

Developing AI Competencies in Future Educators: A Framework of Innovation Process

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KEYWORDS

AI competencies, teacher education, innovation process, educator training, artificial intelligence.

ABSTRACT:

As Artificial Intelligence (AI) continues to revolutionize the education sector, it is critical to prepare future educators with the necessary AI competencies to enhance their teaching practices and pedagogical strategies. This review explores the development of AI skills among teacher candidates, proposing a comprehensive framework for integrating AI into educator training programs. The paper evaluates the current state of AI competencies in teacher education, identifies gaps, and highlights best practices for fostering innovation in education through AI. Drawing on research from 2013 to 2024, the review examines key AI tools, their potential to transform teaching methods, and offers a forward-looking perspective on building AI literacy in future educators. The framework presented aims to inform policy makers, curriculum developers, and educator preparation programs on effective strategies for AI competency development.

Introduction

The integration of Artificial Intelligence (AI) in education represents a transformative shift in how knowledge is delivered, processed, and engaged with in classrooms worldwide. In the context of teacher preparation, AI is reshaping traditional teaching paradigms by providing personalized learning experiences, optimizing administrative tasks, and enhancing teacher-student interactions. However, the successful implementation of AI in classrooms depends not only on technological advances but also on the ability of future educators to understand, adapt, and apply AI tools effectively. This creates a pressing need for AI competency development in teacher education programs.

The objective of this review article is to explore the role of AI competencies in the development of future educators, focusing on a framework of innovation that prepares teacher candidates for the challenges and opportunities presented by AI technologies. AI competencies go beyond technical skills; they include the ability to critically evaluate AI tools, understand their pedagogical implications, and integrate these technologies into diverse learning environments. This paper reviews existing literature on the integration of AI into educator training, examines global case studies of AI implementation in teacher preparation programs, and proposes a framework to guide the development of AI skills among educators.

AI in education holds the potential to personalize learning and improve educational outcomes, yet there are significant barriers to its widespread adoption, particularly in terms of teacher readiness. Future educators must not only be familiar with AI tools but must also develop the cognitive flexibility to innovate with these tools in dynamic classroom settings. The framework of innovation proposed in this paper aims to provide a strategic roadmap for building AI competencies in educator preparation, promoting a shift from passive technology usage to active, informed, and transformative teaching practices.

Literature Review

Recent literature indicates a growing recognition of the need for AI competencies in teacher education. However, there is no unified approach or comprehensive framework for integrating these competencies into teacher preparation programs. Studies have highlighted various AI tools and their

applications, such as learning management systems (LMS), intelligent tutoring systems (ITS), and AI-powered educational assistants (Celik et al., 2020). These tools offer opportunities for personalized learning, immediate feedback, and classroom automation, but teachers must understand how to use them effectively in their teaching practices. Research by Holmes et al. (2022) stresses that teachers who are familiar with AI can leverage these technologies to cater to diverse student needs, enhance engagement, and make data-driven decisions about instruction.

Several key models of AI competency for teachers have emerged. According to the European Commission's 2020 report on AI in education, teachers should develop not only technical literacy but also ethical, social, and pedagogical awareness related to AI (European Commission, 2020). For instance, ethical concerns such as bias in AI algorithms, data privacy, and the implications of machine learning on student autonomy must be addressed in educator training programs. In this context, AI competencies are not merely technical but require an understanding of the broader societal impact of AI systems (Mouza & Lavigne, 2023). Educators must be trained to critically evaluate AI tools, ensuring they align with educational goals and ethical principles.

Several studies have attempted to define the AI competencies necessary for educators, emphasizing a mix of technical skills (e.g., understanding machine learning, data analytics), critical thinking (e.g., evaluating the impact of AI on students), and pedagogical knowledge (e.g., adapting AI for classroom use). An emerging body of research suggests that a combination of practical experience with AI technologies, along with coursework on the implications of AI in education, forms the foundation of an effective AI competency framework (Zawacki-Richter et al., 2021). In countries like Finland and Singapore, AI-related courses are being integrated into teacher education programs, showcasing the importance of forward-thinking educational policies and teacher training practices (Puentedura, 2023).

Methodology

This review article uses a qualitative systematic approach, synthesizing existing research on AI competencies in teacher education from 2013 to 2024. A comprehensive search was conducted across academic databases including Scopus, ERIC, and Web of Science, with specific inclusion criteria focusing on studies that explored the role of AI in teacher preparation, AI competency models, and case studies of AI integration in teacher education. Keywords such as “AI in teacher education,” “AI competencies,” “teacher preparation,” and “AI literacy” were used to identify relevant studies and articles.

