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A Quantitative Study of Madrasah Ibtidaiyah Teacher Education Students' Perspectives on Artificial Intelligence as a Facilitative Strategy for 21st-Century Pedagogy

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Abstract

As the third decade of the 21st century unfolds, the pedagogical landscape of primary education has been significantly disrupted by the integration of Artificial Intelligence (AI), necessitating that prospective educators possess robust digital literacy and 21st-century classroom management competencies. Objective: This research seeks to conduct a quantitative evaluation of the perceptions held by Madrasah Ibtidaiyah (MI) teacher candidates regarding the utilization of AI as a strategic instructional support tool. Methods: Adopting a quantitative approach, this study utilized a descriptive cross-sectional survey design. Data were gathered from 72 students majoring in Madrasah Ibtidaiyah Teacher Education (PGMI) through a Likert-scale questionnaire adapted from the Technology Acceptance Model (TAM) and the 21st-century skills framework (4C). Data were analyzed using descriptive statistics, including frequencies, means, and standard deviations, to describe students' perceptions toward the integration of Artificial Intelligence (AI) in pedagogical practices. Results: The empirical findings revealed a "High" level of perception across all measured dimensions, specifically Academic Productivity (3.75), 4C Skills Implementation (3.75), and Self-Efficacy & Digital Ethics (3.80). Notably, the highest indicator was recorded for the practice of fact-checking AI-generated information, yielding a mean score of 4.17. Conclusion: MI teacher candidates demonstrate favorable technological acceptance and a profound ethical consciousness regarding AI. Consequently, higher education institutions must develop curricula that formally incorporate AI-TPACK competencies to maximize student potential as educators in the digital era.

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Introduction

The onset of the 21st century's third decade has witnessed profound educational upheavals catalyzed by the assimilation of Artificial Intelligence (AI) (Alam, 2022; Wang et al., 2024). Within the context of elementary schooling, particularly Madrasah Ibtidaiyah (MI), there is an intensifying imperative to cultivate graduates proficient in digital literacy and critical inquiry via cohesive curricular frameworks (Farhani et al., 2025). AI has transcended its role as a mere technical utility, evolving into a sophisticated pedagogical strategy capable of tailoring content, identifying learner preferences, and facilitating adaptive, inclusive educational governance (Aisyah et al., 2025; Herawati et al., 2024). Prospective educators serve as the primary agents of this paradigm shift (Wafa & Kesuma, 2025). The efficacy of technological implementation within classrooms hinges upon how teachers perceive and embed AI within their instructional practices, a notion encapsulated by professional frameworks such as AI-TPACK (Celik, 2023; Tan et al., 2025). Furthermore, ethical and strategic directives are being advocated to ensure generative AI is leveraged effectively while upholding fundamental educational values (Boonlue, 2024).

Empirical data indicates an exponential rise in AI integration among both educators and pre-service teachers. Field observations substantiate that generative AI has emerged as a fundamental tool for optimizing operational efficiency. Future educators leverage these technologies to streamline foundational administrative tasks, execute pedagogical assessments, and provide more focused academic support (Muzacy & Musril, 2025). Furthermore, there is a strong conviction among prospective teachers regarding AI's potential to facilitate educational frameworks that cultivate 21st-century competencies, specifically problem-solving, critical thinking, and creativity (Lee et al., 2025; Sopacua et al., 2026). The concurrent application of such technology is perceived to enhance instructional quality within madrasahs by Afifah et al. (2025) while serving as a mechanism for professional development across Islamic educational institutions, including Raudhatul Athfal and broader madrasah contexts (Alim et al., 2025).

While the incorporation of AI within linguistic and general educational frameworks presents significant opportunities for innovation (Özdere, 2023), comprehensive empirical evaluations regarding its adoption among elementary and madrasah educators remain insufficiently explored (Darmawan et al., 2024). A notable research lacuna exists concerning the dynamics of technological acceptance, which may be scrutinized through the lens of the Technology Acceptance Model (TAM) by Davis (1989) or its subsequent adaptations for pre-service teaching contexts (Sun et al., 2025). Furthermore, a fundamental paradox has emerged: despite the perceived utility of AI, prospective educators encounter substantial barriers, including deficiencies in AI literacy, inadequate technical preparedness, and various perceived threats (Özüdoğru & Durak, 2025; Pei et al., 2025). These challenges are further complicated by Islamic epistemological principles—specifically bayani, burhani, and irfani—which necessitate the rigorous validation of knowledge sources (Al-Murabbi & 2018, n.d.). Uncritical reliance on AI, in the absence of robust digital literacy, poses a significant risk to academic integrity through

phenomena such as chatting and cheating, which may ultimately undermine the traditional pedagogical functions of the educator (Cotton et al., 2024).

