

LEVERAGING ARTIFICIAL INTELLIGENCE FOR TEACHERS' PROFESSIONAL COMPETENCY DEVELOPMENT IN NIGERIA: EMERGING PERSPECTIVES AND IMPLICATIONS

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Abstract

This paper examines how AI contributes to teachers' professional competency development in Nigeria. The paper addresses an important gap in existing scholarship. While research on artificial intelligence (AI) in education is growing rapidly, much of the existing literature concentrates on learner outcomes, technology adoption, and institutional implementation. Comparatively limited attention has been given to synthesising how AI can be systematically leveraged to enhance teachers' professional competencies, particularly within the Nigerian context. This paper discusses artificial intelligence and teachers' professional competencies, explores AI applications that support competency development, and discusses the benefits, challenges, and ethical implications associated with AI integration in education. The paper adopts a conceptual review approach, synthesising relevant scholarly literature, international frameworks and contemporary discussions on AI, teacher competence and professional learning. It argues that AI is most educationally valuable when used as a professional learning partner that augments rather than replaces teachers' knowledge, judgement, agency and relationships with learners. Although AI offers significant opportunities to enhance teaching effectiveness and lifelong professional learning, issues relating to digital competence, data privacy and security, algorithmic bias and misinformation, digital inequality and access, and overdependence remain major concerns, particularly in developing countries like Nigeria. This study recommends sustained AI competency development for pre-service and in-service teachers, investment in equitable digital infrastructure, clear institutional and national guidance, and evidence-based evaluation of AI-enabled professional development. The paper contributes a context-sensitive synthesis that connects AI-enabled professional learning with teacher competency development and identifies implications for teacher education, institutional practice and policy in Nigeria.

Keywords: *Artificial Intelligence, teachers' professional competency development, digital transformation, emerging perspectives, educational implications*

Introduction

The educational landscape is changing rapidly as digital technologies reshape how knowledge is created, accessed, communicated and evaluated and as a result teachers are no longer expected to rely solely on subject-matter knowledge and conventional pedagogical routines as they increasingly work in environments characterised by digital resources, data-rich learning systems, online collaboration and emerging artificial intelligence (AI). AI is emerging as one of the most influential innovations shaping contemporary teaching and learning. AI-powered technologies such as generative AI, intelligent tutoring systems, learning analytics, and automated assessment tools are changing how teachers design instruction, assess learners, and engage in professional development. Consequently, teachers are increasingly expected to possess not only strong pedagogical and subject-matter knowledge but also competencies in digital/AI literacy, data-informed decision-making, ethical AI use, and technology-enhanced instructional design. AI is increasingly transforming education through applications in instructional planning, content creation, assessment, feedback, learner support, and professional development, with generative AI further enhancing teachers' ability to create and organise educational resources efficiently. In the evolving educational environments, educators are now required to make use of digital technology and AI while adopting learner-centered approaches that encourage creativity, critical thinking, collaboration, and continuous learning. AI refers to the ability of machines or artificial systems to carry out tasks, problem-solving, communication, interaction, and logical reasoning in a manner that mimics human intelligence (De Zúñiga et al., 2023).

Beyond the application of Artificial Intelligence in Education (AIED) as student-centered education, it also offers various practical uses in education management and teaching, which present an opportunity for the creation of new learning techniques and adult learning strategies (Holmes & Tuomi, 2022). Artificial intelligence is increasingly transforming teacher professional development by providing personalised learning opportunities, intelligent coaching systems, automated feedback mechanisms, virtual mentoring, adaptive professional learning platforms, and learning analytics that enable teachers to identify strengths and areas requiring improvement. AI Generative tools like ChatGPT, Gemini, Claude, and Microsoft Copilot have provided even more options for planning lessons, developing

instructional materials, designing assessments, implementing differentiated instruction, and engaging in reflective teaching. UNESCO (2023) explains that generative AI offers opportunities to support curriculum design, teaching, learning, and assessment, while emphasizing that its implementation should follow a human-centred and ethical approach that benefits and empowers teachers, learners, and researchers. These innovations allow teachers to devote more time to meaningful interactions with learners by reducing routine administrative workloads and supporting evidence-based instructional decision-making.

