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Modeling the Adoption of AI-Powered Learning Tools in Teacher Education

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Abstract
Integrating Artificial Intelligence (AI) in education reshapes teaching and learning, particularly in teacher education. This literature review investigates the adoption of AI-powered learning tools, focusing on pre-service mathematics teachers. It synthesizes cognitive factors such as perceived usefulness (PU), perceived ease of use (PEOU), prior exposure to AI tools, psychological factors like self-efficacy, and social influences like peer support and institutional support. Ethical concerns surrounding perceived trust, technological readiness, and attitudes toward AI in education are examined. Theoretical frameworks like the Unified Theory of Acceptance and Use of Technology (UTAUT) and Bandura's self-efficacy theory are applied to understand AI adoption dynamics. The review finds that PU, PEOU, and institutional support are key predictors of AI adoption, while ethical barriers and technical readiness remain significant challenges. Recommendations are provided for overcoming these barriers to ensure equitable access to AI in teacher education.

Keywords: *AI adoption; teacher education; learning tools; self-efficacy; institutional support;*

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INTRODUCTION

Artificial Intelligence (AI) and machine learning are revolutionizing education by enabling individualized, adaptive learning experiences. In teacher education, AI-based technologies, e.g., intelligent tutoring systems and automated assessment devices, carry high promise towards increasing the efficiency of teaching and boosting learner performance. Nevertheless, using such tools in teacher preparation programs, particularly for pre-service mathematics teachers, is minimal, broadly faced with several challenges such as usability, ethical issues, and lack of institutional support (Fan & Zhang, 2024; Zhang & Hou, 2024).

Although the AI is targeted toward enhancing instructional efficiency, studies have demonstrated that the use of AI technology is affected by perceived usefulness, ease of use, and self-efficacy (Herzallah & Makaldy, 2025; Kong et al., 2024). Subsequently, peer influence and organization readiness are key factors in the effective implementation of AI tools (Zhang & Zhang, 2024; Chou et al., 2024). Nevertheless, strong ethical considerations, like algorithmic fairness and data privacy, are still limiting the broader application of AI in education (Fan & Zhang, 2024; Ou et al., 2024).

This paper synthesizes existing literature on adopting AI-powered learning tools in teacher education, focusing on pre-service mathematics teachers. It aims to identify the factors that influence AI adoption, explore the challenges educators face, and propose strategies for overcoming these barriers to ensure the effective integration of AI in teacher training programs.

METHODS

This literature review aimed to systematically synthesize existing research on adopting AI-powered learning tools in teacher education, focusing specifically on pre-service mathematics teachers. The primary goal was identifying key factors influencing AI adoption and proposing strategies to address barriers. The review process began with a comprehensive search of academic databases such as Google Scholar and ScienceDirect. Keywords such as "AI adoption in education," "AI tools in teacher education," "pre-service teacher education," and "technology acceptance models" were used to identify relevant studies. Only peer-reviewed articles and academic journals published between 2015 and 2024 were included to ensure that the review reflected the most current research. Studies that addressed the direct application of AI in teacher education were selected, while those focused on unrelated fields such as business or healthcare were excluded.

In selecting the studies, the inclusion criteria required that they specifically explore AI adoption in teacher education, addressing factors such as perceived usefulness, ease of use, institutional support, self-efficacy, and ethical concerns. Relevant theoretical frameworks, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) and Bandura's self-efficacy theory, were also central to the inclusion criteria. Studies were excluded if they did not focus directly on teacher education or AI adoption, or if they were published prior to 2015.

Once the relevant studies were identified, key information was extracted, including the authors, publication year, theoretical framework, methodology used, and the main findings related to AI adoption. This data was then organized into categories based on the factors that influence adoption, namely cognitive, psychological, social, institutional, and ethical factors. A qualitative synthesis was conducted, comparing the findings from different studies to understand broader patterns in AI adoption within teacher education. This analysis also identified gaps in the literature, particularly in the context of discipline-specific adoption models, such as those tailored to mathematics education.

