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Digital Pedagogies and Artificial Intelligence: Tools for Effective Classroom Instruction

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ABSTRACT

Integration of Artificial Intelligence (AI) into education is reforming instructional design, delivery, and assessment, giving rise to innovative digital pedagogies that emphasise personalisation, interactivity, and data-informed practice. Grounded in Constructivist Learning Theory and Connectivism Theory, this study examines how selected digital pedagogies and AI-powered tools, including adaptive learning systems, intelligent tutoring systems, and generative AI, can enhance classroom instruction. The study adopted expository research design to synthesis contemporary AI in education literature, the paper focuses on three core dimensions of AI-supported pedagogy: differentiated instruction through real-time content adaptation and automated feedback; teacher augmentation through AI-assisted lesson planning and content generation; and learner agency supported by conversational tools that facilitate inquiry and collaboration. Findings suggest that AI can reduce routine cognitive load, identify learning gaps, and improve access for diverse learners when guided by sound pedagogical principles. However, concerns relating to algorithmic bias, data privacy, and over-reliance on automation remain significant. The paper contributes new insight by reconceptualising AI as a co-orchestrator of teaching and learning rather than a replacement for teachers. It further proposes a Teacher-AI Co-orchestration framework that advances knowledge on ethical and pedagogically grounded AI integration. The study highlights practical implications for teacher professional development, AI literacy, inclusive learning, and responsible classroom implementation. It concludes that AI, when embedded within learner-centred design, enhances rather than replaces pedagogical practice.

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1. Introduction

Education globally is undergoing a paradigmatic shift from traditional content-delivery models to technology-enhanced, learner-centered models. This shift is driven by the emergence of the Fourth Industrial Revolution and the increasing demand for graduates with 21st-century skills such as critical thinking, digital literacy, and self-directed learning. Digital pedagogy refers to the use of digital tools, platforms, and approaches to enhance teaching and learning, while maintaining sound pedagogical principles (Mishra & Koehler, 2006). When integrated with Artificial Intelligence (AI), digital pedagogy moves beyond mere digitization of content to intelligent personalization of learning. AI in education includes adaptive learning platforms such as Knewton and Carnegie Learning, Intelligent Tutoring Systems (ITS), generative AI tools like ChatGPT, automated assessment and feedback systems, learning analytics, and AI chatbots for academic support (Zawacki-Richter et al., 2019; Holmes et al., 2019).

Recent empirical evidence shows that structured AI integration in classrooms can significantly enhance student outcomes. A randomized controlled trial found that students supplemented with a bespoke AI Digital Teacher achieved superior academic performance, reported lower anxiety, and experienced lower extraneous cognitive load compared to control groups (Sun & Liu, 2026). Similarly, studies in the UK showed that guided AI intervention increased independent study engagement, critical thinking, and overall performance, with engagement mediating academic success (Education and Information Technologies, 2024). At Kenyan universities, AI-driven tools facilitated content personalization, real-time feedback, and improved course completion rates (Nyamwange, 2025).

According to Selwyn (2021), expansion of digital technologies has reformed contemporary education, leading to the emergence of digital pedagogies that integrate technological tools into teaching and learning processes to improve interaction, engagement, and knowledge construction. Digital pedagogies extend beyond the use of digital devices to include intentional instructional designs that support learner-centred, interactive, and flexible learning environments (Döğer, 2026). In recent years, Artificial Intelligence (AI) has become a major driver of this transformation by enabling adaptive, data-driven, and intelligent instructional support systems that enhance classroom teaching practices (Strielkowski et al., 2025; Döğer, 2026). Artificial Intelligence in education refers to the application of computational systems capable of performing cognitive tasks such as reasoning, prediction, language processing, and decision-making to support teaching and learning processes (Holmes et al., 2022).