Despite these opportunities, integrating AI into teacher professional development presents several challenges. Concerns have been raised regarding data privacy, algorithmic bias, overdependence on AI-generated content, digital inequality, inadequate infrastructure, limited digital competence among teachers, and the absence of comprehensive policies governing AI use in education. UNESCO (2023) noted that differences in digital infrastructure, regulatory preparedness, and human capacity across countries present significant challenges to the equitable implementation of generative AI in education, particularly in resource-constrained contexts. The increasing adoption of AI in education reflects broader global efforts to improve educational quality and prepare learners for digitally driven societies. UNESCO (2024) emphasized that AI should be used to enhance teachers' professional practice by supporting teaching, learning, assessment, and professional development while ensuring that educators retain responsibility for pedagogical decisions and apply AI in an ethical, human-centred, and inclusive manner.

Teachers' professional competencies encompass the knowledge, skills, attitudes, values, and professional dispositions required to facilitate effective teaching and learning. These competencies extend beyond subject matter expertise to include pedagogical competence, assessment literacy, classroom management, communication and collaboration, digital competence, reflective practice, and continuous professional development (Caena, 2014; Redecker, 2017; UNESCO, 2023; Miao & Cukurova, 2024). Although a growing body of research has examined AI applications in education, much of the literature emphasizes student learning outcomes, technology adoption, or institutional implementation. Comparatively, fewer studies provide a comprehensive synthesis of how AI can be leveraged to

develop teachers' professional competencies especially in Nigerian context. This creates a knowledge gap regarding the opportunities, challenges, and strategic approaches required to prepare teachers for AI-enabled educational environments.

It is against this background that this paper examines how artificial intelligence can contribute to developing teachers' professional competencies. A contemporary perspective is therefore needed to guide AI integration into teacher education, professional development, institutional practices, and broader educational systems. Against this background, this study specifically aims to: (i) examine how AI develops multiple dimensions of teachers' professional competencies and which technology develops those competencies; (ii) explore AI technologies that support teacher competency development; (iii) analyse the benefits and challenges associated with AI integration into teachers' professional learning; and (iv) identify future directions and policy implications for maximizing AI's contribution to teacher professional development.

Conceptual Review

Artificial Intelligence

The definition of artificial intelligence is the ability of computers to do things that normally need human intelligence, such as learning, thinking, solving problems, language processing, decision making, and recognizing patterns. According to UNICEF (2021), artificial intelligence (AI) comprises machine-based systems designed to achieve objectives set by humans by generating predictions, offering recommendations, or making decisions that affect physical or digital environments and in which these systems interact with people and their surroundings either directly or indirectly. The use of AI technologies and software in an education setting to improve the teaching, learning, and decision-making process is referred to as Artificial Intelligence in Education (AIED) (Hwang et al., 2020). It involves the use of artificial intelligence technology in the teaching, learning, assessment, and management of education. It encompasses technologies such as machine learning, intelligent tutoring systems, and natural language processing, which enable personalized learning, automated feedback, and data-informed educational decision-making (Olajide et al., 2026). Unlike conventional computer programmes that rely

on fixed instructions, AI systems continuously improve their performance by learning from large volumes of data through algorithms such as machine learning and deep learning (Rane et al., 2024). AI in education has grown from simple computer-based learning to complex intelligent systems that can individualize learning, automate tasks, give immediate feedback, help with assessments, and even offer professional development for teachers. Intelligent tutoring systems, adaptive learning platforms, learning analytics, educational chatbots, automated grading systems, speech recognition technologies, and generative AI applications have become increasingly common in schools and higher education institutions. These technologies are reshaping the educational landscape (Hassan, 2023) by enhancing teaching effectiveness while creating new opportunities for professional growth among educators (Duan & Zhao, 2024).

Teachers' Professional Competencies

Teachers' professional competencies refer to the integrated knowledge, skills, attitudes, values, and professional behaviours that enable teachers to perform their instructional responsibilities effectively and promote meaningful learning outcomes. According to Mulder (2014), professional competence is demonstrated when an individual performs duties responsibly and effectively in accordance with established standards of performance. Kunter et al., (2013) described professional competence as the set of personal attributes, knowledge, and abilities that enable teachers to effectively meet the demands and responsibilities of their profession. Aghaie (2006) emphasizes that effective teachers need diverse professional competencies, including critical thinking, modern teaching methods, classroom management, effective communication, ICT integration, educational research, and learner assessment. Professional competencies can be categorized into several interconnected domains. These are: Content competence which refers to a teacher's comprehensive and accurate knowledge of the subject matter, including factual, conceptual, and procedural understanding, and the ability to explain complex ideas, address misconceptions, answer learners' questions, and relate concepts to real-world applications; Pedagogical competence which is the ability of teachers to plan, implement, manage, and evaluate effective teaching and learning, using appropriate methods that engage diverse learners and promote critical thinking, creativity, collaboration, and problem-solving; Digital competence which refers to teachers' ability to use digital and AI

