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AI Integration In Education: A Scoping Review Of Teachers' Literacy As A Catalyst For Pedagogical Transformation

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Abstract:

Numerous technologies and platforms, including AI, which enhance teaching and learning pedagogy, abound. However, their effective adoption and implementation in developing African countries such as Nigeria depend on teachers' sufficient technological skills and competency, particularly in the use of AI tools. This study set out to investigate the technological skills and competencies of higher education teachers and their implications for pedagogical innovation. To realize this objective, the study adopted a scoping literature review strategy, using a systematic keyword-based search of databases, specifically Google Scholar, Scopus, and Web of Science to retrieve 163 recent studies on this subject from diverse literature. After applying inclusion and exclusion criteria, 21 articles met the selection criteria and were included in the study. Accordingly, the selected literature was coded and analyzed in line with the study's conceptual framework. Overall, it was found that technology skills, competency, and knowledge of the appropriate AI tool required to effect pedagogical transformation by teachers are insufficient.

Index Terms **-** Pedagogy, literacy, Artificial intelligence, expert system, transformation

1. INTRODUCTION

Artificial intelligence (AI) is a high-level sophisticated integrated technologies that utilizes complex algorithms and vast datasets or knowledge bases to analyze, learn, and provide intelligent solutions to diverse problems, often interacting through text or human-like interfaces (Yang et al., 2025). Thus, the intersection of digital technology and Artificial Intelligence (AI), such as generative AI, offers transformative technological tools for enabling pedagogical transformation and effective teaching and learning solutions in education systems (Adeleye et al., 2024; Chan, 2024; Ayanwale et al. 2025). Interestingly, teaching pedagogy presents strategies that effectively motivate, retain, and enhance learners' understanding, critical thinking, and problem-solving skills (Eden et al., 2024). Apparently, teachers play a crucial role in adopting and implementing technical tools for pedagogical transformation in educational settings (Ayeni et al., 2024; Lademann et al., 2025; Yang et al., 2025). However, success strongly depends on teachers' level of literacy (Chan, 2024; Yang et al., 2025 Lademann et al. 2025), in selecting appropriate technical tools and their skill in using them for effective instructional delivery. Arguably, these digital technologies have been hindered by various factors, such as the digital divide – unequal access to and skills in selecting, utilizing, and making optimum use of these tools to complement existing pedagogical approaches to enhance students' learning experiences. Although slow policy implementation and limited internet accessibility, particularly in remote communities, were also reported in some studies, the growing internet penetration in Nigeria is evident in the

proliferation of various online platforms, such as social networks and collaborative tools like Google meet. However, the majority of users acquired such skills out their own curiosity, limiting their knowledge of its vast potential benefits and, hence, underscoring the need for capacity building through digital literacy, particularly for teachers' trainees and educators in higher institutions of developing countries like Nigeria.
Considering the dynamics in the emergence of new technologies such as machine learning, data mining, large language models, expert systems, and natural language processing – all under the umbrella of AI – and their critical role in all facets of human activity, especially in education, providing teachers with basic technical training for proficiency in handling AI tools and other related technologies can serve as a catalyst for pedagogical transformation (Lademann et al., 2025). It is on this premise that this study reviews the intersection of AI integration in education, teachers' literacy, and its impact on pedagogical transformation. To gain insights into the subject, the study will address the following research questions:
RQ1: Does the AI literacy of instructors influence pedagogical transformation within the classroom?
RQ2: What is the present level of instructors' proficiency in AI integration within educational contexts?
RQ3: What are the potential impacts and factors limiting AI adoption in education for improve teaching and learning?

This study applied a scoping review method to identify and explore existing studies on teacher literacy in effecting innovative pedagogies in an AI-driven educational environment. This method is particularly useful when exploring broad or emerging study areas such as AI in the context of this study, thus providing an overview of research findings on the current status of knowledge on AI integration in education.

1.1 Theoretical Framework

Due to promising impacts of AI in education, various theoretical frameworks were formulated to provide a roadmap for updating teachers and students with necessary technical skills for understanding its application in the classroom. In line with this, the study relies on UNESCO's AI competency frameworks, aimed at equipping both teachers and learners with essential skills and competencies in AI, DigCompEdu framework emphasizes the use of technologies for transforming teaching and learning. Other guiding frameworks include the Inclusive AI Learning Design, a subset of Universal Design Learning (UDL) focusing on inclusivity, equity, and accessibility to innovative technologies and most suitably AI literacy framework, which was developed for understanding, evaluating, and applying innovative technologies even at lower levels of education (Daher, 2025).