Artificial Intelligence systems include adaptive learning platforms, intelligent tutoring systems, learning analytics tools, and generative AI applications that assist in content creation, feedback generation, and instructional planning. The increasing adoption of AI in education reflects global efforts to enhance instructional efficiency, improve learning outcomes, and provide personalised learning experiences for diverse learners (Zawacki-Richter et al., 2019). A central promise of AI in education is its capacity to support differentiated instruction, teacher augmentation, and learner agency. AI systems can analyse learner performance data in real time,

identify knowledge gaps, and recommend personalised learning pathways that accommodate individual differences in ability, pace, and learning style. This capability aligns with the goal of differentiated instruction, which seeks to ensure that all learners receive appropriate educational support tailored to their needs (Tapalova & Zhiyenbayeva, 2022).

AI technologies assist teachers by reducing administrative workload through automated lesson planning, assessment design, grading, and feedback provision, thereby enhancing instructional efficiency and effectiveness (Holmes et al., 2019; Ahmad et al., 2023). Beyond teacher support, AI also strengthens learner agency by enabling interactive, self-directed, and inquiry-based learning experiences. Conversational AI tools and intelligent platforms allow learners to engage actively with content, ask questions, receive immediate feedback, and explore concepts independently. This shifts the learning process from passive reception to active participation, consistent with learner-centred pedagogical approaches. Such developments reflect the growing recognition of AI as a co-participant in learning processes rather than merely a technological tool (Siemens, 2005).

The theoretical foundation of this study is anchored in Constructivist Learning Theory and Connectivism Theory. Constructivism emphasizes that learners construct knowledge through interaction, reflection, and experience, while Connectivism views learning as the process of connecting information across digital networks and technological systems. Within these frameworks, AI functions as a mediating tool that supports knowledge construction, collaboration, and access to distributed learning resources in digital environments (Kathleen, 2011; Holmes & Tuomi, 2022). These theories provide a strong basis for understanding how AI can be meaningfully integrated into pedagogical practice.

Despite these potentials, significant challenges persist in the integration of AI into education, including algorithmic bias, data privacy concerns, over-reliance on automation, and threats to teacher professional autonomy. Existing literature has largely focused on the technical capabilities of AI systems, with limited emphasis on how teachers and AI can collaboratively function within instructional environments in a pedagogically and ethically grounded manner. This gap necessitates a structured framework that positions AI as a supportive instructional partner guided by pedagogical intentionality, ethical transparency, professional agency, learner-centred design, and adaptive governance. It is against this background that this study investigates digital pedagogies and AI as tools for effective classroom instruction and proposes a Teacher–AI Co-Orchestration (TACO) framework as a response to the identified gap.

The integration of digital pedagogies and AI tools in classroom instruction has become imperative, yet several interrelated problems led to this study, which include, but not limited to: inadequate Personalization in Large Classes; Nigerian educational classes are bedeviled by overcrowded classes with student-teacher ratios that make individualized instruction nearly impossible; the traditional one-size-fits-all pedagogy fails to cater to diverse learning styles and paces, leading to disengagement and poor learning outcomes among others (Saraswat, 2024).

The objective of this study is to examine the role of digital pedagogies and Artificial Intelligence (AI)-powered tools in enhancing effective classroom instruction. Specifically, the study investigated how AI-supported instructional systems contribute to differentiated instruction, teacher augmentation, and learner agency in contemporary educational settings. It also conceptualises the pedagogical and ethical dimensions that should guide the integration of AI in teaching and learning processes. The study developed a conceptual understanding of how teachers and AI systems can interact meaningfully in instructional environments without undermining teacher professional judgement or reducing learning to automated processes. The study proposes a Teacher–AI Co-Orchestration (TACO) model that explains how human and artificial intelligence can collaboratively enhance instructional effectiveness.

