immersive and collaborative learning experiences that are consistent with social constructivism theory. Social constructivism asserts that learning is inherently social, and students acquire knowledge through interactions with their peers and environment. Interactive virtual environments

supported by AI offer opportunities for collaboration, allowing learners to engage in shared problem-solving and exploration in a controlled, dynamic setting. These environments not only enhance engagement but also facilitate personalised learning experiences, catering to diverse learning styles and promoting deeper understanding through active participation. AI-powered virtual environments, like immersive simulations or collaborative digital workspace can connect teacher trainees across different schools in Nigeria. They engage in shared problem solving, role play challenging classroom scenarios in a safe environment and construct knowledge with peers, effectively simulating a global classroom experience within a local context. However, these opportunities cannot be achieved without tackling some of the challenges that come with them, which are discussed below as well.

Challenges to AI Integration in Teacher Education

Despite the identified opportunities, the successful integration of AI into Nigerian teacher education faces significant, multifaceted barriers. These challenges span competence gaps, institutional deficits, and psychological resistance.

1. Competence and Readiness Gaps. Many teachers worldwide lack the necessary competencies to understand and use AI for pedagogical purposes, and this insufficient readiness is a major obstacle to integration in schools. In Nigeria, teacher preparation programs typically have not fully incorporated AI-related content, leaving future educators underprepared for an AI-driven educational landscape. Although pre-service teachers generally study courses like "Introduction to Educational Technology" and "ICT in Education," specialised AI training is largely absent from their required curriculum.

3. Policy and Infrastructure Limitations. AI integration requires substantial policy review and financial commitment. Nigeria has not yet introduced AI as a mandatory subject, despite the existence of computer studies in the curriculum; thus, it can be said that Nigerian AI lack specific-specific content. Key concerns raised by educational stakeholders regarding implementation include policy issues, lack of funding for infrastructural facilities, and a deficiency in appropriate learning resources. Without targeted policies and investments, disparities in resources and technological infrastructure

risk exacerbating the existing digital divide, leading to unequal access to quality AI education.

3. Psychological and Ethical Concerns. Psychological factors, including attitude and anxiety, are critical to the successful implementation of AI in schools. Teachers in Nigeria express concerns regarding potential job loss, an anxiety that stems from fear of AI's impact on employment rates (Annus 2024). They are troubled by potential equity issues, worried that specialised AI learning may be restricted primarily to private or urban schools with greater resources. Ethical concerns surrounding data privacy, algorithmic bias, and the potential negative societal implications of AI are also paramount, particularly for students.

4. The Use-Creation Trade-off. An unexpected finding (Ayanwale et al., 2022) among Nigerian pre-service teachers indicated a negative relationship between using and applying existing AI tools (UAAI) and actively participating in the creative process of AI creation (CRAI). This suggests a potential trade-off: a heavy reliance on using existing AI applications might diminish an educator's inclination or motivation to engage in designing and developing new AI applications. This highlights a challenge in curriculum design, where simply exposing teachers to existing tools may inadvertently hinder the cultivation of a creative, innovative mindset crucial for future AI developers. From a curriculum perspective, this creates an important dilemma. Many current educational programmes introduce AI primarily through practical exposure to ready-made tools such as automated grading systems, generative AI platforms, or intelligent tutoring systems. While these tools help teachers understand how AI can support teaching and learning, they often position teachers as passive users rather than active creators of AI-driven solutions. As a result, the curriculum may unintentionally limit deeper engagement with the technical, ethical, and creative aspects of AI development.

Another challenge is that excessive focus on AI usage may lead to technological dependency. Pre-service teachers may rely heavily on AI to generate lesson plans, teaching materials, or assessments without understanding the underlying algorithms, data processes, or design principles behind these technologies. This lack of foundational knowledge can prevent educators from critically evaluating AI tools, adapting them to local educational

needs, or contributing to the development of contextually relevant AI solutions, particularly in countries like Nigeria, where local educational challenges require innovative responses.

Furthermore, this trade-off can weaken the development of innovation and problem-solving skills, which are essential competencies in modern education. If the curriculum emphasises only the operational use of AI tools, pre-service teachers may not develop the computational thinking, creativity, and experimentation skills needed to design new AI-based educational applications. Over time, this may reduce the potential for teachers to become innovators or contributors in the AI ecosystem, leaving them primarily as consumers of technologies developed elsewhere.