technologies confidently, critically, ethically, and creatively to support teaching, learning, assessment, communication, collaboration, and professional development. It includes AI and data literacy, digital ethics, evaluation of digital resources, and effective integration of technology into teaching practices; Assessment competence which refers to teachers' ability to design, administer, interpret, and use assessment effectively to monitor learners' performance, provide constructive feedback, and improve teaching and learning through data-informed instructional decisions; Classroom management competence which refers to teachers' ability to create and maintain a safe, inclusive, orderly, and productive learning environment by managing learner behaviour, classroom activities, engagement, conflicts, instructional time, and enhancing positive teacher–student relationships; Communication and collaboration competence which refers to teachers' ability to communicate and work effectively with learners, colleagues, parents, and other educational stakeholders through teamwork, information sharing, professional networking, conflict resolution, and participation in professional learning communities. According to Swan (2021), communication and collaboration competence is particularly important because it supports the effective use of AI tools, facilitates discussion, and promotes collaborative engagement across disciplines; Research and reflective practice competence which refers to teachers' ability to systematically investigate educational problems, evaluate evidence, reflect critically on instructional practices, and use research findings to improve teaching and learning. It encompasses action research, data analysis, scholarly inquiry, evidence-based decision-making, self-evaluation, and continuous professional improvement; Professional ethics, leadership and lifelong learning which means that teachers should demonstrate integrity, fairness, accountability, respect for diversity, and confidentiality as well as act as leaders which involves mentoring colleagues, promoting innovation, and contributing to school improvement, while also engaging in continuous professional development and updating of knowledge, skills, and practices.

Theoretical Framework

Technological Pedagogical Content Knowledge (TPACK)

According to the TPACK (technological pedagogical content knowledge) model presented by Mishra and Koehler (2006), technology integration can only be successful if technology, pedagogical and content (TK, PK, and

CK) are combined together rather than being considered separately (Mishra & Koehler, 2006). TPACK assumes that effective teaching results from the integration of technological, pedagogical, and content knowledge. It emphasizes that technology should be purposefully matched with teaching methods, subject content, learners, and context, and that teachers can develop this integrated knowledge through experience and continuous professional development. In the context of AI, this involves understanding AI technologies, integrating them into teaching practices, and applying them appropriately to subject content (Cee, Ann, & Lee, 2025; Nyaaba et al., 2024). TPACK provides a useful lens for explaining how AI can contribute to teacher competency development. For example, using a generative AI tool to prepare a lesson requires knowledge of the tool, pedagogical understanding of how learners should engage with the content, and sufficient subject knowledge to evaluate the accuracy and suitability of the generated material. AI-supported professional learning can therefore strengthen the interaction between technological, pedagogical and content knowledge while also requiring teachers to exercise critical and ethical judgement.

Transformative Learning Theory

Transformative Learning Theory was propounded by Jack Mezirow (1991) and explains adult learning as a process through which individuals critically examine and potentially revise established assumptions, perspectives and frames of reference. Transformative Learning Theory was developed by Jack Mezirow during the 1970s and 1980s (Akinsooto et al., 2020). Mezirow (1997) described the theory as an explanation of adult learning based on a set of ideal conditions that facilitate transformative learning. Transformation can occur when adults encounter new experiences that challenge existing ways of understanding and subsequently engage in reflection and dialogue. It assumes that adults can transform their perspectives when experiences challenge existing assumptions, prompting critical reflection, dialogue, and the development of new and more meaningful ways of understanding and acting (Akinsooto et al., 2020). The emergence of AI may challenge teachers' established assumptions about lesson preparation, assessment, professional learning and the teacher's role. AI-enabled professional development can provide opportunities for teachers to experiment with new practices, critically reflect on their experiences and develop revised understandings of technology-supported

teaching. The theory is therefore relevant to the paper because professional competency development through AI involves not only acquiring technical skills but also adapting professional beliefs, practices and identities to changing educational conditions.