2. Literature Review

2.1. Digital Pedagogies in Education

Digital pedagogies represent instructional approaches that integrate digital technologies into teaching and learning to enhance engagement, interaction, collaboration, and knowledge construction. Rather than focusing on technology as an end in itself, digital pedagogies emphasise how digital tools are purposefully embedded within instructional design to improve learning outcomes. Döğer (2026) conceptualises digital pedagogy as a socio-technical practice shaped by the interplay between teachers, learners, curriculum, and digital infrastructures. In this sense, digital pedagogies are not neutral; they reflect pedagogical choices and broader educational goals. Similarly, Mishra and Koehler (2006) argue through the Technological Pedagogical Content Knowledge (TPACK) framework that effective digital teaching requires the integration of content knowledge, pedagogical knowledge, and technological knowledge in a balanced and context-sensitive manner.

In contemporary classrooms, digital pedagogies have expanded through the use of learning management systems, online collaborative tools, simulations, and multimedia instructional resources. These tools enable teachers to move from traditional lecture-based instruction to more interactive and learner-centred approaches. According to Koehler et al. (2013), the effectiveness of digital pedagogies depends not only on access to technology but also on teachers' ability to redesign instructional strategies that promote active learning. This shift has made teaching more dynamic, allowing learners to engage with content through exploration, collaboration, and problem-solving activities supported by digital environments. Consequently, digital pedagogies have become central to educational reform efforts aimed at improving quality and inclusiveness in teaching and learning.

Despite these benefits, the implementation of digital pedagogies is often constrained by infrastructural limitations, digital literacy gaps, and inconsistent integration into classroom practice. Döğer (2026) notes that the adoption of digital technologies in education is frequently uneven, with some institutions using technology superficially rather than transforming pedagogical practice. This suggests that digital pedagogy requires more than access to tools; it

demands systemic support, teacher training, and alignment with curriculum objectives. Therefore, understanding digital pedagogies as a pedagogical transformation rather than a technological upgrade is essential for meaningful educational improvement.

2.2. Artificial Intelligence in Education

Artificial Intelligence (AI) in education refers to the application of computational systems capable of performing tasks that typically require human intelligence, including reasoning, prediction, language processing, and decision-making. AI technologies in education include intelligent tutoring systems, adaptive learning platforms, automated grading systems, and generative AI tools. Holmes et al., (2019) describe AI as a transformative force capable of reshaping how teaching, learning, and assessment are designed and delivered. These systems are increasingly used to personalise learning experiences, support instructional decision-making, and enhance educational efficiency across different learning environments.

A major contribution of AI in education lies in its ability to enable adaptive and personalised learning. Adaptive learning systems analyse learner data to identify strengths, weaknesses, and learning patterns, thereby tailoring instructional content to individual needs. Tapalova and Zhiyenbayeva (2022) argue that such systems can provide real-time feedback and targeted interventions, which improve learner performance and engagement. This is particularly important in large and diverse classrooms where teachers may struggle to provide individualised attention to all learners. AI thus serves as a mechanism for scaling personalised instruction in ways that were previously difficult to achieve within traditional educational structures.

However, the integration of AI into education also raises concerns about ethical use, data privacy, and algorithmic bias. Williamson and Eynon (2020) highlight that AI systems in education are often shaped by the datasets on which they are trained, which may reflect existing social and educational inequalities. This can result in biased recommendations or unfair learning outcomes if not properly addressed. Additionally, Zawacki-Richter et al. (2019) caution that while AI has significant potential, its pedagogical integration remains underdeveloped, with many applications focusing more on efficiency than on meaningful instructional transformation. These challenges underscore the need for careful governance and ethical frameworks in AI-supported education.

2.3. AI-Powered Tools for Classroom Instruction

The landscape of AI tools available to educators is rapidly expanding. Four categories are particularly significant: adaptive learning platforms, intelligent tutoring systems, generative AI, and learning analytics.