2. Literature Search and Identification

In order to identify relevant literature for this study, our search strategy was open, and not restricted to any particular databases, due to the broad nature of the topic under discussion. Thereafter, a systematic search was conducted to identify and collect literature presume to be relevant by the system from various sources, including Google Scholar, Scopus and Web of Science respectively. With systematic approach, 163 pieces of literature were identified and retrieved through search strings connected with either "AND" or "OR" Boolean operators, thereby minimizing irrelevant retrieval. Accordingly, the following search strings was used to retrieve literature for the review: "AI OR Artificial Intelligence" AND "Education" OR "Pedagogy", "Teacher AI Literacy" AND "Pedagogical transformation", "AI integration" AND "Education" AND "Challenges" AND" Opportunities". These search strings enabled precise literature retrieval.

2.1 Selection Criteria

The selected literature was based on inclusion and exclusion criteria, a common practice for a review research methods. Table 1 highlighted these inclusion and exclusion criteria used in filtering the most relevant literature for inclusion in the research.

Table 1. Reviewed Article Selection Criteria

Selection Criteria	
Inclusive	Exclusive
Peer-review: The article must be peer review *Language*: It must be written in English language *Study design*: An empirical review article focused on AI integration in education *Relevance and timeframe*: Recent and relevant capturing key concepts like, teacher AI literacy, AI enhanced pedagogy and transformation *Focus*: Examine Challenges and opportunities of AI integration in education	Any duplicated literature or studies not focused on AI in education Articles written in languages other than English Articles not based on an empirical research methodology – purely based on theoretical or conceptual without any empirical data. Literature not recent or outside these basic concepts

With the help of these criteria, the study was able to narrow down our initial search results, while ensuring focus on the relevance and quality of the retrieved literature to the author and hence guaranteed reliable synthesis of the review findings.

2.2 Data Extraction Flowchart

At this stage, the study employed a systematic process culminating in the identification of articles or records, retrieved, and recordings of relevant information from the literature from specific sources that addresses the research questions, as presented in the flowchart in figure 1 below.

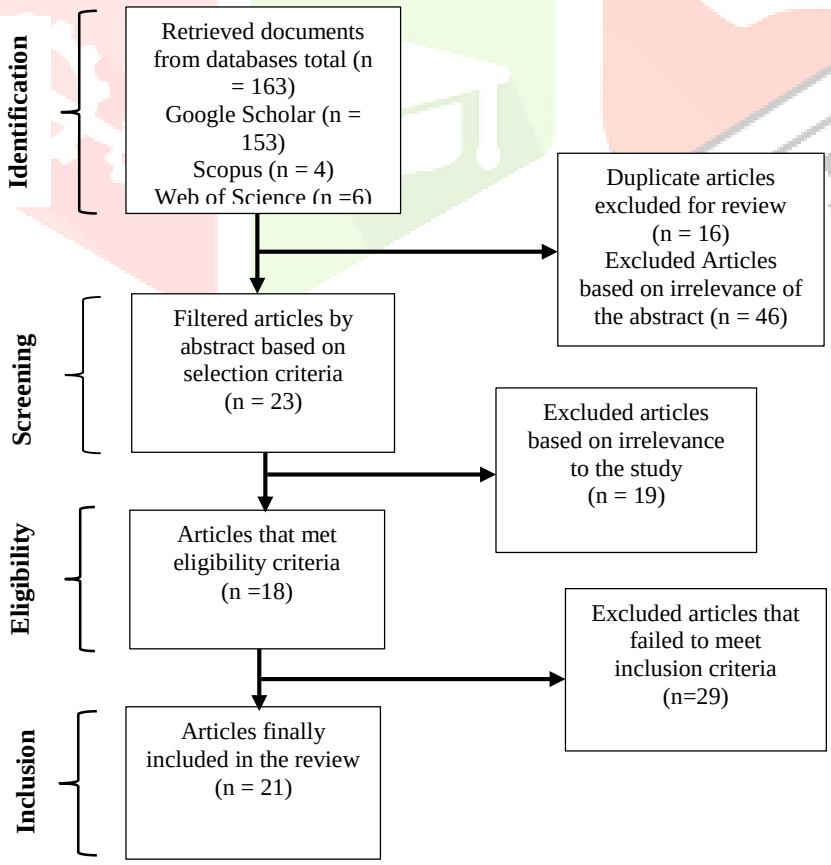

Fig.1: Review Article Selection Procedure

3. Results and Discussion

In this study, we have presented review findings under four conceptual frameworks. This will enable clearer understanding of the relationship between AI in education, teacher's AI literacy, and pedagogical transformation, allow support for the study's valid research questions, and provide a guide for readers to comprehend the research focus, context and overall findings.