Therefore, curriculum designers must carefully balance AI literacy, AI usage, and AI creation within teacher education programmes. Instead of focusing solely on how to use AI tools, curricula should incorporate activities such as basic AI programming concepts, project-based AI design tasks, problem-solving using data, and collaborative innovation projects. By doing so, pre-service teachers can develop both practical competence in using AI and the creative capacity to design AI solutions tailored to educational contexts.

5. Inadequate Preparation: The literature identifies inadequate AI preparation as a major barrier for pre-service and in-service teachers due to insufficient training in integration (Ali, 2025). Many teacher preparation programs fail to keep pace with technological advancements, leaving future educators ill-equipped to implement AI effectively. Without proper training, teachers may struggle with implementation, feeling overwhelmed by AI's complexities, which can undermine student engagement and limit AI's potential benefits. Ethical concerns, particularly regarding student data privacy and algorithmic bias, further complicate adoption (Remian, 2019).

Strategies for Teacher Education Development

To enhance the preparedness of teachers and ensure the successful, responsible integration of AI in Nigerian schools, a comprehensive approach involving deliberate policy changes, dedicated professional development, and curricular reform is essential.

1. Policy and Institutional Reform. Government action is crucial, starting with addressing the urgent need to develop future teachers for AI skills and experiences. A foundational step suggested is for the government, through relevant authorities, to mandate that all universities and colleges incorporate AI education as a compulsory course for all students and specifically in teacher education, regardless of their discipline, within teacher education programs (B.Ed.). Policymakers must also enact strategic policies targeted at AI education and support research reports on AI learning to address the institutional concerns identified by stakeholders.

2. Comprehensive AI Professional Development (PD). Teacher education programs focused on AI must be instituted to adequately develop pre-service teachers' AI literacy. This PD should go beyond mere exposure to technical skills and must be designed to enhance teacher confidence by empowering them with pedagogical content knowledge of AI. Professional development should be tailored to address the unique challenges of the context, integrating hands-on workshops and modules covering fundamental AI concepts and practical applications.

3. Balancing Use, Creation, and Ethics. To address the critical finding of the trade-off between using and creating AI, educational strategies must adopt a balanced approach that nurtures a creative mindset. Curricula should be designed to encourage the practical application of AI while also exploring its creative possibilities, ensuring teachers develop the capacity to both utilise and design AI solutions. Simultaneously, ethical considerations are non-negotiable for responsible AI implementation. Practical implementation strategies must include dedicated modules on ethical considerations and responsible AI use within the curriculum, thereby cultivating a deep awareness of societal implications and ethical dilemmas associated with AI in education.

4. Strengthening Subjective Norms and Research. Since subjective norms are key determinants of a pre-service teacher's intention to learn AI, policymakers, administrators, and educators must actively promote a positive impression of AI usage and impact through authentic workshops and seminars. Given the recognised paucity of research in the African context regarding AI education, continued empirical studies are essential.

Conclusion

This paper concludes that Artificial Intelligence (AI) holds significant transformative potential for teacher education programmes in Nigeria by improving the quality, effectiveness, and inclusiveness of teacher preparation. AI technologies such as adaptive learning systems, automated assessment tools, and intelligent tutoring platforms can enhance instructional delivery, personalise learning experiences, support continuous professional development, and improve assessment practices within teacher education institutions. However, despite these promising opportunities, the adoption of AI in Nigerian teacher education remains at an emergent stage and is constrained by several systemic challenges.

The key obstacles include inadequate digital infrastructure, limited digital competence among teacher educators, ethical concerns related to data privacy and security, the absence of comprehensive national policies on AI integration in education, and resistance to technological change. These challenges, if unaddressed, may widen existing inequalities and limit the effective use of AI in teacher preparation. Therefore, the paper asserts that the successful and sustainable integration of AI in teacher education programmes in Nigeria requires deliberate planning, policy support, capacity building, and collaboration among key stakeholders. When strategically implemented, AI can catalyse strengthening teacher education and advancing national educational development goals.