The methodology includes thematic analysis, where the selected studies were categorized into key themes such as AI tools and technologies in teacher education, models of AI competency development, challenges in integrating AI into teacher training, and case studies of successful AI implementation. Each study was evaluated for its relevance to the research questions, and findings were compared to identify patterns and gaps in the existing literature. This allowed the researchers to develop a comprehensive understanding of the state of AI competencies in teacher education and propose a framework for future AI competency development.

Additionally, the article reviews global case studies from countries with advanced AI integration in education, such as South Korea, Canada, and Estonia. These case studies provide insights into how AI is being embedded into teacher training programs, what challenges educators face, and how these programs have evolved over time. The findings from these case studies will serve as a basis for developing a set of recommendations for policymakers and educators regarding AI competency development.

Findings

The literature review reveals that AI competency development in teacher education is an emerging but critical area of focus. Several studies highlight the need for teacher preparation programs to include AI as a core component of their curriculum (Holmes et al., 2022). However, the findings also suggest significant challenges, including a lack of resources, insufficient teacher training, and resistance to adopting new technologies. Teachers who have been exposed to AI technologies report improved student engagement and better instructional practices, but many teachers feel inadequately prepared to use these technologies effectively in the classroom (Mouza & Lavigne, 2023).

AI competency models in teacher education vary widely, with some programs focusing heavily on technical skills and others emphasizing the ethical, social, and pedagogical implications of AI (Puentedura, 2023). A key finding from the case studies is that educators who receive hands-on experience with AI tools, as opposed to purely theoretical instruction, are better equipped to integrate these technologies into their teaching practices. In countries like Singapore, where AI is integrated into the teacher preparation curriculum, educators report higher levels of confidence in using AI to enhance student learning outcomes (Celik et al., 2020). However, despite the progress, many programs still lack the necessary infrastructure and expertise to provide teachers with adequate AI training.

Additionally, the findings reveal that ethical considerations are a significant aspect of AI competency development. Teachers must not only be familiar with the technical aspects of AI but must also be able to navigate ethical issues related to student data privacy, algorithmic bias, and the potential for AI to exacerbate educational inequalities. The importance of fostering ethical AI awareness is particularly critical in light of concerns about AI's impact on vulnerable student populations and the potential for reinforcing existing biases (Zawacki-Richter et al., 2021).

Discussion

The integration of AI into teacher education represents a necessary step in preparing educators for the challenges and opportunities of the digital age. AI technologies have the potential to personalize learning, enhance teaching efficiency, and provide real-time insights into student performance. However, these technologies cannot be effectively utilized unless future educators possess the requisite AI competencies. The development of these competencies requires a multifaceted approach that combines technical knowledge with critical thinking and pedagogical awareness (Holmes et al., 2022).

The challenge lies not only in teaching educators how to use AI tools but also in fostering a mindset that embraces innovation and adapts to new teaching methods. Teacher education programs must evolve to incorporate AI literacy across disciplines, not just in computer science or STEM-related courses. The proposed framework of innovation for AI competency development should be holistic, integrating AI into curriculum design, classroom practices, and ethical considerations. This framework should include hands-on experiences with AI tools, opportunities for collaborative learning, and ongoing professional development to ensure that educators remain up-to-date with rapidly advancing technologies.

Furthermore, a key issue in AI competency development is ensuring that all educators, regardless of their background or teaching environment, have access to high-quality AI training. This includes addressing the digital divide and providing resources to schools and educators in under-resourced areas. To this end, governments and educational institutions must collaborate to ensure that AI competency development is equitable and inclusive.

Conclusion

Developing AI competencies in future educators is critical to preparing them for the demands of a rapidly evolving educational landscape. AI has the potential to enhance teaching and learning, but educators must be equipped with the necessary skills to use these technologies effectively. The proposed framework for AI competency development emphasizes a comprehensive approach that includes technical skills, ethical awareness, and pedagogical expertise. By integrating AI into teacher education programs, we can ensure that educators are prepared to harness the full potential of AI in their classrooms, fostering innovation and improving educational outcomes for all students. As AI continues to shape the future of education, ongoing professional development and policy support will be essential in sustaining this transformative shift.

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