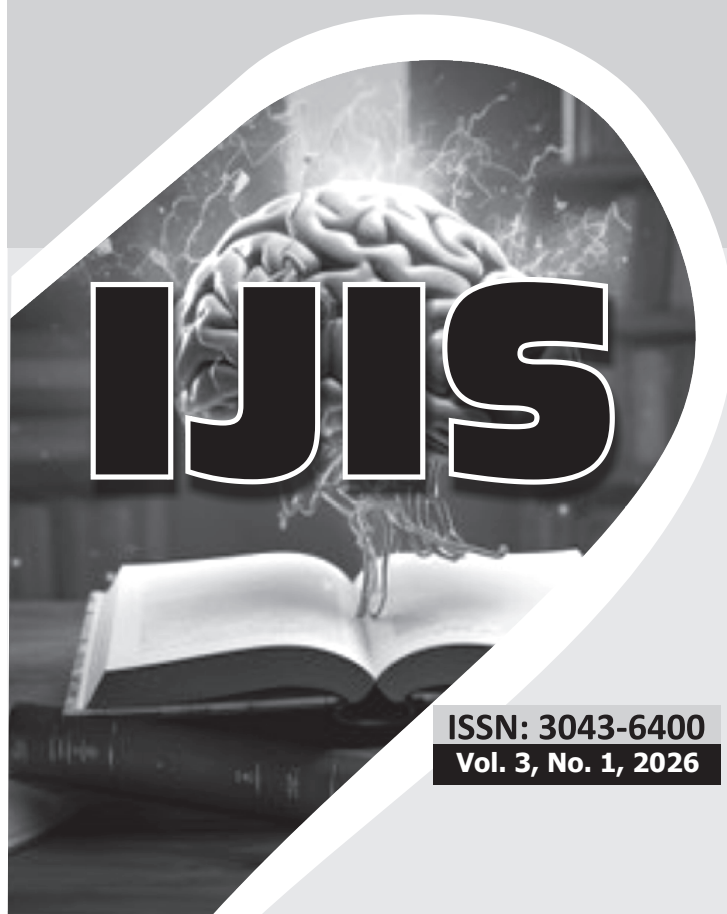




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**REVOLUTIONIZING SCIENCE EDUCATION IN NIGERIA:
THE ROLE OF ARTIFICIAL INTELLIGENCE IN
ENHANCING CLASSROOM PEDAGOGY IN SCIENCE
EDUCATION**

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NASIR & IBRAHIM, HASSAN BISIRIYU

**REVOLUTIONIZING SCIENCE EDUCATION IN
NIGERIA: THE ROLE OF ARTIFICIAL INTELLIGENCE
IN ENHANCING CLASSROOM PEDAGOGY IN
SCIENCE EDUCATION**

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Abstract

Science education in Nigeria continues to struggle with problems emanating from outdated pedagogical practices, inadequate instructional resources, and limited alignment with emerging technologies. These have constrained student engagement and meaningful learning outcomes in most science classrooms. This position paper argues that Artificial Intelligence (AI) presents opportunities for improving classroom pedagogies in science education. The paper discusses some key AI applications relevant to Nigerian science classrooms, including adaptive learning platforms, intelligent tutoring systems, automated assessment tools, and virtual laboratories. Evidence is increasingly showing that these tools can support personalized learning, timely feedback, and inquiry-based instruction when used in complementing teachers rather than replacing them. The paper also examines contextual barriers to AI adoption in Nigeria, including infrastructure deficits, teacher

preparedness, policy gaps, and ethical concerns. It is argued that strategic and phased integration of AI, supported by government investment, teacher capacity building, and curriculum reform, can reposition science education in Nigeria. Appropriately implemented, AI-supported pedagogies have the potential to enhance equity, improve instructional quality, and better prepare learners for participation in a knowledge-driven global society.

