Journal of Theoretical and Empirical Studies in Education (Special Issue)
September, 2025; ISSN: 2360-7172

LEVERAGING ARTIFICIAL INTELLIGENCE TO ENHANCE TEACHER COMPETENCE IN NIGERIA'S EDUCATION SYSTEM: TECHNOLOGICAL AND SOCIOLOGICAL PERSPECTIVES

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Abstract

Nigeria's education system faces persistent challenges of teacher competence, inadequate digital infrastructure, and systemic inequities that limit effective teaching and learning. Artificial Intelligence (AI) presents a transformative opportunity to address these gaps by supporting adaptive instruction, automating professional development, and enhancing pedagogical decision-making. However, its integration remains constrained by infrastructural limitations, low digital literacy, and sociocultural barriers. This study develops a conceptual framework for integrating Artificial Intelligence (AI) into Nigeria's education sector, emphasizing its transformative potential in enhancing teacher competence and advancing systemic outcomes. The framework is structured around four interrelated constructs: technological and sociological readiness, teacher professional development, AI-enhanced teacher competence, and student and system outcomes. This study explored how AI can be inclusively positioned to strengthen teacher capacity. It adopts a dual-lens framework: the technological perspective**,** focusing on tools, platforms, and infrastructure; and the sociological perspective**,** emphasizing on teacher attitudes, equity of access, and systemic readiness. The research addresses a critical gap by contextualizing AI adoption within Nigeria's unique educational realities, rather than relying on global models that may not align with local needs. The study found out that inclusive and context-sensitive AI strategies are essential to ensure teacher

empowerment, reduce inequalities, and foster resilience within Nigeria's education system. The study concludes that AI adoption in Nigerian education requires a holistic approach that balances technology, human expertise, and sociocultural realities. It recommends that investing in robust infrastructure, sustained professional development, and inclusive policies in Nigeria educational system can leverage AI to reduce educational inequalities and align with global innovations.
Keywords: Artificial Intelligence, Teacher Competence, Inclusivity, Technological Perspective, Sociological Perspective.

Introduction

Artificial Intelligence (AI) has emerged as one of the powerful drivers of educational transformation in the 21st century. Globally, AI has been deployed to personalize learning experiences, enhance teacher workload and provide predictive insights into student performance (Holmes *et al*., 2022). Emerging technologies that subsumes advanced systems such as automated grading tools, adaptive tutoring platforms and natural language processing–based feedback mechanisms are restructuring how teachers teaches and how students learns (UNESCO, 2022). These technologies promised efficiency and also redefine teacher competence by equipping educators with intelligent support systems that allow them to focus on higher-order pedagogical tasks (Anderson & Rainie, 2018). Furthermore, engagement of AI in pedagogic experiences have contributed in no small measure to global educational equity debates. For instance, in Organisation for Economic Co-operation and Development (OECD) countries, AI has been utilized to reduce disparities by providing targeted interventions for struggling learners (OECD, 2021). However, scholars caution that unless deliberately managed, AI can widen the existing inequalities in teaching and learning due to digital literacy, issues of access, and socio-economic divides (Zawacki-Richter *et al*., 2019). The global conversation has increasingly focuses on what AI can do and on how it can be inclusively integrated to support both teacher competence and equitable educational outcomes.

Nigeria presents a unique landscape where the promise of AI is particularly critical. The education system is plagued with persistent challenges of teacher shortages, overcrowded classrooms, weak professional development structures and inadequate instructional resources (Okebukola, 2020; Oyekan, 2022). UNESCO (2022) reports that Nigeria has over 20 million out-of-school children, being the highest figure globally while those enrolled often suffer poor learning outcomes, largely due to poor teaching effectiveness. Teacher competence has consistently been identified as a determinant of educational quality in Nigeria (Umar & Hassan, 2020). However, evidence reveals widespread of gaps in digital literacy classroom management, teacher preparedness, and content delivery (Ogunlade, 2021). ICT initiatives have been launched to build capacity, however, fall short due to weak integration into teacher education curricula, limited infrastructural support and lack of sustainability (Yusuf & Onasanya, 2022).