Motivated by these observations, the current study provides a thorough quantitative examination of how pre-service elementary Islamic school (Madrasah Ibtidaiyah) teachers perceive Artificial Intelligence as a pivotal strategy for future pedagogical support. More precisely, the investigation utilizes an augmented TAM to delineate technology adoption levels, investigates existing AI literacy challenges, and evaluates the relationship between technical proficiency and fact-checking behaviors essential for upholding academic rigor. These findings are intended to offer empirical evidence for teacher education programs to develop curricula aligned with 21st-century skill requirements.

Accordingly, this study aims to examine MI teacher candidates' perceptions of Artificial Intelligence (AI) as a pedagogical support tool, with particular attention to academic productivity, 21st-century skills development, and self-efficacy and digital ethics. To achieve this objective, the study addresses the following research questions: (1) How do MI teacher candidates perceive the contribution of AI to academic productivity? (2) How do MI teacher candidates perceive the role of AI in supporting the development of 21st-century skills? (3) What are their perceptions regarding self-efficacy and digital ethics in the use of AI? and (4) What are MI teacher candidates' overall perceptions of AI as a pedagogical support tool?

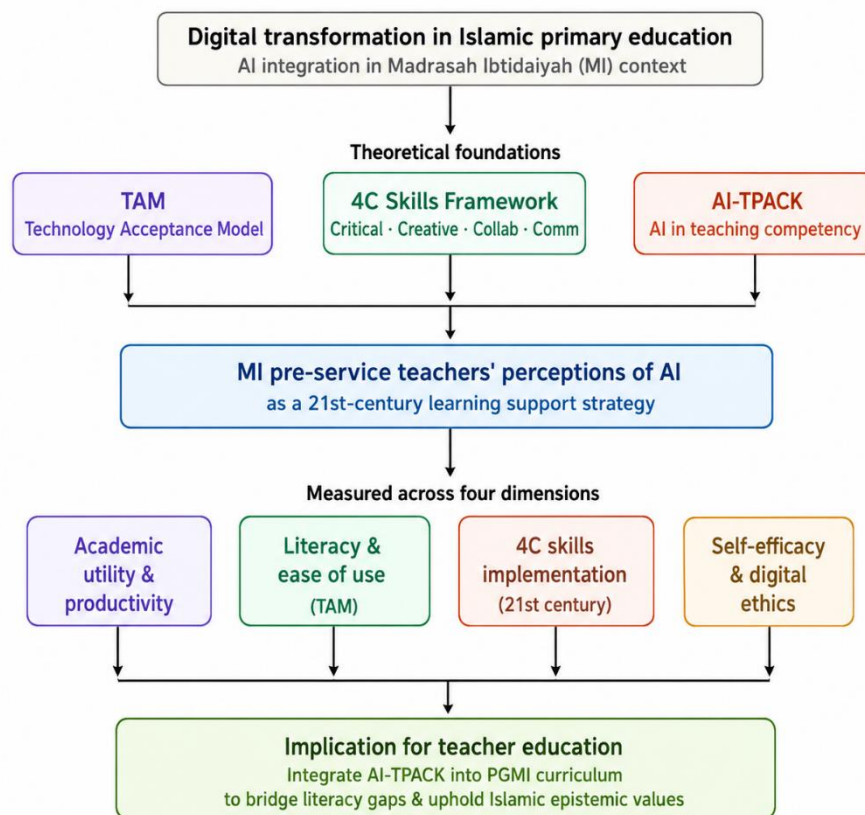


Figure 1. Theoretical framework — AI as a 21st-century pedagogy strategy in MI teacher education

Figure 1 illustrates the conceptual framework of this study. The framework begins with the context of digital transformation in Islamic primary education, particularly the integration of Artificial Intelligence (AI) in Madrasah Ibtidaiyah (MI). This context is supported by three theoretical foundations: the Technology Acceptance Model (TAM), which explains users' acceptance of technology through perceived usefulness and perceived ease of use; the 4C Skills Framework, which emphasizes the development of Critical Thinking, Creativity, Collaboration, and Communication as essential competencies for the 21st century; and the AI-TPACK framework, which highlights teachers' competencies in integrating AI into pedagogical practices.

These three frameworks collectively shape the perceptions of MI pre-service teachers regarding AI as a learning support strategy. Subsequently, these perceptions are examined through four dimensions: (1) Academic Utility and Productivity, which measures the perceived benefits of AI in improving learning efficiency; (2) Literacy and Ease of Use, which evaluates AI literacy and perceived ease of operating AI technologies; (3) 4C Skills Implementation, which assesses the role of AI in promoting Critical Thinking, Creativity, Collaboration, and Communication; and (4) Self-Efficacy and Digital Ethics, which examines students' confidence in using AI responsibly and ethically.