The theoretical frameworks guiding the review were the Unified Theory of Acceptance and Use of Technology (UTAUT) and Bandura's self-efficacy theory. UTAUT emphasizes factors like performance expectancy, effort expectancy, social influence, and facilitating conditions, all of which were found to impact technology adoption significantly. Bandura's self-efficacy theory was applied to understand the psychological factors that shape educators' confidence in adopting AI tools. While the review aimed to be comprehensive, it was limited by the availability of studies specifically addressing AI adoption in teacher education. Many relevant studies were excluded due to their broader focus on technology in other fields, and the review was confined to studies published in English.

FINDING AND DISCUSSIONS

This literature review explores the adoption of AI-powered learning tools in teacher education, particularly focusing on pre-service mathematics teachers. The findings reveal several factors that significantly influence the adoption of AI tools, categorized into cognitive, psychological, social, institutional, and ethical dimensions.

Cognitive Factors: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are pivotal in determining the adoption of AI tools. Pre-service teachers are more inclined to adopt AI tools when they perceive them as enhancing teaching effectiveness or reducing workload. Studies have consistently shown that AI tools offering automation of repetitive tasks such as grading or feedback are particularly appreciated in mathematics education (Kong et al., 2024; Zhang & Hou, 2024). Ma and Lei (2024) further support this, noting that the perceived utility of AI tools in automating tasks like grading and assessment is a key driver of adoption in educational contexts.

Teachers who perceive AI tools as useful are more inclined to use them regularly and integrate them into their teaching practices.

However, perceived ease of use plays a crucial role in the initial stages of adoption, though it tends to lose significance as teachers gain more experience with the technology (Lu et al., 2024). Ma and Lei (2024) also highlight that teachers who initially find AI tools easy to use are more likely to overcome challenges in the adoption process. As teachers become more familiar with the technology, ease of use may become less of a concern, while its perceived usefulness becomes a stronger determinant for sustained use. This finding is consistent with the Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasizes the importance of both PU and PEOU in technology adoption (Venkatesh et al., 2003).

Furthermore, prior exposure to AI tools was found to influence both PU and PEOU. Teachers who had prior experience with AI tools were more likely to perceive these tools as both useful and easy to use, making them more likely to adopt these tools in their teaching (Zhang & Hou, 2024; Ma & Lei, 2024). Ma and Lei (2024) also suggest that prior exposure to similar technologies helps to reduce anxiety around new tools, which in turn fosters a more positive attitude toward their adoption.

Psychological Factors: Self-efficacy, or teachers' confidence in their ability to use AI tools effectively, was found to be a strong predictor of AI adoption. Teachers with high self-efficacy are more likely to embrace AI tools, even when faced with technical challenges (Herzallah & Makaldy, 2025). This finding supports Bandura's self-efficacy theory, which posits that individuals' belief in their abilities directly influences their willingness to engage with new technologies (Bandura, 1997). Furthermore, teachers who know how to use AI tools may experience a transformation in their roles, as AI empowers them and enhances their efficiency in management and decision-making (Ng et al., 2022; Vazhayil et al., 2019).

Social and Institutional Factors: Social influence and institutional support were identified as critical enablers of AI adoption. Peer influence, particularly through professional communities and mentoring programs, significantly boosts teachers' confidence in using AI tools (Chou et al., 2024; Shuaiyao & Lei, 2024). Teachers are more likely to adopt AI when they observe their colleagues using these tools successfully. This aligns with Venkatesh et al.'s (2003) UTAUT model, which highlights social influence as a key determinant of technology acceptance.

Additionally, institutional support, such as access to training, technical resources, and clear policies, was found to increase the likelihood of successful AI integration in classrooms (Zhang & Zhang, 2024). Educational institutions that prioritize professional development in AI technology adoption provide a crucial support system that empowers teachers to integrate AI tools effectively. This finding underscores the importance of creating a supportive environment in educational institutions to facilitate AI adoption.