Keywords: Science Education; Artificial Intelligence; Classroom Pedagogy; Adaptive Learning; Virtual Laboratories

Introduction

Science education plays a critical role in national development by equipping learners with the knowledge and skills required to address societal challenges and contribute to innovation. In Nigeria, however, science teaching and learning remain constrained by conventional pedagogical approaches, inadequate learning resources, and declining student interest. Many science classrooms still rely heavily on teacher-centered instruction and rote memorization. Such approaches are increasingly insufficient for preparing learners for the demands of the 21st-century knowledge economy. Globally, education systems are experiencing a gradual shift toward technology-supported learning environments. One of the most significant developments within this shift is the emergence of Artificial Intelligence (AI). AI-enabled educational tools are increasingly being applied to support adaptive learning, intelligent tutoring, automated assessment, and virtual experimentation (Hwang et al., 2024). In many Nigerian contexts, where large class sizes, limited laboratory facilities, and diverse learner needs persist, AI presents opportunities to address long-standing instructional gaps.

This paper therefore takes the position that AI is no longer a distant innovation for science education in Nigeria but an emerging necessity. This position is informed by the authors' professional experience in science teacher education within Nigerian Colleges of Education. The paper maintains that when thoughtfully integrated, AI can enhance teaching effectiveness, support personalized learning, and improve student engagement in science classrooms.

Purpose of the Study

The main purpose of this position paper is to advocate the application of Artificial Intelligence in science education in Nigeria as a strategy for improving classroom pedagogy. Specifically, the paper seeks to describe prevailing challenges affecting science teaching and learning, explain how AI-based tools can address these challenges, emphasize the supportive role of AI in complementing teachers' instructional efforts, and propose strategic actions for policymakers and education stakeholders.

Significance of the Study

This paper is significant in several respects. From a policy perspective, it provides insights that may guide decision-makers on integrating AI into national education reforms. In terms of teacher development, it highlights the importance of equipping science teachers with relevant technological and pedagogical competencies. The paper also underscores the potential of AI-supported instruction to enhance student engagement, learning outcomes, and equity in access to quality science education. As a position paper, it further contributes to scholarly discourse on technology-driven pedagogical transformation within the Nigerian education context.

Literature Review

Research evidence increasingly suggests that AI-supported instructional systems can enhance learning outcomes in science and STEM education. Adaptive learning platforms and intelligent tutoring systems have been shown to provide personalized feedback and learning pathways that improve achievement and motivation (Md. Shah *et al.*, 2025; Ovadia & Li, 2025). Systematic reviews further indicate that these tools are most effective when integrated alongside sound pedagogical practices and teacher guidance (Hwang *et al.*, 2024).

Virtual laboratories have gained attention as viable alternatives in contexts where physical laboratory facilities are inadequate. Studies conducted in different settings, including Nigeria, indicate that virtual laboratory use can improve students' conceptual understanding and retention (Anari *et al.*, 2024; Rosli & Ishak, 2024).

However, teacher readiness and technological competence remain critical determinants of classroom adoption (Onyema *et al.*, 2025).

AI-supported assessment tools have also influenced formative assessment practices by enabling timely feedback and scalable evaluation. While such tools offer efficiency, scholars have raised concerns regarding algorithmic bias, transparency, and ethical use (Zhai *et al.*, 2023; Li *et al.*, 2024). Overall, evidence from both international and Nigerian studies suggests that AI can support science instruction when aligned with contextual realities and pedagogical intent.

Applications of AI in Nigerian Science Classrooms

Artificial Intelligence offers several pedagogical applications relevant to science education in Nigeria. Adaptive learning platforms allow instructional content to be adjusted based on learners' abilities and progress. Intelligent tutoring systems guide students through problem-solving processes by providing step-by-step feedback and corrective prompts. Automated assessment tools support timely feedback and enable teachers to identify misconceptions early. Virtual laboratories provide simulated practical experiences in environments where physical laboratories are limited or unavailable.

In many Nigerian schools, these applications have the potential to reduce disparities in access to quality science instruction. Their effectiveness, however, largely depends on infrastructure availability, teacher preparedness, and institutional support.