3.1 Teachers' Understanding of AI and how it impacts on their teaching methodology

AI has undoubtedly transformed the education sector, functioning as both an instructional delivery mechanism and a means to enhance teacher productivity, while simultaneously serving as a companion for students and being essential for the implementation of student-centered pedagogies such as personalized learning, adaptive learning systems, and customized educational experiences through platforms like LearnSmart, Knewton, and Squirrel AI adaptive learning (Chan, 2024; Eden et al., 2024; Lademann et al., 2025). Consequently, the transformative potential and agenda of AI are contingent upon educators' comprehensive understanding of AI tools and platforms. In this regard, outcomes from several studies on this subject have substantiated this assumption (Ayeni et al., 2024; Chan, 2024; Yang et al., 2025). Similarly, the study by Temitope et al. (2024) investigated the use of AI in Nigerian higher education institutions, focusing on its opportunities and problems for both students and instructors. Their study recognized AI as a significant paradigm shift in learning outcomes, yet it revealed only moderate awareness and competence regarding AI in Nigerian higher education. It also found that a lack of infrastructure, limited internet connection, and the digital divide are all barriers to AI inclusion in education. In the same way, Daher (2025) looks at the limits of teachers when it comes to learning about and becoming skilled in AI, and not just basic technology abilities. The study's findings indicate that if teachers lack sufficient knowledge and understanding of AI, the future right of students to inclusive and quality education may be jeopardized, further marginalizing teachers and underscoring their critical role in the adoption of AI in education. Aligning with previous studies emphasize the crucial responsibility and urgent need for teachers to engage in professional development training on AI tools, Lademann et al. (2025) observed limited research efforts addressing teachers attitudes' towards AI integration in education,6 despite its diverse potential benefits in teaching practices. Having examine the problem by evaluating online training sessions for in-service teachers on AI literacy and their perspectives, pre and post-test investigations revealed that professional training programs for educators on AI can effectively address diverse AI literacy, even without limiting it to specific aspects of AI tools. However, given that participants responded positively on just half of the test question, post-training results indicate persistent gaps in the literature.

Building on teachers' critical roes in implementing innovative technologies that foster learner-centered pedagogy, and recognizing the importance of teachers professional development training for effective teaching practices in the Nigerian context, Helen et al. (2025) examined the merits of AI and challenges of its full adoption in transforming the education system in Nigeria. Finding form their study noted limited adoption of AI in Nigeria's schools, attributing this to limited digital technology infrastructure, policy implementation issues, and, more importantly, unequal digital accessibility and inadequate teacher training, knowledge, competency in AI literacy. Furthermore, these lead to an investigation of transformative capabilities of AI with adaptive learning tools for transforming teaching pedagogies in Nigeria's education system by Mariam et al. (2025). Their findings revealed that successful implementation and use of AI in Nigerian institutions are constrained by human resource development for AI literacy among teachers, limited infrastructure, poor internet access, and a rigid curriculum. Overall, it can be concluded that all these findings underscore teacher training programs as a promising solution for teacher education, preparing them for the increasing innovative challenges sparked by AI technologies and platforms.

3.2 Teachers' Proficiency Levels for Effective AI Integration in Education

The research on potentials of AI acceptance, multifaceted application, adoption, and integration, particularly in the field of education for pedagogical transformation, has spanned over a decade, as evident in (Guo et al., 2024). Accordingly, the study, which focused on bibliometric analysis of AI role in promoting learning experiences and effective teacher instructional delivery, with an intent to understand the state of current research directions on AI integration in the education system. Consistently, their findings show that a significant number of published studies on AI use in education, were from China or United States of America (Chan, 2024), and mostly review articles with limited scope on higher education and biased towards Science Technology Engineering and Mathematics (STEM) courses, especially in Computer Science. This implies

that only a few leading countries in top economies have been exploring the benefits of AI and have integrated it into their education system a couple of years ago.