In the context of enhancing teachers' productivity, AI offers transformative opportunity in enhancing teacher professional development through personalized training platforms, assist in lesson planning via intelligent systems, and provide real-time feedback on teaching practices (Adebayo & Omilani, 2023). However, the Nigerian reality is characterized with perennial challenges such as inconsistent internet connectivity, poor electricity supply, high costs of digital tools and socio-economic inequality that raises critical questions about the feasibility and inclusivity of AI adoption (Adedokun-Shittu & Shittu, 2020).

Educational innovation cannot be sustained by technical attributes alone; its adoption and impact are largely shaped by sociological, cultural, and institutional factors (Voogt & Roblin, 2012). This study emphasizes that educational innovation extends beyond technical attributes; its successful implementation requires alignment with cultural, institutional, and pedagogical frameworks. In Nigeria, several sociological

related realities challenge the integration of AI to education. Socio-economic inequality remains unembellished due to the fact that private, urban and elite schools often adopt digital innovations in facilitating pedagogic experiences, while public schools in the rural areas are significantly lagging behind (Olatokun, 2021). This creates "digital divide" that risks being widened by AI-driven education reforms.

Also, cultural perceptions and teachers' resistance to change particularly older that had spent considerable number of years in service, often perceive digital technologies as threats to job security (Ogunlade, 2021). Similarly, some communities harbour skepticism towards technology, framing it as alien or incompatible with traditional educational practices (Eke, 2022). Subsequently, gender disparities in access to digital tools continue to undermine equitable participation. Study conducted by Adebayo (2021) revealed that most of the female teachers and students in Nigeria institutions of learning have less exposure to the use of ICT resources compared to their male counterparts. These sociological barriers suggests that the adoption of AI in Nigeria need to be approached with nuanced understanding of human factors and not only based on availability software and hardware. Hence, inclusivity in AI-driven education depends on how well structured are sociological realities, such as resistance, equity, rural-urban and gender disparities are addressed alongside technological readiness. The technological dimension of AI adoption in Nigerian education reveals both opportunities and constraints. Studies exemplified that mobile technology serving as a major enabler of connectivity has made Nigeria to witness increasing digital penetration in the recent past showing a good indicator for the future adoption (GSMA, 2023). The uLesson and Edmodo-based platforms are emerging Educational Technological innovations within Nigeria that has demonstrated the high growing potential of AI-supported learning systems (Adedokun-Shittu & Shittu, 2020); especially in the developing nations of the world. However, systemic challenges,

lukewarm attitudes towards technological readiness, inconsistent Internet penetration across regions, unreliable electricity supply and limited or poor access to computers or AI-enabled platforms in most public schools in Nigeria (Yusuf & Onasanya, 2022); and other related developing countries of the world. In a similar vein, there is inadequate digital literacy among most Nigerian educators, as majority educators do not have sufficient competencies required to effectively deploy and engage with AI-driven platforms (Umar & Hassan, 2020). Therefore, intensive training, investment in infrastructure and support systems are major agents of transformation for the adoption of AI. Deployment and engagement of ICT and digital learning resources have been studied extensively in Nigeria, however, most the studies has either focused on technological perennial challenges in isolation such as poor provision of infrastructural facilities, and inadequate procurement of technological devices (Adeoye & Adeoye, 2017) or sociological constructs separately such as gender or geographical inequality of access and resistance to technological adoption (Olatokun, 2021). There is a dearth of research on integration of both technological and sociological perspectives in examining how AI can inclusively enhance teacher competence in Nigeria's education system. Globally, as documented by Zawacki-Richter *et al*. (2019) that adoption of AI need to consider both human and contextual constructs in facilitating their judicious and effective usage. However, research in the context of Nigeria rarely operationalizes this dual lens. Therefore, existing studies risks the production of fragmented solutions that may not sustainably provide viable solutions to systemic challenges facing Nigerian education system due failure of integrating sociological constructs with technological related constructs.