Challenges of AI Integration in Nigeria

Despite its potential benefits, AI integration in Nigerian science education faces notable challenges. Infrastructure limitations remain significant, as many schools lack reliable electricity, internet connectivity, and digital devices (The Nigeria Education News, 2025). Teacher readiness is another major concern, given limited exposure to educational technologies and AI-driven tools (Onyema *et al.*, 2025). Policy and curriculum gaps further constrain systematic adoption, as current frameworks provide limited guidance on classroom-level integration (NITDA & NCAIR, 2024). Cost,

sustainability, and ethical issues, including data privacy and algorithmic bias, also require careful attention (Li *et al.*, 2024).

Artificial Intelligence's Rise in Science Education

Artificial intelligence (AI) technology is becoming more and more important in a number of fields, including education. Artificial intelligence technology has revolutionised education, especially in the domains of science, technology, engineering, and mathematics. But AI will also transform schooling as a whole. Artificial intelligence (AI) is the newest technology. In the realm of education, among other work duties, this technology is crucial. AI has applications in education as well. Instructors are more able to comprehend students' demands (Fitria, 2021). Additionally, students can easily adapt their learning to suit their needs. Artificial intelligence (AI) is thought to be able to improve learning and more successfully accomplish educational goals. Therefore, it is not surprising that many AI-based innovations and breakthroughs are currently being applied and will be used to support the learning process in order to make it more practical and effective.

Therefore, it is a difficulty to overcome in order to maintain education if artificial intelligence is present in the educational sector and affects teachers. Teachers' cooperation with AI in the execution of learning is one of the significant arguments against AI replacing teachers. The application of intelligent algorithms and systems to support individualised learning, automate administrative duties, and deliver real-time feedback is referred to as artificial intelligence (AI) in education. Artificial intelligence (AI) technologies in science education, such as chatbots, virtual laboratories, intelligent tutoring systems, and adaptive learning platforms, provide new ways to simulate experiments, create interactive learning environments, and customise instruction to each learner profile (Ahmad *et al.*, 2020; Al Darayseh, 2023).

AI is revolutionising science education worldwide by making it possible for:

Personalised Learning: AI systems use data on student performance to create lesson plans that are tailored to each student's strengths and limitations (Goel *et al.*, 2024).

Enhanced Engagement: Simulations using virtual reality (VR) and augmented reality (AR) make abstract scientific ideas concrete and understandable (Haleem *et al.*, 2022).

Effective Evaluation: AI-powered analytics and automated grading offer immediate feedback, enabling prompt actions (Basu *et al.*, 2016).

Teacher Support: By automating repetitive chores, AI frees up teachers to concentrate on teaching and student interaction (Nile University, 2024).

AI Applications in Nigerian Basic Science Teaching

Adaptive Systems and Personalised Learning

AI-assisted learning methods are quickly being used to customise scientific education in Nigeria. These platforms offer focused exercises and explanations that enhance comprehension and memory while accommodating students' varying learning speeds. Particularly in varied Nigerian classrooms where students function at different academic levels, adaptive teaching systems assess individual learning styles and offer customised instructional materials (Ahmed *et al.*, 2020).

Simulations and Virtual Laboratories

Practical scientific experiments are frequently limited in Nigerian classrooms due to a lack of resources. Students can carry out virtual experiments remotely thanks to artificial intelligence, which eliminates infrastructural constraints and encourages hands-on learning. These immersive methods enhance conceptual knowledge and offer safe, reproducible, and affordable substitutes for actual laboratories.

Chatbots and Intelligent Tutoring Systems

Intelligent tutoring solutions mimic one-on-one coaching, which is otherwise uncommon in packed Nigerian classrooms, by offering personalised instruction and prompt responses (Chen *et al.*, 2020). AI chatbots encourage active learning and curiosity in science subjects by interacting with students, answering queries, and offering clarification (Ng, Tan & Leung, 2024).

Predictive analytics and administrative efficiency

AI reduces the administrative burden on teachers and facilitates data-driven decision-making by automatically supporting grading, attendance tracking, and performance monitoring (Nile University, 2024). By identifying students who are at danger of performing poorly, predictive analytics enables early intervention to enhance learning outcomes (Nile University, 2024).