Artificial Intelligence and Teachers' Professional Competency Development

Artificial intelligence is increasingly transforming teachers' professional development by providing intelligent tools that enhance instructional effectiveness, improve decision-making, facilitate reflective practice, and promote lifelong learning. Unlike traditional professional development programmes that often rely on periodic workshops and seminars, AI supports continuous, personalized, and data-driven learning experiences tailored to individual teachers' needs. Consequently, teachers can acquire new competencies at their own pace while receiving timely feedback on their professional practice. AI supports teachers professional competency development in the following ways;

AI-supported professional learning

Professional learning has increasingly shifted from occasional face-to-face workshops toward continuous, technology-supported learning environments. AI contributes to this transformation by recommending personalized professional development resources based on teachers' interests, competencies, and career goals. Du Plessis (2024) cited in Nyaaba et al., (2024) found that 115 teachers reported that generative AI enhanced their instructional practices and improved access to teaching resources. AI also promotes continuous professional learning by recommending personalized resources such as scholarly articles, online courses, and webinars based on teachers' learning needs. Additionally, AI assists teachers in developing clear explanations, examples, case studies, simulations, and problem-solving activities that make complex content more accessible to learners while supporting curriculum objectives. Studies also show that preservice teachers use generative AI as a learning companion to locate relevant resources, deepen conceptual understanding, and access practical examples that strengthen their subject knowledge (Nyaaba et al., 2024). Overall, AI promotes continuous pedagogical innovation by helping teachers access relevant research, professional development, and emerging instructional strategies.

Personalised teacher development

AI-enabled learning system can analyse teachers learning activities and recommend resources according to their professional needs, experience and goals. Personalised Pathways may support teachers to work at an appropriate pace and concentrate on competencies requiring further development. Evidence from AI supported professional training indicates the potential of learning analytics and adaptive systems to tailor professional learning to needs (Chaipidech et al., 2022; Somabut et al., 2026). Yue et al. (2024) found that preservice teachers primarily use generative AI as a learning companion for personal learning and knowledge acquisition.

AI-assisted lesson planning and instructional design

AI has transformed instructional planning by assisting teachers in developing comprehensive teaching materials efficiently. AI-powered instructional design tools recommend teaching strategies, generate multimedia learning resources, produce instructional presentations, and align lesson plans with curriculum objectives. Labadze et al. (2023) noted that AI-powered chatbots function as instant learning assistants by responding to employees' questions, recommending relevant learning resources, and providing feedback on assessments. Furthermore, AI facilitates the incorporation of interactive simulations, visual explanations, educational games, and collaborative learning activities that enhance classroom engagement. Generative AI tools such as ChatGPT, Microsoft Copilot, Google Gemini, and Claude assist teachers in developing lesson plans, learning objectives, instructional materials, and classroom activities, while other AI writing tools, including Rytr, Jasper, CopyAI, Writesonic, Kafkai, Copysmith, Peppertype, Articoolo, Article Forge, and Copymatic, facilitate content creation (Eke, 2023). Studies by Sattelmaier and Pawlowski (2023) and Nyaaba et al. (2024) further emphasize the role of generative AI in supporting lesson preparation, instructional design, and the development of assessment strategies. Teachers can use these applications such as *ChatGPT*, *Google Gemini*, *Microsoft Copilot*, and *Claude* to generate lesson plans, learning objectives, classroom activities, discussion questions, case studies, assessment items, marking guides, and differentiated instructional materials. According to Sattelmaier and Pawlowski (2023), teachers should leverage GenAI technologies like ChatGPT to design personalized lesson plans for scaffolding students'

learning activities. AI supports collaborative instructional planning by generating lesson ideas, curriculum materials, assessment tasks, and multimedia resources, while requiring teachers to critically evaluate AI-generated content. AI-powered learning management systems and learning analytics enable teachers to monitor attendance, participation, assignment completion, and learner engagement, helping them identify students who require additional support and implement timely interventions.

AI-supported assessment and feedback

Artificial intelligence (AI) significantly enhances teachers' assessment competence by automating routine assessment tasks, supporting formative and summative assessment, improving feedback quality, enabling data-informed decision-making, and assisting in assessment design. By automating repetitive assessment tasks, AI allows teachers to focus on interpreting assessment results and designing appropriate instructional interventions rather than spending excessive time on manual grading (Luckin et al., 2016). AI also supports continuous formative assessment and learning analytics by monitoring learners' progress, identifying misconceptions, and providing evidence-based insights that help teachers adjust instruction and reflect on their practices. This enables teachers to adapt instruction promptly and offer targeted support based on learners' individual needs. In summative assessment, automated grading systems such as e-Rater and teacher-support tools like Graide improve assessment efficiency while ensuring that teachers retain responsibility for final evaluation. Similarly, AI-powered applications such as Open Essayist and Grammarly provide automated feedback on students' writing (Holmes & Tuomi, 2022). Generative AI also supports the development of assessment instruments, including test items, essay questions, rubrics, and differentiated assessment tasks.

