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Research Article

Preservice Teachers' Perceptions of AI-Powered Adaptive Learning Models

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Abstract: The integration of Artificial Intelligence (AI) in higher education has led to the increasing use of AI-powered adaptive learning models that support personalized and data-driven learning. However, studies examining preservice teachers' perceptions of these models remain limited, despite their important role in future classroom implementation. This study aims to explore preservice teachers' perceptions of AI-powered adaptive learning in higher education, focusing on perceived usefulness, learning adaptivity, learning experience, and perceived concerns. A descriptive qualitative research design was employed involving 53 preservice teachers from various universities. Data were collected using a Likert-scale questionnaire and open-ended questions. Quantitative data were analyzed descriptively using percentage distributions, while qualitative data were examined through simple thematic analysis. The findings reveal that preservice teachers generally demonstrate positive perceptions of AI powered adaptive learning, particularly in terms of learning effectiveness, adaptability, and engagement. Nevertheless, concerns related to over-reliance on AI, ethical issues, and data privacy were also identified. These results indicate that preservice teachers show readiness to engage with AI-supported learning, while highlighting the need for teacher education programs to promote responsible and pedagogically informed AI integration.

Keywords: Adaptive Learning; Artificial Intelligence; Higher Education; Learning Perception; Preservice Teachers

1. Introduction

The integration of Artificial Intelligence (AI) in higher education is a central component of the global digital transformation, reshaping how learning is designed, delivered, and assessed. AI technologies enable data-driven decision-making, personalized learning pathways, and adaptive instructional support. Universities worldwide have adopted AI in learning management systems, performance analytics, and automated feedback to enhance learner engagement, efficiency, and self-regulated learning (OECD, 2021; UNESCO, 2021). Among these applications, AI-powered adaptive learning systems have gained prominence due to their ability to dynamically adjust content, instructional strategies, and feedback based on individual learners' performance and needs, thereby optimizing learning outcomes (Zhai et al., 2021). Recent studies have demonstrated that AI-powered adaptive learning systems significantly enhance personalization, learner engagement, and academic achievement in higher education contexts. For example, Varma et al. (2021) found that adaptive AI systems enable real-time instructional adjustments that improve learning efficiency and learner satisfaction. Similarly, Wang et al. (2024) reported that AI-based personalization positively influences students' motivation and self-regulated learning. These findings support the growing recognition that AI-driven adaptive learning is not merely a technological trend, but a pedagogical innovation that reshapes teaching and learning practices.

In teacher education, preservice teachers' readiness to engage with AI-supported learning environments is increasingly important. As future educators, preservice teachers are expected to integrate AI technologies while making informed pedagogical and ethical decisions. However, despite extensive research on AI in higher education, existing studies largely emphasize technological effectiveness and student outcomes. Chiu & Chai (2020)

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emphasized that teachers' beliefs and attitudes toward educational technologies strongly influence their willingness to adopt innovative tools in classroom practice. More recently, Garzón et al. (2025) argued that positive perceptions of artificial intelligence are key predictors of teachers' intention to integrate adaptive technologies into teaching. Empirical evidence focusing on preservice teachers' perceptions of AI-powered adaptive learning remains limited, particularly regarding key dimensions such as perceived usefulness, learning adaptability, learner engagement, and ethical concerns (Ouyang & Jiao, 2021; Teo, 2020). This gap is critical, as teachers' perceptions strongly influence technology adoption and instructional practice.

To address this gap, this study explores preservice teachers' perceptions of AI-powered adaptive learning in higher education, focusing on perceived usefulness, adaptability of learning, learner engagement, and ethical considerations. The novelty of this research lies in its integrated examination of pedagogical and ethical dimensions of preservice teachers' perceptions within AI-powered adaptive learning contexts, an area that has received limited empirical attention. The findings are expected to inform teacher education programs in preparing future educators to integrate AI technologies responsibly and effectively.

The integration of Artificial Intelligence (AI) in higher education forms part of a global digital transformation that significantly changes how learning is designed, delivered, and assessed. AI, capable of performing tasks requiring human intelligence such as data analysis and decision-making, enables personalized, adaptive, and data-driven learning. Universities worldwide have incorporated AI in learning management systems, student progress monitoring, and automated feedback, which enhance engagement and support autonomous learning (OECD, 2021; UNESCO, 2021). AI-powered adaptive learning systems adjust content, strategies, and feedback according to individual learner performance, identifying gaps and providing real-time interventions to optimize learning outcomes (OECD, 2021; Zhai et al., 2021).