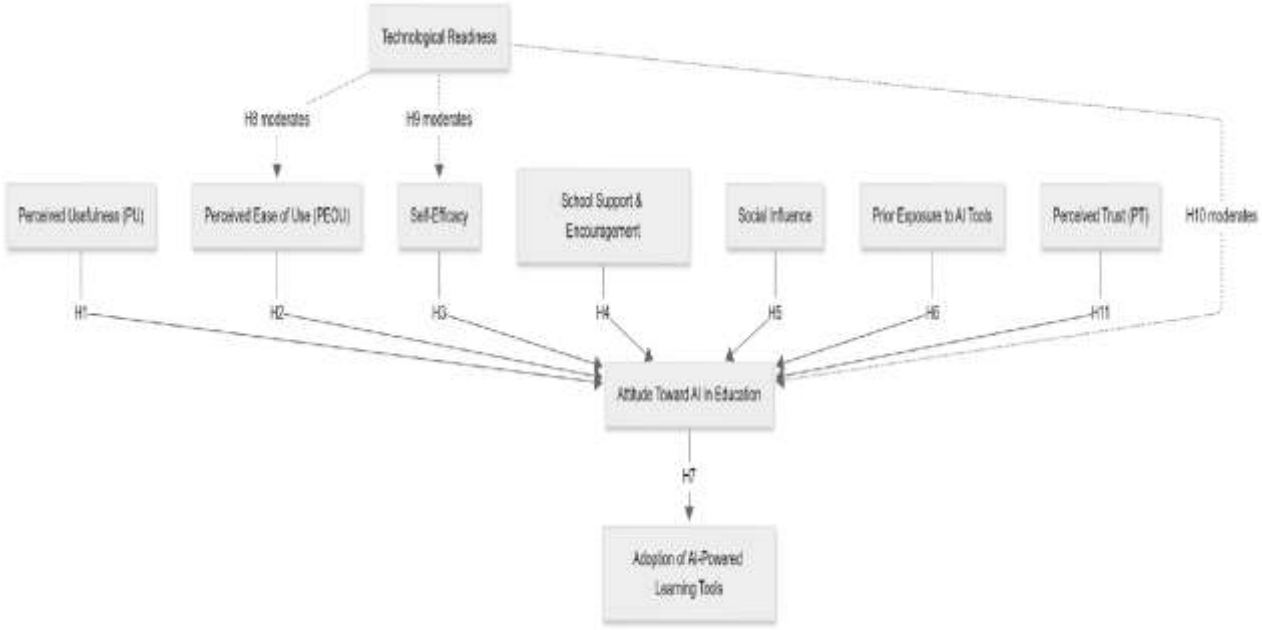
Ethical and Contextual Factors: Ethical concerns, such as data privacy and algorithmic fairness, remain significant barriers to AI adoption in education. Teachers must trust the technology they are using, and ethical frameworks are necessary to ensure this trust is maintained. Fan and Zhang (2024) and Ou et al. (2024) note that the lack of clear ethical guidelines often leads to reluctance in adopting AI tools. Teachers are concerned about how student data is used and how algorithms affect decision-making in education. These concerns are critical in fostering trust, which is necessary for the adoption of AI (Taddeo et al., 2025).

Furthermore, technological readiness, defined as the availability of infrastructure and support within educational institutions, was identified as a key factor. Technologically prepared schools tend to have higher adoption rates of AI tools (Jöhnk et al., 2020). This includes access to high-speed internet, sufficient hardware, and continuous technical support. Teachers are more likely to adopt AI if they feel confident that the technology will work reliably and that technical issues can be resolved promptly (Chou et al., 2024).

Attitude toward AI in education also plays a significant role in adoption. Teachers with a positive attitude toward technology are more open to trying new tools and approaches, including AI. Studies show that a teacher's attitude toward technology is a strong predictor of their

willingness to engage with AI tools (Ajzen, 1991; Venkatesh et al., 2003). Teachers who view AI as a valuable resource are more likely to integrate it into their teaching practice, while those with a negative attitude may resist its adoption, even if they acknowledge its usefulness (Zhang & Zhang, 2024). Teachers' positive attitudes are often shaped by their prior experiences, institutional support, and perceived usefulness of AI (Lu et al., 2024).