Literature Review

Globally, Artificial Intelligence (AI) is recognized as catalyst for sporadic development and reimagining pedagogic experiences. AI-powered tools such as intelligent tutoring platforms, adaptive learning systems, predictive analytics, and natural language processing are redefining the roles of teacher by supporting differentiated instruction, augmenting decision-making, and providing real-time feedback (Holmes *et al*., 2019; Holmes *et al*., 2022). Rather than thinking of replacing teachers in the classrooms. AI functions to complement teachers' and administrators' competencies by automating repetitive teaching and administrative tasks respectively, thereby facilitating them to concentrate on higher-order pedagogical functions such as mentorship, creativity, and critical thinking (Roll & Wylie, 2016). Teacher competence development encompasses pedagogical knowledge, subject mastery, adaptability, classroom management and ability to integrate innovations effectively (Darling-Hammond, 2017). With reference to this study, AI performs myriads of function that is not restricted to its used as tool for efficient teaching but also as a vital mechanism for continuous professional development. However, effective and judicious use of AI technologies depends largely on the readiness of teachers' and willingness to adopt those technologies in influencing pedagogic experiences, which this aspects are not deeply explored in the context of Nigeria educational system (Adedokun-Shittu & Shittu, 2020).

Vis-à-vis the perspective of technological deployment and engagement, the potential of AI in advancing teacher competence is significant. Machine learning algorithms has the in-built mechanisms of predicting students' academic performance, adaptive platforms can personalize learning trajectories, and AI-driven simulations can enhance teacher training by providing real-time feedback and analytics (Chen *et al*., 2020; Zawacki-Richter *et al*., 2019). Subsequently, emerging AI-supported professional

learning communities (PLCs) enable teachers to share resources, collaborate, and refine their instructional strategies. However, contextualizing the integration and wide acceptance of AI for adoption in the developing nations like Nigeria is been faced with formidable infrastructural bottlenecks. Also, persistent and perennial challenges such as limited internet penetration, unstable electricity supply and unequal access to digital devices constrained equitable adoption AI (Adediran & Adegboye, 2021; Afolabi, 2021). Unlike in the developed countries of the world where the deployment of AI is rapidly scaling up, systemic infrastructural barriers has exacerbated the digital divide between schools in rural and urban centres, thereby, raising concerns about technological exclusion in Nigeria. This underscores the urgent and ardent need for AI frameworks that are locally relevant and sensitive to Nigeria's infrastructural realities.

The adoption of AI is not solely a technological issue but also a sociological one that is shaped by equity considerations, social perceptions and teacher agency. Studies conducted by Venkatesh *et al*., (2003) and Umar and Yusoff (2020) revealed that teachers' beliefs, attitudes and perceived usefulness towards AI has a significant influence on its adoption and integration by the users. However, there was persistent skepticism, ethical concerns, fears of job displacement and lack of confidence in digital pedagogy that often inhibit acceptance (Selwyn, 2019). Social inequities further made the inclusivity inn the adoption of AI more complicated. The related factors and variables like socioeconomic status, gender disparity and urban-rural divide determine both teacher readiness and student access to AI-enhanced learning opportunities (Oyediran *et al*., 2022). These disproportions are magnified due to fact that many teachers in Nigeria didn't have sufficient exposure to digital pedagogy and institutional support received for professional upskilling is limited (Oluwatobi & Akinola, 2020). Many schools in rural areas are frequently excluded from AI-driven initiatives, thereby propagating cycles of

disadvantage. Therefore, Olanrewaju, (2022) opined that to facilitate inclusivity of AI in education, adoption frameworks must address acceptance, availability of technology, cultural alignment and issues related social trust.

The inclusivity of education has to do with equitable access to resources and opportunities, irrespective of socioeconomic status, gender or geographic locale (UNESCO, 2021). Applying this principle to the adoption and engagement of AI in teacher development necessitates ensuring that all educators in the rural and urban, marginalized and privileged and male and female can harness the best advantage of AI for professional growth. Also, AI-powered platforms has high potentials in providing mentoring systems, personalized professional development modules and virtual teaching assistants that can be contextualized to Nigerian realities. However, inclusivity in education is more often not been undermined by generic and one-size-fits-all policy approaches that fail to reflect local contexts. Imported AI models has been perceived to assume infrastructural sophistication that many Nigerian schools do not have sufficient technical know-how about. This disparity highlights a critical gap on the need for adoption frameworks that are rooted in sociocultural diversity of Nigeria languages and technological realities, with teachers been positioned as central agents of transformation and not just passive recipients.

