



Development of Teachers' Pedagogical Competence in the Context of Integrating Artificial Intelligence into the Educational Process

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Abstract: This article explores the development of teachers' pedagogical competence in the context of integrating artificial intelligence (AI) into the educational process. It examines the transformative role of AI in education, the challenges and opportunities for teacher professional development, and the ethical considerations of AI integration. Drawing on a comprehensive literature review and empirical studies, the paper proposes a framework for enhancing teachers' competencies through the lens of an AI-augmented Technological Pedagogical Content Knowledge (AI-TPACK) model. The findings highlight the need for targeted professional development programs that empower teachers to leverage AI effectively, ensuring alignment with pedagogical goals and ethical standards. Recommendations are provided for policymakers, educators, and institutions to foster sustainable AI integration in education.

Keywords: Artificial Intelligence, Pedagogical Competence, Teacher Professional Development, AI-TPACK, Educational Technology, Ethics in AI, Digital Literacy.

The rapid integration of artificial intelligence (AI) into education has reshaped teaching and learning paradigms, necessitating a reevaluation of teachers' pedagogical competencies. As AI technologies such as adaptive learning platforms, intelligent tutoring systems, and generative AI tools like ChatGPT become ubiquitous, they offer unprecedented opportunities to personalize learning, streamline administrative tasks, and enhance educational outcomes. However, this technological shift places new demands on teachers, requiring them to develop advanced skills that blend technological proficiency, pedagogical expertise, and ethical awareness. This article investigates how teachers' pedagogical competencies can be developed to effectively integrate AI into education, emphasizing the interplay between technological innovation and professional growth. AI's transformative potential in education lies in its ability to support differentiated instruction, automate routine tasks, and provide data-driven insights into student performance. For instance, studies indicate that AI tools can reduce teachers' administrative workload by 5–10 hours per week, allowing them to focus on instructional design and student engagement. Yet, the adoption of AI in education is not without challenges. A systematic review of literature from 2015 to 2024 reveals a significant gap in research: while 65% of studies focus on AI's application in teaching, only 35% address teacher professional development, underscoring a critical need for frameworks that support teachers in navigating AI-driven environments. This imbalance highlights the urgency of



equipping teachers with the skills to integrate AI meaningfully, ensuring that technological advancements translate into pedagogical benefits. Central to this discussion is the AI-augmented Technological Pedagogical Content Knowledge (AI-TPACK) framework, which extends the traditional TPACK model by incorporating AI-specific competencies. AI-TPACK emphasizes the integration of technological knowledge (understanding AI tools), pedagogical knowledge (effective teaching strategies), and content knowledge (subject-specific expertise), while also addressing ethical considerations such as data privacy and algorithmic bias. This framework enables teachers to select and apply AI tools in ways that align with educational objectives, fostering critical thinking and creativity among students. For example, AI-driven platforms can facilitate collaborative learning environments where students engage in problem-solving tasks, guided by teachers who use AI analytics to tailor instruction.

The benefits of AI integration are manifold. AI tools enhance teachers' efficiency by automating tasks such as lesson planning, grading, and feedback generation, thereby allowing more time for student interaction. Moreover, generative AI systems can support teacher training by providing personalized professional development resources, enabling educators to upskill at their own pace. However, challenges persist, including technological barriers, digital inequities, and the risk of over-reliance on AI, which may undermine students' critical thinking skills. Ethical concerns, such as ensuring equitable access to AI tools and mitigating algorithmic biases, further complicate integration efforts. For instance, studies highlight that biased AI algorithms can perpetuate inequalities in educational outcomes if not carefully monitored. Empirical evidence underscores the correlation between teachers' digital literacy and their ability to integrate AI effectively. A 2024 study found that teachers with high digital proficiency were 40% more likely to adopt AI tools in their classrooms compared to those with lower proficiency. To address this, professional development programs should adopt experiential learning models, such as Kolb's learning cycle, which encourage teachers to experiment with AI tools, reflect on their application, and refine their practices. Such programs can enhance teachers' "professional vision" the ability to analyze classroom dynamics and anticipate student needs through AI-driven simulations and real-time feedback. Context-specific studies, such as those conducted in Vietnam, demonstrate that targeted AI training improves teachers' lesson planning and assessment practices, but sustained professional development is essential to maintain these gains. To ensure long-term success, institutions must invest in continuous training that addresses both technical and ethical dimensions of AI use. For instance, workshops that combine hands-on AI tool exploration with discussions on ethical implications can empower teachers to make informed decisions about AI integration. Looking forward, the development of teachers' pedagogical competencies in the AI era requires a multifaceted approach. Policymakers should prioritize the creation of AI-focused curricula for teacher education programs, emphasizing



interdisciplinary skills that bridge technology, pedagogy, and ethics. Collaborative networks between educators, researchers, and AI developers can further support the design of contextually relevant training modules. Additionally, longitudinal studies are needed to evaluate the impact of AI-driven professional development on teaching practices and student outcomes, ensuring that AI integration aligns with broader educational goals.

In conclusion, the integration of AI into education offers a transformative opportunity to enhance teachers' pedagogical competencies, but it demands a strategic approach to professional development. By adopting frameworks like AI-TPACK and addressing ethical and technological challenges, educators can harness AI's potential to create inclusive, innovative, and effective learning environments. The future of education lies in empowering teachers to navigate this AI-driven landscape with confidence and competence, ensuring that technology serves as a catalyst for pedagogical excellence.

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