AI-enabled reflective practice and continuous learning

AI develops teachers' research and reflective practice competence by improving access to scholarly literature, enabling efficient discovery and summarization of research, identification of emerging trends, and application of research evidence to teaching. Preservice teachers use generative AI for literature reviews and action research, while tools such as ChatGPT support data generation, analysis, and research reporting (Aaron, 2018; Nyaaba et al., 2024; Eke, 2023). AI further assists teachers in

research design and academic writing by developing research questions, refining objectives, organizing literature, constructing conceptual frameworks, selecting methodologies, and improving writing quality. AI-powered analytical tools also enhance data analysis by supporting the organization, visualization, interpretation, and identification of patterns in quantitative and qualitative data. In addition, learning analytics promote reflective practice by providing evidence on learner engagement, participation, achievement, and classroom interactions, enabling teachers to evaluate and improve their instructional practices. AI-supported professional learning platforms recommend relevant publications, courses, webinars, conferences, and research communities, fostering continuous professional inquiry, lifelong learning, and evidence-based professional development. Additionally, AI enhances CPD through personalized learning pathways, recommendations for research, courses, webinars, instructional resources, and professional learning communities, while learning analytics provide feedback that supports reflection and professional growth. AI-assisted lifelong learning assistants can also provide continuous, personalized guidance and learning support throughout individuals' educational journeys (Holmes et al., 2019).

Emerging Perspectives on AI-Enabled Teacher Professional Development

The following are the emerging areas in AI enabled teacher professional development;

AI as a professional learning partner

AI is increasingly being positioned as a support resource for professional learning. Teachers can use conversational systems to brainstorm lesson ideas, rehearse explanations, generate reflective questions, locate starting points for inquiry and organise professional learning resources. The value of AI thus depends on the teacher's ability to interrogate outputs rather than accept them uncritically. UNESCO (2024) explains that teachers should be seen as the main users of AI in the process of teaching, and they should act as the designers and facilitators of learners' AI-assisted learning, as well as stewards of ethical and safe practice in rich AI-infused educational settings.

Human-AI collaboration in teaching

Emerging practice points towards human AI collaboration rather than full automation of teaching. AI can handle or assist with selected routine and analytical tasks, while teachers retain responsibility for interpreting context, building relationships, exercising ethical judgement and making consequential pedagogical decisions. UNESCO (2024) emphasises human agency and responsible use in AI-enabled education.

AI literacy as an emerging teacher competency

The spread of generative and analytical AI makes AI literacy increasingly relevant to teacher professionalism. AI-PACK Framework proposed by Lorenz and Romeike (2023) extends this view by highlighting the significance of algorithmic literacy, data awareness, and the critical evaluation of AI systems. Teachers need to understand basic AI concepts, limitations, data and privacy issues, bias, intellectual property, prompt design and methods for verifying outputs. AI literacy therefore extends beyond operational skills to critical and ethical competence (Shi, 2025; UNESCO, 2024).

Personalised and lifelong professional learning

AI is evolving beyond task automation toward intelligent professional coaching and decision support. AI-powered learning platforms curate relevant research articles, webinars, online courses, instructional videos, and professional communities that support continuous learning. Emerging systems can analyse classroom interactions, identifying instructional strengths, recommending professional development activities, and providing real-time teaching support. Furthermore, the growing integration of generative AI with learning analytics, adaptive technologies, and immersive learning environments is creating more personalized and competency-based professional development pathways for teachers. For instance, AI-driven immersive training and assessment system provides a platform that tailors instructional support by adapting task complexity to trainee performance and includes a human-in-the-loop framework through which teachers can refine grading standards (Lan & Azimi, 2025). These innovations are expected to redefine teacher education by promoting continuous learning, reflective practice, collaboration, and evidence-informed instructional improvement.