This findings is consistent with the study of Oyekemi and Kayaode (2025), which traced the research trend and application of AI in education as far as the year 2022. Developing African economy like Ghana, Kenya, South Africa, and Nigeria among others have introduced initiatives that support the adoption of AI-powered tools in education. Harnessing its full potential benefits hinges on adequate teacher training in the form of capacity building, equitable access to digital technology infrastructure, policy support. However, these requirements have not yet been met, which means that AI is still in its early stages. This is a serious concern because there aren't enough professionally skilled teachers in AI, and access to digital technology and policy implementation are not equal (Oyekemi and Kayaode, 2025; Mathew and Isaac, 2025). Matthew and Isaac (2025) emphasized a balanced approach to AI application in the education system, maximizing its potential benefits while addressing unethical issues. This is essential because teachers in underdeveloped countries are having a hard time learning how to utilize new technologies that might affect how they educate. Also, kids are utilizing AI in ways that aren't right, which would impair their ability to think critically.

Uzodinma et al. (2025) not only looked into how well AI is being used and integrated by teachers, but they also looked into how Nigerian teacher trainees feel about the pros and cons of using AI-powered tools for teaching. The study illustrated a significant influence of AI in acquainting teacher educators with advanced AI technologies that enabled pedagogical transformation for enhanced student engagement in collaborative learning, personalized learning, tailored instructional delivery, adaptive learning, and inclusive educational opportunities. Conversely, it was noted that attaining these results entails hurdles, including inconsistent access to technological resources such as internet connectivity, unavailability of AI tools, unreliable power supply, and, crucially, the necessity for ongoing teacher professional development training.

3.3 Impact of Professional Teacher Development in AI Literacy on Pedagogical Practices

Innovative technologies are increasingly dynamic, necessitating regular professional development for teachers in coping with the realities of the digital transformation further sparked by AI driven technologies. This has prompted the Chinese National Commission for UNESCO and the Shangai Municipal People's Government jointly convened the World Digital Education Conference in 2024, titled "Digital Education: Application, Sharing, and Innovation" specifically focused on themes for promoting teacher digital literacy and competence including developing digital education and learning society, evaluation of global trends and indices in digital education development and many others (Chan, 2024). Consequently, this study like in Guo et al. (2024), revealed that insufficient systemic AI capacity building for teachers of lower levels of education was the second most significant contributing factor that made it difficult for teachers to apply AI in education. A similar study conducted by Ayeni et al. (2024) regarding the trend of AI integration and utilization in education demonstrates the transformative impact of AI technologies on the design, development, and delivery of educational curricula. In addition, they noted that a concerted efforts are required for providing educators with necessary technical skills and competence sufficient enough to effectively engage students in AI driven pedagogy. Yang et al., (2025), reviewed the trends in AI literacy for the periods, 2014 – 2024 through a bibliometric analysis. Consistent with previous research studies highlighting the urgent needs for AI training for educators, their study recognizing limited AI literacy as the major challenge to its full deployment by teachers especially in developing countries, have suggested an international collaborative effort with policy makers and other relevant stakeholders to prioritized AI literacy for both teachers and students. According to Zhou et al. (2025), gaining requisite knowledge and skill in AI in the present intelligent world of AI by individuals, especially teachers, remains essential to cope with the increasing innovative technologies under AI.

3.4 Benefits and Impediments for Effective AI Adoption into Education System

As technology continues to grow, it is important to know its pros and cons, especially in the sphere of education, in order to use it and adapt to it. Many studies have shown that digital technologies have a big impact on education, and AI is one of the most promising new technologies. Ahmadu et al. (2025) say that these improvements could make education better by closing gaps, making it more accessible to everyone, and improving learning outcomes. Realizing the significant impact of AI and other associated technologies has informed the Nigerian government's decisions to formulate policies aimed at integrating technology into education as part of essential preparation for both teachers and students, with a focus on developing technical skills and competency, underscoring yet another critical role of technology policy support for optimizing AI benefits in education. However, it was found that this policy suffered serious challenges ranging from