Adaptive Learning Platforms

Adaptive learning platforms employ machine learning algorithms to model individual learner knowledge states and dynamically adjust instructional sequences, content difficulty, and practice opportunities accordingly (VanLehn, 2011). Platforms such as Carnegie Learning's MATHia, Knewton, and Smart Sparrow exemplify this approach. By continuously updating probabilistic models of learner understanding — often operationalised through Bayesian Knowledge Tracing

(BKT) — these systems approximate a master tutor's capacity for individualised instruction at scale (Corbett & Anderson, 1994; Pane et al., 2014). Empirical evidence from large-scale implementations suggests measurable gains in mathematics achievement, though effects are sensitive to implementation fidelity and teacher integration (Kulik & Fletcher, 2016).

Intelligent Tutoring Systems

Intelligent Tutoring Systems (ITS) represent a more sophisticated form of AI-assisted instruction, incorporating explicit models of domain knowledge, learner cognition, and pedagogical strategy (Woolf, 2010). Classic ITS architectures — including the student model, domain model, pedagogical model, and interface — enable nuanced, step-level scaffolding analogous to one-on-one human tutoring. AutoTutor, ALEKS, and Cognitive Tutor are among the most extensively researched systems, with meta-analyses reporting effect sizes in the range of 0.4 to 0.8 standard deviations over traditional instruction (Ma et al., 2014; Vanlehn, 2011). Crucially, ITS effectiveness is greatest when systems are deployed as supplements to human instruction rather than as replacements, consistent with the co-orchestration perspective advanced in this paper.

Generative AI

The emergence of Large Language Models (LLMs) such as GPT-4, Gemini, and Claude has inaugurated a new era of generative AI in education. These systems can produce coherent text, generate explanations across domains, create assessment items, simulate Socratic dialogue, and provide multimodal content at scale (OpenAI, 2023; Kasneci et al., 2023). For learners, generative AI functions as an always-available conversational partner capable of scaffolding inquiry, explaining misconceptions, and supporting the drafting and revision of written work. For teachers, it enables rapid generation of lesson plans, rubrics, differentiated materials, and student feedback. However, generative AI also introduces significant risks around hallucination, academic dishonesty, and the superficial appearance of understanding without genuine comprehension (Bender et al., 2021; Mollick & Mollick, 2023).

Learning Analytics

Learning analytics involves the measurement, collection, analysis, and reporting of data about learners and their contexts, with the purpose of understanding and optimising learning and the environments in which it occurs (Siemens & Baker, 2012). AI-powered analytics dashboards provide teachers with real-time visibility into student engagement, progress, and risk status, enabling timely and targeted intervention. Predictive models can identify students at risk of failure weeks before summative assessments, allowing educators to address emerging difficulties proactively (Arnold & Pistilli, 2012; Gasevic et al., 2015).

2.4. Theoretical Framework

This study is grounded in Constructivist Learning Theory and Connectivism Theory, both of which provide a strong foundation for understanding AI-supported digital pedagogies. Constructivist Learning Theory posits that learners actively construct knowledge through experience, interaction, reflection, and social engagement. From this perspective, learning is not a passive transfer of information but an active process of meaning-making. Digital tools and AI systems support this process by creating interactive environments where learners can explore concepts, test ideas, and receive feedback that enhances understanding (Alam, 2023). Connectivism Theory further extends this understanding by emphasizing the role of networks, technology, and digital connections in contemporary learning environments. Siemens (2005) argues that knowledge is distributed across networks and that learning consists of the ability to navigate and connect information sources effectively. In AI-supported environments, learners interact with intelligent systems, digital databases, and collaborative platforms, which collectively form a dynamic learning network. Within this theoretical perspective, AI functions as a cognitive partner that supports knowledge access, synthesis, and application across digital ecosystems, thereby reinforcing the relevance of Teacher–AI Co-Orchestration in modern education.

3. Methodology

The study adopted an expository research design to conceptualise the role of digital pedagogies and Artificial Intelligence (AI) in enhancing effective classroom instruction. This design was considered appropriate because the study is primarily theoretical and aims to explain, interpret, and synthesize existing ideas, models, and empirical findings on AI-supported education rather than generate new experimental data. The expository approach allowed for a systematic presentation of concepts, relationships, and emerging trends in AI integration in educational practice, with particular emphasis on instructional design and pedagogical transformation.