For preservice teachers, understanding AI's pedagogical applications is crucial to preparing for technology-rich classrooms. However, research on their perceptions of AI, especially adaptive learning models, remains limited, even though these perceptions strongly influence adoption and effective integration in teaching practice (Ouyang & Jiao, 2021; Teo, 2020).

2. Literature Review

AI-Powered Adaptive Learning Models

Definition and Characteristics

AI-powered adaptive learning models are educational systems that utilize Artificial Intelligence (AI) technology to adjust content, methods, and learning pace based on the needs, abilities, and characteristics of individual learners. These models operate by collecting learning data, analyzing interaction patterns, and providing continuous and automated learning recommendations (Zhai et al., 2021). According to UNESCO, AI-based adaptive learning is characterized by the system's ability to learn from user data, adjust content in real-time, and provide personalized, ongoing feedback (UNESCO, 2021). These characteristics make learning more responsive compared to conventional, uniform teaching approaches. Holmes et al. (2019) stated that AI-powered adaptive systems are capable of diagnosing learning difficulties and providing targeted interventions more effectively than traditional learning management systems. In addition, Zawacki-Richter et al. (2019) highlighted that AI-driven adaptivity supports differentiated instruction by responding dynamically to learners' cognitive and behavioral data.

The OECD emphasizes that AI-powered adaptive learning models are designed to support learner-centered education, where students are at the center of the learning process and follow learning paths tailored to their individual needs (OECD, 2021). In higher education, this model enables students to engage in self-directed learning with intelligent systems acting as facilitators. Other characteristics include the use of learning analytics and machine learning to predict learning difficulties and identify early intervention needs (Ouyang & Jiao, 2021). Consequently, these models serve not only as learning media but also as tools for pedagogical decision-making.

The Role of AI in Learning Personalization

Learning personalization is one of AI's main contributions to education. AI allows learning systems to adapt materials, methods, and assessments based on individual learner data, including learning styles, comprehension levels, and progress (Zhai et al., 2021:2205).

OECD notes that AI supports learning personalization through continuous learning data analysis, enabling timely and relevant instructional recommendations (OECD, 2021:53). This positively impacts learner engagement and motivation.

Furthermore, UNESCO highlights that AI-based personalization can help bridge learning gaps by providing additional support for struggling learners without neglecting highachieving students (UNESCO, 2021). In teacher education, understanding AI's role in learning personalization is crucial for preparing preservice teachers to use the technology pedagogically rather than relying uncritically on automated systems.

Preservice Teachers and AI in Education

The Role of Preservice Teachers in the AI Era

In the AI era, preservice teachers' roles shift from information transmitters to facilitators, instructional designers, and data-informed pedagogical decision-makers. UNESCO asserts that teachers today must possess technological literacy, critical thinking skills, and ethical understanding in educational technology use (UNESCO, 2021). Preservice teachers need to understand how AI can support learning rather than replace the teacher's role. Ouyang and Jiao emphasize that AI should be positioned as a pedagogical partner to help teachers manage complex and diverse learning environments (Ouyang & Jiao, 2021).

In primary education, preservice teachers' roles are particularly strategic as they lay the foundation for learners' knowledge and character. Therefore, their readiness to integrate AI appropriately is crucial for future educational development.

Importance of Readiness and Attitude toward Technology

Preservice teachers' readiness and attitudes toward technology are key factors in successful AI integration in education. Teo explains that technological readiness includes knowledge, skills, and positive attitudes toward technology use in learning (Teo, 2020:1041). Research indicates that positive attitudes correlate with intentions to use technology in teaching, whereas negative or uncertain attitudes can hinder the adoption of AI-based learning innovations (Teo, 2020).

OECD emphasizes that teacher education institutions play a vital role in fostering readiness and positive attitudes through curriculum, training, and technology-based learning experiences (OECD, 2021). Hence, preservice teachers' readiness is not only an individual responsibility but also an institutional one.

Perception as a Key Factor in Technology Adoption

Perceived Usefulness, Ease of Use, and Relevance

Perception is a crucial factor in educational technology adoption. In the Technology Acceptance Model (TAM), perceived usefulness and perceived ease of use are primary determinants of technology acceptance (Teo, 2020). Perceived usefulness refers to the degree to which an individual believes technology enhances learning performance, while perceived ease of use relates to how effortlessly technology can be applied (Teo, 2020). In AI-powered adaptive learning, perceived relevance how appropriate and applicable the technology is to the learner's educational context is also significant. Ouyang and Jiao stress that preservice teachers' perception of AI relevance influences how they interpret the role of technology in pedagogical practice (Ouyang & Jiao, 2021)

Relationship between Perception and Technology Acceptance

The link between perception and technology acceptance is well-documented in educational research. Teo notes that positive perceptions of usefulness and ease of use significantly influence intentions to adopt and use technology in learning (Teo, 2020). OECD further highlights that educators' acceptance is shaped by their perception of pedagogical benefits and the risks of technology use (OECD, 2021). In the context of AI, ethical considerations and data security also affect preservice teachers' acceptance. Therefore, examining preservice teachers' perceptions of AI-powered adaptive learning is essential for understanding technology acceptance and designing sustainable, responsible AI implementation strategies in education.