infrastructural investment deficiency, digital divide, to the provision of regular training on AI literacy and other related technologies for maximizing its potential gains. These views are in line with those of Helen et al. (2025); Fatima, (2025), which blame AI adoption in Nigerian schools to limited infrastructural facilities, and lack of competency and training by the teachers. Effective instructional delivery lies in the appropriateness of the methodology used, as well as the instructional media. AI technologies stand out in this regard due to their motivational, tailored learning experiences, and learner-centered nature, a characteristic common to emerging innovative technologies that leads to a paradigm shift in teaching and learning pedagogies. This assertion was supported by Fatima (2025), who in her study, referred to AI as a game changer that ushered in new and effective methodologies, improving teaching and learning practices in the present AI-driven world through technologies like machine learning, intelligent tutoring systems, natural language processing, and others. In support of many scholars like Oyekemi and Kayode (2025), Fatima (2025), Ahmadu et al. (2025), on the challenges limiting the full adoption and use of AI in Nigeria's schools, Daniel and Mgbeodichinma (2025) also attributed the situation to policy implementation gaps, lack of AI literacy for educators and learners, and digital infrastructural facility deficiencies, despite AI's prominent role in pedagogical transformation for effective learning.

These findings conformed to the objective of the study by Okeke (2025), on examining financial and infrastructural impediments against successful AI implementation by educators in Nigerian higher education system. Ayanwale et al. (2025) discussed teachers' evaluations of the readiness for AI integration in education, emphasizing various AI-driven technological supports for pedagogical transformation and the provision of tools tailored to diverse learners' educational needs. They also identified several constraints, including insufficient high-speed internet access, infrastructural inadequacies, inadequate teacher training, and uneven ICT policy implementation, which impede its success. In a similar manner, a study conducted by Abubakar et al. (2025) regarding the transformative potentials of AI technologies in entrepreneurship education demonstrated that these technologies provide unique capabilities for the analysis of extensive data sets through data mining technology. Nevertheless, common barriers like inadequate funding and insufficient continuous professional training support for teachers still remain a threat, highlighting significant gaps in ICT policy support.

4. Result Interpretation

After an in-depth examination of relevant diverse literature from various sources focusing on integrating AI in education in developing African countries like Nigeria, 163 recent studies were identified and retrieved. Out of this number, only 12 met the eligibility and inclusion criteria and were therefore included in the study. The findings from these studies were summarized under 4 conceptual frameworks, allowing readers to easily comprehend the review's findings while highlighting relationships between the concepts in the study. Analysis of the findings under the teachers' AI literacy and pedagogical transformation framework revealed and supported the assertion that the success of transforming existing teaching pedagogical approaches through emerging AI technologies in education for effective instructional delivery practices is strongly dependent on teachers' adequate knowledge, skills, and competency in handling technical instructional technology tools such as AI. Thus, teachers' roles remain critical in AI integration and use in the education system. This implies without AI literate teachers, transforming pedagogical approaches can be difficult, potentially limiting students' understanding and support for personalized learning experiences leading to pedagogical stagnation, while threatening AI integration in education. These findings accordingly address the study's critical research question, RQ1: *Does the AI literacy of instructors influence pedagogical transformation within the classroom?*

Likewise, research on teachers' literacy about AI integration in education shows that developed nations like China and the USA have made a lot of progress in AI literacy and integration, but only in higher education. But in developing African countries like Ghana, South Africa, and Nigeria, instructors are still having a hard time adapting to and using AI in the classroom or other learning settings since they don't know much about it or don't know anything about it at all. This part answers research question RQ2, which asks what instructors' AI literacy is like right now so that it can be used in the school system. Furthermore, drawing from the findings in conceptual framework 4, the implication from the findings suggests that AI integration in education has potential benefits, including impact on teachers, educators, pedagogical transformation, effective instructional delivery, and enhanced student learning support. However, the study's literature review revealed low teacher literacy levels, converging on common delimiting factors such as epileptic power supply, poor digital infrastructural facilities, poor policy implementation, and most importantly inadequate AI knowledge. These

findings echo empirical studies on limited AI integration in developing countries like Nigeria, providing evidence to address RQ3 *what are the potential impacts and factors limiting AI adoption in education for improve teaching and learning?*

5. Conclusion

The study, through scoping review, examined the AI integration in education system and how crucial teacher literacy influenced pedagogical transformation, highlighting the roles of teachers as drivers of AI integration in education. In addition, it reviewed current development on the state of teachers' literacy on AI integration, noting limited commitments and efforts towards its success despite research reports highlighting the constraints, particularly in developing African countries including Nigeria. Overall, the potential impacts and challenges of AI integration in education was exposed against the backdrop of AI driven educational transformation, thus, establishing research gaps in ineffective instructional delivery by teachers and educators due to inadequate knowledge of AI-driven technologies. For future research directions, the study recommends an investigation on effective AI integration models by exploring successful AI integration models in different educational contexts, while examining strategies to address inequities in AI access and integration.

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