The focus of the study was on conceptual analysis and interpretation of existing scholarly literature on digital pedagogies, AI-powered educational tools, differentiated instruction, teacher augmentation, and learner agency. Relevant literature was critically reviewed and synthesized to identify recurring patterns, relationships, and gaps in knowledge. This process enabled the researcher to construct a coherent understanding of how AI functions within instructional environments and how it interacts with pedagogical principles to influence teaching and learning outcomes. The study involved the development of a conceptual framework known as the Teacher–AI Co-Orchestration (TACO) Framework. This framework was derived through analytical integration of findings from the literature and the researcher's conceptual interpretation of how teachers and AI systems can collaboratively function in classroom settings. The framework highlights key components such as pedagogical intentionality, ethical transparency, professional agency, learner-centred design, and adaptive governance, which collectively guide the effective use of AI in education.

Data for the study were obtained from secondary sources, including peer-reviewed journal articles, academic books, and reputable educational technology reports. These sources were

selected based on their relevance to AI in education, digital pedagogies, and instructional design. The outcome of the methodological process is a structured conceptual explanation of how AI can be integrated into classroom instruction as a supportive and collaborative tool rather than a replacement for teachers. The methodology therefore provides a foundation for understanding the theoretical relationships between AI technologies and pedagogical practice, culminating in the proposed Teacher–AI Co-Orchestration framework.

4. Findings

In response to the affordances and tensions documented above, this paper proposes a framework for Teacher-AI Co-Orchestration (TACO) centred on five interconnected principles: pedagogical intentionality, ethical transparency, professional agency, learner-centred design, and adaptive governance.