Recommendations

1. Policy Formulation and Regulatory Frameworks

Effective integration of Artificial Intelligence (AI) in teacher education requires the development of comprehensive national policies and regulatory frameworks. The Federal Ministry of Education, in collaboration with regulatory agencies such as the National Commission for Colleges of Education and the National Universities Commission, should formulate clear policies that guide the adoption, implementation, and monitoring of AI technologies within teacher education institutions. Such policies should provide clear standards and operational guidelines regarding how AI can be used in teaching, learning, assessment, and academic research. They should also address critical issues such as data

privacy, intellectual property, ethical AI use, academic integrity, and quality assurance in the application of AI tools. Without well-defined policies, institutions may adopt AI technologies inconsistently, which could lead to misuse, ethical concerns, and disparities in educational quality.

Furthermore, policy frameworks should establish regulatory oversight mechanisms that ensure compliance with national educational standards and ethical principles. These policies should also promote equitable access to AI technologies so that institutions across different regions of Nigeria, including those in rural areas, can benefit from AI-driven educational innovations. By creating a coherent policy environment, government agencies can provide the strategic direction needed to integrate AI effectively into teacher education while safeguarding educational values and learners' rights.

2. Infrastructure Development and Investment

The successful implementation of AI in teacher education is heavily dependent on the availability of adequate digital infrastructure. AI technologies rely on strong computing capabilities, stable internet connectivity, reliable electricity supply, and access to digital devices. However, many teacher education institutions in Nigeria face infrastructural challenges that may hinder the effective adoption of AI technologies.

Government agencies, educational institutions, and private sector partners must therefore invest in modern digital infrastructure that supports AI-driven teaching and learning. This includes expanding broadband internet access, upgrading computer laboratories, establishing cloud-based learning platforms, and providing AI-enabled educational tools. A reliable power supply is also essential to ensure that digital learning environments function effectively without interruptions.

Special attention should be given to rural and underserved communities, where infrastructural deficits are often more pronounced. If these disparities are not addressed, the integration of AI could widen the digital divide between well-resourced institutions and those with limited resources. Strategic investments in infrastructure will therefore help create a more inclusive and equitable technological environment, ensuring that all teacher education institutions can participate in AI-driven educational transformation.

3. Capacity Building for Teacher Educators

Another critical factor for successful AI integration in teacher education is the capacity of teacher educators themselves. Many educators may have limited experience with advanced digital technologies or AI-based tools, which can create challenges in effectively incorporating these technologies into teaching and learning processes.

To address this issue, institutions should organise continuous professional development programmes aimed at improving the digital competence and AI literacy of teacher educators. These programmes should focus not only on the technical aspects of AI but also on practical pedagogical applications, such as using AI for personalised learning, automated assessment, curriculum development, and educational data analysis.

Capacity building initiatives should also emphasise critical and ethical engagement with AI technologies. Educators need to understand the limitations, risks, and ethical implications of AI in education, including concerns related to algorithmic bias, student data protection, and academic integrity. By strengthening educators' skills and knowledge in these areas, teacher education institutions can ensure that AI tools are used effectively, responsibly, and creatively in educational practice.

4. Stakeholder Collaboration and Partnerships

The successful integration of AI in teacher education cannot be achieved by government institutions alone. It requires strong collaboration among multiple stakeholders, including policymakers, educational institutions, technology developers, professional associations, and international organisations. Partnerships between teacher education institutions and technology companies can facilitate access to advanced AI tools, technical expertise, and innovation resources. Such collaborations can support the development of context-specific AI solutions tailored to the unique needs of Nigeria's educational system. For example, AI tools can be developed to support local languages, culturally relevant teaching materials, and context-sensitive learning analytics.

International organisations and research institutions can also contribute by providing technical assistance, funding opportunities, and global best practices for

integrating AI into education. Collaborative research initiatives can help generate empirical evidence on the effectiveness of AI in teaching and learning, thereby informing policy and curriculum development. Furthermore, engagement with professional bodies and educators' associations can help build awareness and foster acceptance of AI technologies among teachers. When stakeholders work together, they can create a sustainable ecosystem for AI innovation, ensuring that technological advancements are aligned with educational goals and societal needs.

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