3. Research Method

Research Design

This study employed a descriptive qualitative research design to explore preservice teachers' perceptions of AI-powered adaptive learning models in higher education. A descriptive qualitative approach was chosen because it enables the researcher to describe and interpret participants' perspectives in depth without manipulating variables or testing hypotheses. This design focuses on understanding how preservice teachers perceive the

usefulness, adaptability, and challenges of integrating Artificial Intelligence (AI) into learning processes.

By emphasizing natural settings and participants' authentic responses, this research design allows for a comprehensive depiction of preservice teachers' views on AI-powered adaptive learning. The descriptive qualitative approach is appropriate for capturing complex perceptions related to pedagogical benefits, learning experiences, and ethical considerations of AI use in education, thereby providing a rich and contextualized understanding of the phenomenon under investigation.

In this section, you need to describe the proposed method step by step. Explanations accompanied by equations and flow diagrams as illustrations will make it easier for readers to understand your research.

Participants

Preservice Teachers

The participants in this study were preservice teachers, defined as university students enrolled in teacher education programs. These participants were selected because they are prospective educators who will potentially integrate Artificial Intelligence (AI) into future teaching practices. Their perspectives are considered essential for understanding the readiness and acceptance of AI-powered adaptive learning in educational contexts. b. Number and Context of Participants

A total of 53 preservice teachers participated in this study, consisting of 14 male students (26.4%) and 39 female students (73.6%). The participants came from various higher education institutions, reflecting diverse academic backgrounds and institutional contexts.

Table 1. Participants

No.	University	Students Participation	Percentage (%)
1.	University of Darul Ulum, Islamic Centre Sudirman GUPPI University	34	64,2%
2.	University of Ivet Semarang	1	1,9%
3.	State University of Semarang	2	3,8%
4.	State Islamic University of Salatiga	8	15,1%
6.	Fahmina Institute for Islamic Studies, Surabaya	1	1,9%
7.	State University of Surabaya	1	1,9%
8.	Islamic Institute of Pemalang	1	1,9%
9.	Indonesia Teachers Association	1	1,9%
10.	Ngudi Waluyo University	1	1,9%
11.	Muhammadiyah University of Semarang	4	7,5%

The involvement of preservice teachers from multiple universities allowed this study to capture a wider range of perspectives on AI-powered adaptive learning across different institutional settings.

Likert-Scale Perception Questionnaire

The research instrument used in this study was a perception questionnaire based on a Likert scale. The questionnaire was designed to examine preservice teachers' perceptions of AI-powered adaptive learning models in higher education. It measured several aspects, including perceived usefulness, learning adaptability, student engagement, learning motivation, and perceived challenges related to the use of AI in learning.

The questionnaire consisted of closed-ended statements rated on a Likert scale, allowing participants to indicate their level of agreement with each statement. The Likert scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). This instrument enabled the collection of structured data reflecting participants' attitudes and perceptions toward the implementation of AI-powered adaptive learning.

Indicator Research Indicators Research Indicators

The indicators used in this study were developed to measure preservice teachers' perceptions of AI-powered adaptive learning models and were adapted from prior research on technology acceptance and artificial intelligence in education. Perceived usefulness refers to preservice teachers' beliefs regarding the extent to which AI-powered adaptive learning enhances learning effectiveness, supports understanding of learning materials, and improves overall learning performance. Perceived adaptivity captures preservice teachers' perceptions of the ability of AI systems to adjust learning content, learning pace, and learning pathways according to individual needs, abilities, and learning progress. Engagement and motivation focus on preservice teachers' views of how AI-powered adaptive learning influences students' interest, engagement, and motivation throughout the learning process. Learning support

reflects perceptions of the extent to which AI systems provide feedback, guidance, and assistance that facilitate independent, effective, and self-regulated learning. In addition, concerns and challenges examine preservice teachers' perceptions of potential issues associated with the use of AI-powered adaptive learning, including technological dependence, ethical considerations, data privacy, and readiness to integrate AI into teaching practice. To enrich the quantitative findings, optional open-ended questions were included to allow participants to elaborate on their experiences, opinions, and concerns, thereby providing qualitative insights that complement the Likert-scale responses.