The related global literature reviewed highlights the transformative power and potential of AI in education, with considerable numbers of evidence been derived from developed nation contexts with strong policy support, robust infrastructural facilities, and high levels of digital literacy (Luckin, 2021; Holmes *et al*., 2022). However, Nigeria's reality is markedly different due to related pressing teacher competence challenges, severe infrastructural limitations, and sociocultural factors that is having strong influence on technology acceptance (Oyelekan & Olorundare, 2021). Few studies have

methodically examined how AI can enhance teacher competence in Nigeria through both technological and sociological lenses. Majority of Nigerian studies has focused largely on ICT integration and e-learning adoption (Adedokun-Shittu & Shittu, 2020; Oyelekan & Olorundare, 2021), with dearth of studies in addressing how AI specifically intersects with teacher competence, inclusivity and social realities. This leaves a substantial gap bordering on understanding how AI can be inclusively leveraged to strengthen teacher competence within Nigeria's cultural, infrastructural and policy related constraints. This study therefore seeks to address this gap by contextualizing AI adoption within Nigeria's unique realities, positioning AI as a technical intervention and as a socially embedded tool for empowering teachers and transforming the education system.

Conceptual Framework

This conceptual framework integrates technological and sociological dimensions to explain how Artificial Intelligence (AI) can enhance teacher competence in Nigeria's education system. The framework acknowledges that while technological readiness provides the tools, sociological factors shape teachers' willingness and capacity to adopt AI. These dynamics are mediated by professional development, equity, and collaborative mechanisms, leading to improved teacher competence and, ultimately, enhanced student outcomes and educational quality.

Core Constructs

1. **Technological Dimension:** Availability & Accessibility of AI Tools, Infrastructure Readiness (power, internet, devices) and Digital Literacy & Training.
2. **Sociological Dimension:** Teacher Attitudes and Perceptions of AI, Institutional Support & Policy Framework and Cultural and Ethical Considerations.

3. **Mediating Variables**: Teacher Professional Development Programs, Collaboration & Peer Support and Equity & Inclusivity in Access.
4. **Outcome Variable:** Enhanced Teacher Competence (pedagogical effectiveness, classroom management, innovation in teaching, improved student engagement & outcomes)

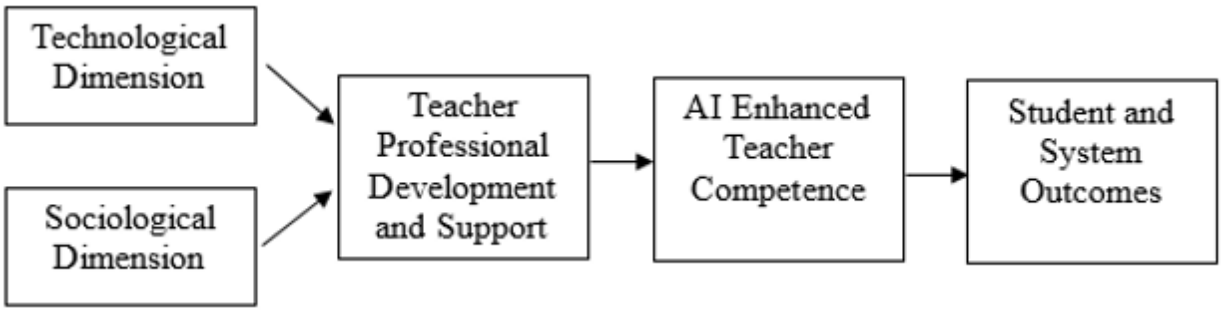

Figure 1: Conceptual Framework on AI-Enhanced Teacher Competence in Nigeria's Educational System

Figure 1 shows a simplified integrated conceptual model with four major stages:

Technological and Sociological Dimensions (Input Constructs): The model begins with technological and sociological dimensions as foundational inputs for AI integration in Nigeria's education system. The technological dimension covers infrastructure, platforms, and AI applications such as adaptive assessments, intelligent tutoring, and predictive analytics, which is essential for innovation and local adaptability. However, reliable technology alone cannot drive transformation without sociological readiness, which includes cultural context, societal perceptions, teacher attitudes, digital literacy, and concerns over equity, ethics, and the rural–urban divide. These dimensions are interdependent: technological capacity must align with human acceptance to create a balanced foundation for sustainable AI adoption in education.