The findings suggest that AI adoption in teacher education is influenced by a complex interplay of cognitive, psychological, social, institutional, and ethical factors. While perceived usefulness and institutional support are strong drivers of adoption, ethical concerns and technical challenges remain significant obstacles. Self-efficacy, peer influence, perceived trust, technological readiness, and attitude also play pivotal roles in determining whether pre-service mathematics teachers will adopt AI tools. These findings align with previous research and offer new insights into the specific challenges faced by pre-service mathematics teachers in the adoption of AI-powered learning tools.



CONCEPTUAL FRAMEWORK

RESEARCH HYPOTHESES

The following are the hypotheses drawn from this study:

H1: Perceived Usefulness positively influences Attitude Toward AI in Education.
H2: Perceived Ease of Use positively influences Attitude Toward AI in Education.
H3: Self-efficacy positively influences Attitude Toward AI in Education.
H4: School Support and Encouragement positively influence Attitude Toward AI in Education.
H5: Social Influence positively influences Attitude Toward AI in Education.
H6: Prior exposure to AI-based Tools positively influences Attitude Toward AI in Education.
H7: Attitude Toward AI in Education positively influences the Adoption of AI-Powered Learning Tools.
H8: Perceived Trust (PT) positively influences Attitude toward AI in Education
H9: Technological Readiness moderates the relationship between Perceived Ease of Use and Attitude Toward AI in Education, such that the relationship is stronger when Technological Readiness is high.
H10: Technological Readiness moderates the relationship between Self-Efficacy and Attitude Toward AI in Education, such that the relationship is stronger when Technological Readiness is high.

H11: Technological Readiness moderates the relationship between Attitude Toward AI in Education and Adoption of AI-Powered Learning Tools, such that the relationship is stronger when Technological Readiness is high.

CONCLUSION

Integrating Artificial Intelligence (AI) in teacher education, particularly for pre-service mathematics teachers, is becoming increasingly essential for enhancing educational practices. This study explored several factors influencing the adoption of AI tools in education, including cognitive factors (perceived usefulness, perceived ease of use, and prior exposure to AI tools), psychological factors (self-efficacy), social factors (social influence), institutional factors (school support and encouragement), and ethical considerations (perceived trust, technological readiness, and attitude towards AI). The findings indicate that perceived usefulness and institutional support are among the strongest predictors of AI adoption, highlighting the importance of recognizing AI tools' effectiveness and providing adequate support for teachers. Additionally, self-efficacy, social influence, and positive attitudes toward AI significantly contribute to teachers' willingness to adopt these technologies. However, barriers such as ethical concerns related to data privacy, algorithmic fairness, and technological readiness remain significant obstacles that impede wider adoption. These factors interact in complex ways, with technological readiness acting as a moderator that influences how the various predictors of adoption impact each other. Therefore, ensuring that schools have the necessary infrastructure and resources is critical to overcoming these barriers and facilitating smoother AI integration in education.

RECOMMENDATION

Based on these findings, it is recommended that teacher education programs focus on improving teachers' self-efficacy by offering comprehensive training that emphasizes the practical benefits of AI tools. Institutions should foster a culture of support through mentorship and peer collaboration, which can significantly enhance social influence and reduce barriers to adoption. Additionally, addressing ethical concerns and ensuring transparency in AI applications will be crucial for building trust among educators. Policymakers and educational institutions must prioritize technological readiness by investing in infrastructure and providing the necessary resources for teachers to engage with AI tools confidently. Furthermore, future research should explore the moderating role of technological readiness in the relationship between cognitive, psychological, and social factors to better understand how readiness impacts AI adoption and how it can be leveraged to improve adoption outcomes.

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