Data Analysis

Descriptive Analysis

Descriptive analysis was employed to examine data obtained from the Likert-scale questionnaire. Participants' responses were converted into percentages and mean percentage scores to describe the general tendencies of preservice teachers' perceptions of AI-powered adaptive learning. The analysis focused on summarizing the average percentage scores for each indicator, including perceived usefulness, perceived adaptivity, engagement and motivation, learning support, and concerns and challenges. This approach was used to provide an overall descriptive overview of participants' perceptions without applying inferential statistical techniques.

Simple Thematic Analysis for Open-Ended Responses

Data from the open-ended questions were analyzed using a simple thematic analysis. The analysis began with an initial reading of all responses to gain a comprehensive understanding of the data. Key ideas and recurring patterns were then identified and coded. Similar codes were subsequently grouped into broader themes that reflected participants' shared perceptions, experiences, and concerns regarding the use of AI-powered adaptive learning. These themes were used to complement the quantitative results and to provide deeper qualitative insights into preservice teachers' views.

4. Results and Discussion

Overall Preservice Teachers' Perceptions

The results of the questionnaire analysis indicate that the majority of pre-service teachers hold positive perceptions toward the use of artificial intelligence (AI)-based adaptive learning in higher education. Most respondents agreed or strongly agreed that AI can support the learning process, while only a small proportion expressed neutral or negative attitudes. These findings are consistent with previous studies reporting generally favorable attitudes among pre-service teachers toward AI-supported learning environments (Mustafaoğlu, 2025; Sivanganam et al., 2025).

The distribution of responses shows that 33% of respondents strongly agreed and 43% agreed with the implementation of AI-based adaptive learning. Meanwhile, 18% of respondents reported neutral perceptions, and 7% expressed disagreement. This distribution demonstrates a relatively high level of acceptance of AI technologies in educational contexts, supporting earlier findings that perceived usefulness significantly influences technology acceptance in education (Qi, 2025).

Table 2. Percentage Response Category

No.	Response Category	Percentage (%)
1.	Strongly agree	33%
2.	Agree	43%
3.	Undecided	18%
4.	Disagree	7%

Perceptions by Indicator a. Perceived Usefulness of AI

Regarding the perceived usefulness of AI, most respondents agreed that AI-based adaptive learning facilitates content comprehension and improves efficiency in completing academic tasks. Specifically, 38% strongly agreed and 44% agreed with statements related to this indicator. These findings align with prior research suggesting that AI tools enhance learning effectiveness by providing timely feedback and personalized support (Nasrudin & Hashim, 2025; Sibarani et al., 2025).

For the adaptive learning indicator, respondents also demonstrated a relatively high level of agreement, although the proportion of neutral responses was higher than in other indicators. A total of 31% strongly agreed and 41% agreed that AI systems can adapt learning materials to individual needs, while 21% reported neutral perceptions and 7% disagreed. This cautious attitude reflects previous studies noting that limited hands-on experience with

adaptive AI systems may influence uncertainty regarding their instructional capabilities (Mustafaoğlu, 2025; Qi, 2025).

Results related to the impact on learning experience indicate that AI-based adaptive learning is perceived as enhancing student engagement and learning motivation. Approximately 35% of respondents strongly agreed and 43% agreed that AI contributes to a more engaging learning experience and supports self-directed learning. Similar conclusions were reported by Sivanganam et al. (2025), who found that AI-supported environments promote interactive and student-centered learning.

Regarding concerns and challenges, respondents expressed more diverse views. While 29% strongly agreed and 39% agreed that AI implementation involves certain risks and challenges, 22% remained neutral and 10% disagreed. This finding suggests that acceptance of AI is accompanied by critical awareness of potential drawbacks, such as over-reliance on technology and ethical considerations, which have been widely discussed in recent literature (Oh & Ahn, 2024).

Table 3. Perceptions by Indicator Results

No.	Indicator	Strongly Agree	Agree	Undecided	Disagree
1.	Perceived Usefulness of AI	38%	44%	13%	5%
2.	Perceived Adaptivity of Learning	31%	41%	21%	7%
3.	Impact on Learning Experience	35%	43%	16%	6%
4.	Concerns and Challenges	29%	39%	22%	10%

Qualitative Findings

Analysis of open-ended responses revealed several prominent themes. Most respondents emphasized that AI tools help them better understand learning materials and prepare for academic activities. Efficiency and ease of access to information were also frequently mentioned, particularly in relation to completing assignments. These qualitative findings support earlier studies highlighting AI's role in improving learning efficiency and accessibility (Mustafaoğlu, 2025:10; Nasrudin & Hashim, 2025: 6085).