Data-informed professional development

Virtual reality (VR), augmented reality (AR), extended reality (XR), digital twins, multimodal AI systems, and AI-powered simulation environments are increasingly being integrated into teacher education programmes. These technologies provide authentic teaching simulations that allow teachers to practise classroom management, instructional decision-making, communication, and assessment skills within risk-free virtual environments. Smart teacher training platforms address many limitations of traditional teacher professional development by using learning analytics and adaptive technologies to deliver personalized learning experiences and provide tailored professional support, timely feedback, opportunities for collaboration, and flexible access that enables teachers to engage in continuous learning despite time and location constraints (Somabut et al., 2026).

Opportunities for Leveraging AI in Teachers' Professional development

Artificial intelligence (AI) is transforming teacher professional development by providing personalized learning, timely feedback, and intelligent instructional support. Unlike traditional professional development, which is often periodic, AI enables continuous learning and enhances teachers' instructional practice, digital competence, and overall professional competencies and offers the following opportunities;

Enhancing Teaching Effectiveness

Artificial intelligence significantly improves teachers' instructional planning by simplifying routine preparation tasks and providing access to innovative teaching strategies. Generative AI applications assist teachers in developing lesson plans, instructional objectives, classroom activities, assessment tasks, discussion questions, and differentiated learning materials within a relatively short period. AI supports lesson preparation, instructional design, and teacher productivity (UNESCO, 2024; Holmes & Tuomi, 2022). Rana and Chicone (2025) observed that one of AI's major contributions to training and development is its ability to deliver highly personalized learning experiences through adaptive learning technologies. This individualized approach enhances learning efficiency and promotes sustained professional growth. AI also supports instructional effectiveness by recommending pedagogical strategies appropriate for learners'

characteristics and learning objectives. Teachers can therefore design more engaging and learner-centred classrooms while dedicating additional time to mentoring, facilitating discussions, and providing individualized support. UNESCO (2024) explicitly frames AI as reducing routine workload so teachers can focus on higher-value teaching activities. Rather than replacing teachers' expertise, AI strengthens their capacity to make informed instructional decisions.

Improving access to Professional Learning

One of the most significant contributions of AI is its ability to increase access to flexible and personalize teachers' professional learning. Traditional professional development programmes usually provide periodic and similar training for all teachers regardless of their prior knowledge, teaching experience, or professional needs. In contrast, AI-powered learning systems analyse teachers' competencies, identify skill gaps, and recommend individualized learning resources that align with their professional goals. Unlike traditional one-size-fits-all approaches, personalized teacher professional development acknowledges that teachers are adult learners with varying levels of experience, knowledge, and career paths and therefore provides tailored learning opportunities that address individual competency needs while strengthening existing professional capabilities (Somabut et al., 2026). Adaptive learning platforms recommend relevant online courses, webinars, scholarly articles, instructional videos, and practical teaching resources based on teachers' learning profiles (Somabut et al., 2026). Such personalized learning pathways are usually flexible and enable teachers to develop competencies at their own pace while focusing on areas requiring improvement.

Increased Teacher Productivity

AI improves teachers' productivity by automating routine administrative tasks such as scheduling, attendance, grading, reporting, and resource organisation. This reduces workload, allowing teachers to focus more on instructional planning, learner engagement, mentoring, curriculum development, and continuous professional development, thereby enhancing teaching quality and professional effectiveness.

Promoting Pedagogical Innovation

AI promotes innovation and reflective practice by providing teachers with instructional ideas, simulations, multimedia resources, and collaborative tools. Generative AI, adaptive systems, simulations and other AI-enabled tools can expose teachers to alternative instructional strategies and new ways of presenting content. Used reflectively, these technologies can stimulate experimentation and pedagogical renewal. Learning analytics enable teachers to evaluate teaching effectiveness, identify areas for improvement, and make evidence-based instructional adjustments, fostering continuous professional growth, lifelong learning, and innovation. AI provides timely formative feedback, enabling teachers to improve instruction while helping learners quickly identify and correct their mistakes. AI also strengthens teachers' capacity to use digital technologies for teaching, assessment, communication, collaboration, and professional learning, design digital learning resources, facilitate online instruction, promote responsible digital citizenship, and critically evaluate and apply AI tools in line with ethical and professional standards. AI strengthens teachers' classroom management and inclusive pedagogy by enabling them to support diverse learners through translation, speech recognition, text-to-speech, captioning, and adaptive learning technologies. These tools help teachers design differentiated instruction, accommodate diverse learning needs, and promote equitable and inclusive learning environments.