Teacher Professional Development and Support (Enabling Construct): Teacher professional development and support is the pivotal bridge between technological

readiness and sociological acceptance, driving AI-enhanced competence and productivity. Advanced AI and receptive attitudes alone cannot transform classrooms without well-prepared, supported teachers. Thus, capacity building must equip educators with technical skills, pedagogical strategies, and adaptive confidence for effective AI integration. Institutional supports communities of practice, mentorship, and continuous training, that are vital for sustainability, while addressing human barriers such as resistance, fears of displacement, and ethical concerns. Positioned as active agents of change, teachers are empowered to align AI with educational goals and societal values.

AI-Enhanced Teacher Competence (Transformative Construct): AI-enhanced teacher competence forms the transformative core of the model, linking technology, sociological readiness, and professional development to improved student and system outcomes. At this stage, teachers progress from adaptation to innovation, using AI for adaptive learning, differentiated instruction, and precise assessment. They blend human expertise with machine intelligence, ensuring AI augments professional judgment while fostering student-centered, engaging, and personalized learning. This marks a shift from traditional to data-informed, dynamic pedagogy, reframing AI not as a disruptor but as a catalyst for sustained educational innovation and teacher empowerment.

Student and System Outcomes (Output Construct): The student and system outcomes stage marks the core output of the framework, where sociological acceptance, technological readiness, and teacher competence converge into tangible gains. At the student level, AI-driven teacher competence fosters personalized learning, adaptive feedback, higher performance, reduced dropouts, and stronger 21st-century skills. At the systemic level, AI enhances administrative efficiency, supports data-driven policymaking, reduces inequality gaps, and aligns education with global innovations. Overall, this construct demonstrates that AI's impact extends beyond classrooms,

creating a ripple effect that empowers learners, equips teachers, and modernizes Nigeria's education system for holistic transformation.

Summarily, the framework illustrates how technological and sociological dimensions jointly shape AI-driven teacher competence in Nigeria's education system. Technological factors include infrastructure, AI tools, and platforms, while sociological factors capture cultural attitudes, perceptions, and policies influencing AI adoption. These antecedents feed into professional development, which equips teachers with technical skills, adaptive mindsets, and support mechanisms like training, mentoring, and peer learning. The outcome is AI-enhanced teacher competence - a fusion of digital literacy, pedagogy, and ethical awareness, thereby enabling personalized learning, inclusive practices, and data-driven instruction. This competence translates into improved student engagement and achievement, as well as systemic gains in equity, efficiency, and innovation. The model underscores that transformation arises not from isolated constructs but from the synergy of technology, society, and professional capacity, repositioning Nigeria's education for 21st-century relevance.

Synergistic Relationships between the Constructs

The framework rests on a synergistic interplay between its constructs**,** where each dimension reinforces and sustains the others. The technological and sociological inputs form the foundation, yet neither is sufficient in isolation. Advanced tools cannot transform education without addressing human factors such as acceptance, ethics, and trust, while sociological readiness alone cannot drive change without the availability of robust technological infrastructure. At the center of this synergy lies teacher professional development and support, which serves as the vital bridge between both dimensions. By equipping teachers with the necessary skills, confidence, and institutional backing, this

construct ensures that educators are not only technologically capable but also socially prepared to embrace AI within their pedagogical practice.

The result of this balance is the emergence of AI-enhanced teacher competence, a transformative construct that does not function as an endpoint but as a feedback mechanism**.** As teachers demonstrate success in leveraging AI, their experiences foster greater sociological acceptance among peers and students, while simultaneously fueling demand for more sophisticated technologies. This cycle accelerates both trust in and adoption of AI within education. Ultimately, student and system outcomes serve as the clearest evidence of the framework's effectiveness. Positive results ranging from improved learning performance to systemic efficiency create a reinforcing loop that validates further technological investment and consolidates sociological confidence. In this way, the framework illustrates a self-sustaining ecosystem of transformation**,** where each construct strengthens the next, and the collective impact reshapes the Nigerian education system.