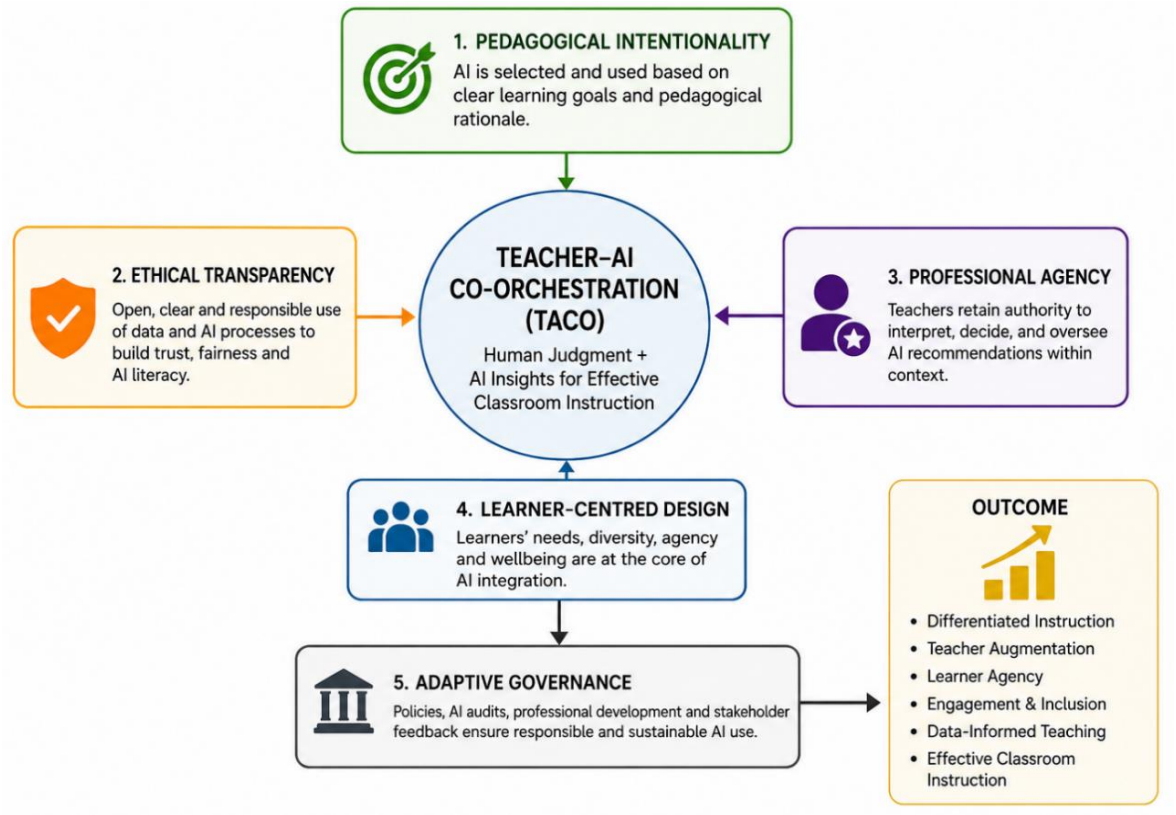


Figure 1: Proposed Teacher–AI Co-Orchestration (TACO) Framework

Figure 1 presents the proposed Teacher–AI Co-Orchestration (TACO) Framework developed from the conceptual findings of this study. The framework illustrates how effective classroom instruction can be achieved through the interaction between teachers and Artificial Intelligence (AI) systems when guided by five interconnected pedagogical and ethical principles. At the centre of the framework is Teacher–AI Co-Orchestration (TACO), which represents the collaborative integration of human professional judgement and AI-driven instructional support for improved teaching and learning outcomes. The framework identifies pedagogical intentionality as a primary

guiding principle for AI integration in education. Figure 1 indicates that AI tools should be selected and implemented based on clearly defined instructional goals and pedagogical relevance rather than technological novelty. This finding suggests that effective AI-enhanced instruction depends largely on aligning AI applications with curriculum objectives, learner needs, and instructional strategies.

The framework further reveals that ethical transparency is essential for responsible classroom AI implementation. The figure shows that transparency in data usage, fairness, explainability, and AI literacy contributes to trust, accountability, and responsible digital learning practices. This implies that stakeholders, including teachers, learners, parents, and institutions, must clearly understand how AI systems operate and how educational data are collected and utilised. Another major finding illustrated in the framework is the importance of professional agency. The framework demonstrates that teachers remain central decision-makers within AI-supported instructional environments. Rather than replacing teachers, AI functions as a supportive instructional partner that provides recommendations and insights, while teachers retain authority to interpret, modify, accept, or reject AI-generated outputs based on contextual classroom realities and professional expertise. The framework also identifies learner-centred design as a critical component of AI-enhanced pedagogy. The figure further demonstrates that the interaction among these five principles collectively contributes to effective classroom instruction. Specifically, the framework identifies differentiated instruction, teacher augmentation, learner agency, engagement and inclusion, and data-informed teaching as the major outcomes of Teacher–AI Co-Orchestration.

5. Discussions

The findings of this study revealed that effective integration of Artificial Intelligence (AI) into classroom instruction depends on aligning technological tools with pedagogical goals. The proposed Teacher–AI Co-Orchestration (TACO) framework showed that AI is most effective when guided by pedagogical intentionality rather than technological novelty. This finding supports Mishra and Koehler (2006), who explained through the TPACK framework that meaningful technology integration requires a balance among technological, pedagogical, and content knowledge. The finding also aligns with Döğer (2026), who conceptualised digital pedagogy as a socio-technical practice shaped by instructional goals and learning contexts.

The study further found that AI supports differentiated instruction through personalised learning and adaptive instructional support. The framework identified differentiated instruction as a major outcome of Teacher–AI Co-Orchestration, indicating that AI systems can respond to learners' individual abilities and learning needs. This finding agrees with Tapalova and Zhiyenbayeva (2022), who reported that AI-powered adaptive systems improve learner engagement and achievement by identifying learning gaps and providing targeted support. Holmes et al. (2019) also reported that AI technologies enhance instructional delivery through personalised learning and intelligent feedback systems. The study therefore suggests that AI can improve

inclusive classroom practices and support instructional flexibility in diverse learning environments.