Supporting Continuous Professional Development

AI facilitates lifelong professional learning by providing teachers with continuous access to scholarly resources, professional learning communities, personalized learning recommendations, virtual training, and AI-assisted research support. These opportunities enable teachers to update their knowledge, adapt to emerging educational innovations, and respond effectively to changing learner needs. As noted by Momoh et al. (2025), AI-driven systems continuously assess learners' strengths, weaknesses, and learning patterns to deliver personalized training that aligns with their competencies and development needs.

Challenges and Ethical Considerations

Although AI offers significant opportunities for teacher professional development, its integration presents technical, ethical, pedagogical, and

institutional challenges that require careful management. These challenges are:

Teachers AI Readiness and competence

Limited AI literacy remains a major barrier to effective AI integration in education, as many teachers lack sufficient knowledge of AI concepts, applications, and ethical issues. In many developing countries, inadequate AI training in teacher education programmes and limited technological infrastructure contribute to disparities in AI competence, making continuous professional development essential. Additionally, Wahjusaputri et al., (2024) noted that teachers require further training to effectively teach AI-related skills. However, many institutions face shortages of AI infrastructure and reliable internet access. Teacher education institutions should therefore integrate AI competencies into pre-service and in-service training to develop teachers' AI knowledge, data literacy, ethical awareness, and practical skills for teaching, assessment, classroom management, and collaboration, while strengthening their ability to critically evaluate AI outputs and make informed instructional decisions.

Digital inequality and access

Inadequate technological infrastructure is a significant challenge to AI implementation in education, particularly in developing countries where unreliable electricity, limited internet access, insufficient digital devices, and weak technical support restrict teachers' effective use of AI. These disparities can widen educational inequalities if not addressed through targeted investments. Chaipidech et al., (2022); Melo et al., (2024) noted that although AI-supported professional development can significantly enhance teachers' competencies, its implementation in developing countries is often constrained by inadequate infrastructure. Successful AI implementation requires investment in reliable digital infrastructure, including electricity, internet access, digital devices, cloud services, and technical support.

Data Privacy and Security

AI's extensive collection and analysis of educational data raise important concerns about privacy, confidentiality, and cybersecurity. Teachers and educational institutions must ensure the ethical use of AI by protecting

learners' personal information and establishing clear policies for data collection, storage, and use.

Algorithmic Bias and Misinformation

Because AI systems learn from existing data, biased or incomplete datasets can produce unfair outcomes in training, assessment, learner profiling, and decision-making. Moreover, AI lacks the critical reasoning, emotional understanding, and ethical judgment required for context-sensitive educational decisions (Frick, 2024; Baidoo-Anu & Ansah, 2023; Marcus & Davis, 2020; Damasio, 2019; Swan, 2021). Therefore, teachers must critically evaluate AI-generated recommendations and rely on professional judgment to ensure fairness and appropriateness. Although AI is capable of processing large amounts of data efficiently, it cannot make judgments that require critical reasoning and contextual evaluation (Frick, 2024). Furthermore, AI has limited capacity to fully understand human communication because it struggles to interpret emotional nuances and the complexities of interpersonal relationships (Baidoo-Anu & Ansah, 2023; Marcus & Davis, 2020). In addition, AI lacks ethical judgment, as it cannot evaluate moral issues through the lens of cultural values, lived experiences, and human emotions, which remain uniquely human capacities (Damasio, 2019; Swan, 2021). AI-generated content may contain inaccurate, misleading, fabricated, or outdated information due to AI hallucinations. Therefore, teachers should treat AI outputs as preliminary and verify them using credible academic, curricular, and authoritative educational sources before using them in teaching or research.

Overdependence on AI Reliability

The widespread use of generative AI poses challenges to academic integrity by increasing the risk of overreliance on AI for student work and teachers' professional tasks. Excessive reliance on automated tools may weaken independent professional reasoning and encourage uncritical acceptance of generated content. Furthermore, excessive reliance on AI may diminish teachers' professional roles by shifting essential instructional responsibilities to automated systems (Guilherme, 2019; Selwyn, 2019). AI should therefore augment professional judgement rather than substitute for teachers' pedagogical knowledge and contextual understanding.