In addition, respondents expressed concerns about excessive dependence on AI and the importance of maintaining independent and critical thinking skills. Ethical issues and data security were also identified as emerging concerns, although less frequently. Such concerns are consistent with recent research emphasizing the need for responsible and ethical AI integration in education (Oh & Ahn, 2024:16).

Table 4. Qualitative Findings

No	Theme	Percentage of Responses (%)
1.	AI helps with understanding material and teaching preparation	46%
2.	Efficiency and ease of learning	27%
3.	Concerns about dependency	19%
4.	Ethical issues and data security	8%

Discussion

The findings of this study demonstrate that pre-service teachers generally hold positive perceptions toward AI-based adaptive learning in higher education. High levels of agreement in both general perceptions and perceived usefulness indicate that AI is viewed as a relevant and beneficial tool for supporting learning activities. This result reinforces prior research suggesting that perceived usefulness is a key determinant in the acceptance and adoption of educational technologies (Qi, 2025; Sibarani et al., 2025). Positive perceptions regarding AI usefulness suggest that pre-service teachers recognize AI as a means to enhance learning effectiveness and efficiency. This is particularly important in teacher education programs, as positive attitudes toward technology are likely to influence future instructional practices (Mustafaoğlu, 2025).

Although most respondents agreed with the adaptive capabilities of AI, the relatively high proportion of neutral responses indicates a cautious stance toward AI's ability to fully personalize learning. This hesitation may stem from limited exposure to adaptive learning systems, as suggested by previous studies highlighting the role of experience in shaping technology perceptions (Nasrudin & Hashim, 2025). The perceived positive impact of AI on learning experience suggests that AI-based adaptive learning environments can foster greater engagement and motivation among students. Interactive features and personalized feedback

may contribute to more meaningful learning experiences, consistent with earlier empirical findings (Sivanganam et al., 2025).

However, the presence of concerns related to dependency, critical thinking, ethics, and data security reflects a balanced and critical awareness among pre-service teachers. This awareness is essential for promoting responsible and sustainable AI integration in higher education. Therefore, teacher education programs should emphasize not only technical competence but also ethical and pedagogical considerations in the use of AI technologies (Mustafaoğlu, 2025; Oh & Ahn, 2024). This study explored preservice teachers' perceptions of AI-powered adaptive learning in higher education, focusing on perceived usefulness, adaptivity, learning experience, and concerns. The findings indicate that preservice teachers generally hold positive perceptions of AI-based adaptive learning. They recognize its usefulness in enhancing learning effectiveness, improving efficiency in completing academic tasks, and supporting engagement and motivation. AI is perceived as a practical tool that facilitates understanding of learning materials and promotes self-directed learning. At the same time, participants expressed cautious awareness regarding potential challenges, including over-reliance on AI, ethical considerations, data privacy, and the need to maintain critical thinking skills. These concerns highlight the importance of responsible, pedagogically informed AI integration in teacher education programs. Overall, the study suggests that preservice teachers are ready to engage with AI-supported learning environments, but effective implementation requires both technical competence and attention to ethical and instructional considerations. These findings provide valuable insights for teacher education programs aiming to prepare future educators for technology-enhanced and ethically responsible classroom practices.

5. Conclusion

This study explored preservice teachers' perceptions of AI-powered adaptive learning in higher education, focusing on perceived usefulness, adaptivity, learning experience, and concerns. The findings indicate that preservice teachers generally hold positive perceptions of AI-based adaptive learning. They recognize its usefulness in enhancing learning effectiveness, improving efficiency in completing academic tasks, and supporting engagement and motivation. AI is perceived as a practical tool that facilitates understanding of learning materials and promotes self-directed learning. At the same time, participants expressed cautious awareness regarding potential challenges, including over-reliance on AI, ethical considerations, data privacy, and the need to maintain critical thinking skills. These concerns highlight the importance of responsible, pedagogically informed AI integration in teacher education programs. Overall, the study suggests that preservice teachers are ready to engage with AI-supported learning environments, but effective implementation requires both technical competence and attention to ethical and instructional considerations. These findings provide valuable insights for teacher education programs aiming to prepare future educators for technology-enhanced and ethically responsible classroom practices.

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