AI Integration's Advantages for Science Education in Nigeria

Motivation and interest in science are increased when students are more engaged with AI-driven gamification and interactive information (Almusaed et al., 2023). By supporting students with disabilities and linguistic problems, assistive AI technologies advance fair access to science education (Mitra, Lakshmi, & Govindaraj, 2023). Mastery of difficult scientific ideas is accelerated by individualised education and prompt feedback (Kim & Kim, 2022). By offering insights into student learning patterns and enabling customised pedagogical tactics, AI systems also empower educators (Al Darayseh, 2023). Additionally, online AI platforms provide access to high-quality science education in Nigeria by removing socioeconomic and geographic constraints (Seo et al., 2021).

Integration of AI in Science Pedagogy

Artificial intelligence (AI) has the potential to significantly improve teaching strategies and student learning results in higher education. Using AI-driven platforms that facilitate collaborative learning and individualised training tailored to students' diverse requirements is a key strategy. These cutting-edge methods increase classroom engagement—a critical component of successful learning—while customising instructional materials to match each student's preferences and learning preferences.

Furthermore, research has demonstrated that project-based learning approaches allow teachers to enhance lesson planning and elevate classroom conversations with the use of advanced AI tools, creating a more lively and engaging learning environment. When compared to conventional teaching techniques, research on AI-based adaptive learning systems has also shown their beneficial effects on student engagement and academic performance.

These results demonstrate that skilfully integrated AI not only improves instructional tactics but also profoundly changes science education, highlighting the efficacy of AI in fostering an active learning environment. This method enables students to actively participate in their educational experiences, creates learning settings that are sensitive to their needs, and stimulates the development of important skills through collaboration and inquiry. As a result, students have the fundamental skills needed to handle upcoming societal and academic problems.

The continuous advancement of AI in education has the potential to further enrich teaching and learning processes in science classrooms, particularly at the secondary school level. Incorporating AI into the science curriculum can markedly improve student engagement and learning outcomes. However, despite its potential, some educators continue to face challenges related to insufficient training and limited technological infrastructure, which must be addressed to ensure effective and sustainable integration of AI in science education.

Challenges and Limitations

Adoption of AI in Nigerian science education is fraught with difficulties, despite its potential. Widespread AI integration is hampered by infrastructure deficiencies, particularly in rural areas, such as poor internet connectivity, a lack of digital devices, and electrical shortages (Nile University, 2024). Comprehensive professional development programs are necessary since many educators lack the abilities necessary to use AI tools effectively (Al Darayseh, 2023). Long-term sustainability in underfunded schools is an issue because of the high expenses of AI platforms and upkeep (Ahmad et al., 2020). AI systems must be adapted for Nigerian situations due to linguistic and cultural variations (Nile University, 2024). Furthermore, the usage of student data in AI systems presents ethical and privacy issues that need to be resolved by suitable legal frameworks (Chen et al., 2020).

Recommendations

To harness the benefits of AI in science education, coordinated actions are required. Government investment in basic infrastructure

is essential to support technology-enabled instruction. Teacher capacity building should be prioritized through continuous professional development and the inclusion of AI-related content in teacher education programmes. Curriculum reforms are necessary to integrate AI-supported pedagogical strategies into science teaching. Strategic partnerships with private sector organizations may help reduce implementation costs, while pilot programmes can provide evidence for informed scaling. Ethical and inclusive adoption frameworks should guide all implementation efforts to prevent widening educational inequalities.

Conclusion

Artificial Intelligence presents a realistic and timely pathway for addressing persistent pedagogical challenges in science education in Nigeria. When applied thoughtfully, AI-supported tools such as adaptive learning systems, intelligent tutoring platforms, automated assessment, and virtual laboratories can enhance instructional effectiveness and promote inquiry-based learning. Evidence from both international and Nigerian studies indicates that these technologies are most effective when they operate in support of teachers rather than as substitutes for professional judgment.

This paper maintains that Nigeria must move beyond exploratory discussions toward deliberate implementation of AI-supported pedagogy in science education. Achieving this goal requires sustained investment in infrastructure, systematic teacher capacity building, curriculum realignment, and the establishment of clear ethical and policy frameworks. By adopting a coordinated and context-responsive approach, AI can serve as a catalyst for repositioning science education in Nigeria and equipping learners with the skills required in the 21st-century knowledge economy.

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