Professional autonomy and academic integrity

Teaching remains a human-centred profession that requires empathy, ethical judgment, emotional intelligence, and interpersonal relationships which are qualities that AI cannot replace. AI use raises questions about authorship, attribution, originality and the boundaries of acceptable assistance. Clear institutional guidance can help teachers and learners understand responsible use. Human-centred AI research emphasizes that AI should complement rather than replace teachers, with educators retaining ultimate responsibility for instructional decisions and professional autonomy (Capel & Brereton, 2023; Garibay et al., 2023; Shneiderman et al., 2020). However, many teacher education programmes have yet to adequately integrate the pedagogical and ethical dimensions of AI into their curricula (Feldman-Maggor et al., 2025a; Zhai, 2025). Institutions and government should thereby establish clear AI use policies, while teachers should promote responsible AI use, proper attribution, originality, critical thinking, and independent learning.

Implications for Teacher Education, Policy and Practice

The following implications can be derived from the study;

Implications for Pre-Service Teacher Education

Teacher education curricula should integrate AI literacy, TPACK-oriented AI pedagogy, digital ethics, data literacy, critical evaluation of AI outputs and opportunities for supervised practice. Student teachers should learn not only how to use AI tools but also when not to use them and how to maintain professional judgement.

Implications for In-Service Teacher Professional Development

Professional development should move beyond isolated AI workshops towards continuous, needs-based learning. Schools and teacher-training institutions can combine face-to-face support with AI-enabled resources, mentoring, communities of practice and reflective activities. Competency frameworks can provide a basis for identifying learning needs and evaluating progress.

Implications for Institutional and Infrastructural Requirements

Educational institutions need reliable electricity, internet connectivity, appropriate devices, technical support, secure digital systems and access to

credible AI-enabled resources. Institutional leadership should establish supportive environments in which teachers can experiment responsibly, share experiences and receive assistance.

Implications for Policy and Regulatory Considerations

Education authorities should establish clear guidance on data protection, intellectual property, assessment, transparency, accountability and acceptable AI use. Policy should be sufficiently adaptable to accommodate rapid technological change while protecting teacher and learner rights.

Strategies for Responsible AI Integration

Responsible integration requires human oversight, verification of AI outputs, privacy safeguards, attention to bias and inclusion, professional development, stakeholder participation and regular evaluation. AI initiatives should be assessed against educational purposes and professional standards rather than technological novelty alone.

Conclusion

The paper has argued that artificial intelligence is becoming an important resource for teachers' professional competency development in Nigeria. AI can support content knowledge, pedagogy, assessment, digital and AI competence, classroom management, communication and collaboration, research and reflective practice, and professional ethics, leadership and continuous professional development. Its emerging role as a professional learning partner also creates possibilities for personalised, data-informed and lifelong development. At the same time, AI does not remove the need for teachers' professional judgement; rather, effective use depends on teachers' ability to evaluate outputs, interpret educational contexts and retain responsibility for consequential decisions. Leveraging AI in Nigeria therefore requires attention to the conditions under which professional learning takes place, including teacher readiness, infrastructure, equitable access, privacy, ethical safeguards and institutional support. Future directions should include more context-sensitive research on AI-enabled teacher development, empirical evaluation of professional-learning interventions, development of locally relevant competency frameworks and continued examination of how AI affects teachers' professional roles and agency. A sustainable approach should treat AI as an evolving component

of teacher professional learning while keeping human-centred educational values at the core.

Recommendations

It is recommended that:

1. Education authorities should develop sustainable AI policies that provide for continuous review and adaptation as AI technologies, professional standards and educational needs evolve.
2. Ministries of education should integrate AI competency standards into national teacher professional standards and certification frameworks. Such integration will ensure that AI literacy becomes an essential component of teacher professionalism.
3. Teacher education institutions should redesign curricula to include AI pedagogy, digital ethics, learning analytics, and responsible AI use across pre-service and in-service programmes. These curricular reforms will prepare teachers to respond effectively to emerging technological developments.
4. School administrators should foster supportive institutional cultures that encourage innovation, experimentation, collaboration, and continuous professional learning. Providing teachers with access to AI technologies, technical support, mentoring, and professional learning opportunities will enhance successful implementation.
5. Policymakers should establish sustainable funding mechanisms that support technological infrastructure, teacher capacity building, educational research, and equitable access to AI resources across all educational institutions.
6. Researchers and teacher-training institutions should undertake systematic, context-sensitive and evidence-based evaluations of AI-enabled teacher professional development to determine what forms of support improve specific competencies.
7. Governments, teacher-training institutions, educational technology providers, professional associations and development organisations should establish partnerships to co-design, test and improve AI-enabled professional-learning initiatives. Such collaboration will ensure that AI systems address authentic classroom challenges while remaining pedagogically sound and ethically responsible.

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