Outcomes of the Study for Nigeria's Education System

This study goes beyond theoretical contributions by offering practical pathways for transforming Nigeria's education system. By integrating technological and sociological inputs, strengthening teacher competence, and fostering AI-driven innovation, the system can achieve sustainable and measurable progress in the following ways:

1. AI-enhanced capacity will empower teachers to adopt adaptive, student-centered instruction, conduct accurate data-driven assessments, and blend human expertise with machine intelligence. This will addresses a long-standing challenges of under-preparedness and uneven instructional quality in Nigeria's teaching workforce.
2. Students will benefit directly from interactive and engaging content, personalized learning pathways and improve performance in critical areas such as STEM and

literacy. AI also it will reduces dropout rates by creating more supportive learning environments, inclusive, and helping Nigeria students to address achievement gaps and its large out-of-school population.

3. AI-driven systems will enable transparent resource allocation, real-time monitoring and evidence-based policymaking. By streamlining administrative processes and reinforcing accountability, many institutions can overcome governance bottlenecks that have historically hindered educational effectiveness.
4. AI-powered platforms will extend quality instruction to marginalized groups, underserved regions and including learners with disabilities. This will ensure inclusive and high-quality education irrespective of social status or geographic locale, by aligning with Nigeria's commitment to SDG 4 (Quality Education).
5. Embedding AI in learning will equip Nigerian students with globally relevant competencies in form of adaptability, digital literacy and problem-solving, thereby closing the persistent skills gap and improving graduates' employability in the international labour market.
6. The positive outcomes will build sociological trust among stakeholders - students, teachers, parents, and policymakers. This trust will reduce resistance related factors to innovation, encourages adoption, and strengthens policy support and investment in AI-driven education.
7. The system will benefits from a reinforcing loop, by enhancing teacher competence drives further towards technological investment, positive outcomes will strengthen trust and policy support and continuous reinvestment sustains a culture of improvement and innovation.

These outcomes will represent a transformative shift for Nigeria's education system. By aligning AI integration with teacher professional development, institutional governance,

and sociological readiness, Nigeria can move toward a modern, inclusive, efficient, and globally competitive educational framework.

Conclusion

This study examined the transformative role of Artificial Intelligence in enhancing teacher competence and shaping student and system-level outcomes within Nigeria's education sector. The proposed framework highlights the interconnected constructs of technological and sociological readiness, professional development, AI-enhanced teacher competence, and their ripple effects on student learning and system-wide efficiency. Findings suggest that when teachers are empowered through targeted training and infrastructure support, AI becomes a catalyst for personalized learning, improved engagement, and equitable access. At the systemic level, AI integration fosters efficiency, data-driven decision-making, and alignment with global educational trends. In conclusion, the study underscores that AI adoption in education must extend beyond technological provision to include strong policy support, equity-focused strategies, and ongoing teacher development. By bridging human expertise with machine intelligence, Nigeria can create an inclusive, future-ready education system capable of addressing current gaps while preparing learners for the demands of the 21st century.

Recommendations

The following recommendations are proffered:

1. To fully harness AI in education, teacher capacity must be prioritized. Also, regular professional development programs through organization of seminar and conferences should be conducted to equip teachers with the digital and pedagogical skills needed to integrate AI tools effectively into classroom practice.
2. Adequate infrastructural facilities such as functional devices, reliable internet access and secure digital platforms is fundamental for effective AI integration.

Hence, Nigeria should be encouraged to prioritize investment in robust ICT infrastructure across rural and urban areas to reduce wide disparities in access.

3. Clear and forward-looking policies should guide the adoption of AI in education. These policies should be formulated to address ethics, equity, accountability, and data privacy related issues, while creating an enabling environment for sustainable technological innovation.
4. AI adoption must be inclusive, ensuring marginalized groups such as rural learners, children with disabilities, and female benefit equally. Strategies should include subsidized access to digital tools and adaptive technologies that accommodate diverse learning needs.
5. Sustained progress requires strong collaboration between government, private sector, academia, and international partners, therefore, partnerships should be encouraged to focus on funding, capacity-building and the co-creation of locally relevant AI-driven educational solutions.
6. Continuous research and innovations should be encouraged in evaluating the impact of AI adoption, develop indigenous innovations and refine practices. Also, establishing research hubs within various universities will go a long way in tracking outcomes, addressing challenges, and promoting context-specific solutions.

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