Another major finding of the study is that AI enhances teacher augmentation rather than teacher replacement. The framework positioned teachers as central instructional decision-makers while AI functions as a supportive instructional partner. This finding corroborates Holmes and Tuomi (2022), who reported that AI should complement teacher expertise rather than replace professional judgement. Similarly, Zawacki-Richter et al. (2019) emphasized that the effectiveness of AI in education depends on pedagogical integration. The study found that AI can assist teachers in lesson planning, grading, feedback provision, and content generation, thereby reducing workload and improving instructional efficiency. However, teachers still retain authority over instructional decisions and classroom practice.

The findings also revealed that AI-supported digital pedagogies promote learner agency through interactive and self-directed learning experiences. This finding aligns with Siemens' (2005) Connectivism Theory, which explained that learning occurs through interaction with digital networks and information systems. The finding equally supports Constructivist Learning Theory, which views learning as an active process of knowledge construction through interaction and reflection (Alam, 2023). Through conversational AI systems and intelligent tutoring platforms, learners can independently explore concepts, ask questions, and receive immediate feedback. The implication is that AI-supported instruction can encourage active participation, critical thinking, and learner autonomy in digital learning environments.

The study revealed that ethical transparency and adaptive governance are essential for responsible AI integration in education. The framework identified fairness, accountability, explainability, and responsible data usage as important components of effective AI-supported instruction. This finding supports Williamson and Eynon (2020), who reported that AI systems may reproduce inequalities when implemented without ethical safeguards. The finding also aligns with Zawacki-Richter et al. (2019), who cautioned that many AI applications focus more on efficiency than pedagogical and ethical concerns. The study therefore concludes that effective Teacher–AI Co-Orchestration requires a balance between technological innovation, professional responsibility, and learner-centred educational practice.

6. Conclusion

The study concluded that digital pedagogies and Artificial Intelligence (AI) have significant potential to enhance effective classroom instruction when integrated within pedagogically and ethically guided learning environments. The findings revealed that AI supports differentiated instruction, teacher augmentation, learner agency, engagement, and data-informed teaching through adaptive and interactive instructional systems. However, the study also established that the effectiveness of AI in education depends on pedagogical intentionality, ethical transparency, professional agency, learner-centred design, and adaptive governance. The proposed Teacher–AI Co-Orchestration (TACO) framework therefore provides a conceptual foundation for

understanding how teachers and AI systems can collaboratively function to improve teaching and learning without undermining teacher professional judgement or learner autonomy. The study concludes that AI should be viewed as a supportive instructional partner that enhances educational practice through responsible, inclusive, and pedagogically meaningful integration.

7. Suggestion

Based on the findings of the study, it was suggested that educational institutions and policymakers should promote the integration of Artificial Intelligence (AI) within pedagogically driven instructional frameworks that prioritise learner needs and curriculum objectives. Teachers should be provided with continuous professional development programmes on AI literacy, digital pedagogies, and ethical technology integration to strengthen their professional agency and instructional competence. Educational stakeholders should also establish ethical guidelines and governance structures that ensure transparency, fairness, accountability, and responsible data usage in AI-supported learning environments. Empirical studies should be conducted to validate and refine the proposed Teacher–AI Co-Orchestration (TACO) framework across different educational contexts and learning environments.

8. Limitations

This study was limited by its reliance on an expository research design and secondary sources of data, which restricted the findings to conceptual analysis rather than empirical validation. The study focused primarily on theoretical interpretations and existing literature on digital pedagogies and Artificial Intelligence in education without direct classroom experimentation or participant involvement. Consequently, the proposed Teacher–AI Co-Orchestration (TACO) framework was not tested in real instructional settings. Despite these limitations, the study provided a useful conceptual foundation for understanding the collaborative relationship between teachers and AI systems in contemporary educational environments.

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