The final stage of the framework emphasizes the implications for teacher education, particularly the integration of AI-TPACK into the Madrasah Ibtidaiyah Teacher Education (PGMI) curriculum to strengthen AI literacy, enhance pedagogical competencies, and maintain Islamic epistemological values in the digital era.

Methods

To facilitate an objective assessment of student perceptions, this study utilizes a quantitative methodology employing a cross-sectional descriptive survey framework. The research population comprises active students enrolled across various Indonesian State Islamic Universities. Participants were selected through a purposive sampling technique, specifically targeting Madrasah Ibtidaiyah students with prior exposure or access to Artificial Intelligence (AI) technologies. A sample size of 72 was established to maintain data robustness and satisfy the normality requirements essential for rigorous quantitative statistical evaluation.

To facilitate the measurement of the research variables, the instrument was developed by adapting the Technology Acceptance Model (TAM) proposed by Davis (1989) and integrating the four dimensions of 21st-century competencies, namely Critical Thinking, Creativity, Collaboration, and Communication. The questionnaire consisted of 15 items distributed across the measured constructs and was assessed using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire items were adapted from Davis (1989) and relevant literature on 21st-century skills to ensure content relevance and contextual suitability. Prior to the formal analysis, the instrument was subjected to validity and reliability testing. Item validity was assessed using the

Pearson Product-Moment correlation, with items considered valid when the calculated correlation coefficient exceeded the critical value at the predetermined significance level. Reliability was evaluated using Cronbach's Alpha, and a coefficient of $\alpha \geq 0.70$ was considered indicative of acceptable internal consistency.

The concluding phase of this investigation involves data processing facilitated by statistical software packages. Descriptive statistical methods were employed to delineate frequency distributions, arithmetic means, and standard deviations across all perceptual indicators. Furthermore, inferential analysis was conducted to evaluate the propensity of student readiness regarding the integration of Artificial Intelligence (AI) as a pedagogical support strategy. These analytical findings were subsequently synthesized with contemporary educational frameworks to provide a holistic overview of the preparedness of students as future Islamic Elementary School (Madrasah Ibtidaiyah) teachers within the context of digital transformation.

Result

This section presents the empirical findings obtained from questionnaires administered to 72 students enrolled in the Madrasah Ibtidaiyah Teacher Education Program at Indonesian State Islamic Universities. The results were analyzed using descriptive statistical techniques to examine students' perceptions regarding the integration of Artificial Intelligence (AI) in educational contexts. The analysis focuses on several dimensions, including perceived usefulness, perceived ease of use, Critical Thinking, Creativity, Collaboration, and Communication as representations of 21st-century competencies.

The findings indicate that respondents generally exhibited positive perceptions toward the implementation of Artificial Intelligence in learning activities. Most participants reported prior experience using generative AI technologies, such as ChatGPT, Gemini, and DeepSeek, to support academic activities and learning processes. The mean scores for each indicator were subsequently calculated and interpreted according to the predetermined criteria to identify the level of students' perceptions regarding AI integration in education.

Table 1 presents the distribution of mean scores and their corresponding interpretation for each indicator. Overall, the findings reveal that Artificial Intelligence is perceived positively by prospective Madrasah Ibtidaiyah teachers and has considerable potential to support learning effectiveness, innovation, and the development of 21st-century competencies.

Table 1. Illustrates the distribution of mean perception scores among prospective Madrasah Ibtidaiyah (MI) teachers concerning Artificial Intelligence (AI)

Point	Statement Indicator	Average Score	Interpretation
1	AI improves administrative productivity (RPP/Module)	3,67	High
2	AI helps discover innovative learning content	3,91	High
3	AI makes it easier to understand difficult material concepts	3,83	High
4	AI makes digital learning outcome evaluation more effective	3,64	High
5	AI will benefit the teaching profession in the future	3,70	High
6	Independence to operate AI without assistance	3,45	High
7	Ease of finding the features you need	3,72	High
8	The ability to compose instructions (prompts) that AI understands	3,57	High
9	Feeling skilled using AI after trying	3,68	High
10	Using AI to train students' critical thinking	3,57	High
11	Using AI to encourage student creativity	3,83	High
12	The Use of AI for Engaging Communication	3,81	High
13	Use of AI for Group Collaboration	3,80	High
14	Confidence in teaching with the help of AI technology	3,42	High
15	Cross-check information from AI	4,17	High
Total		3,73	High

To facilitate a more holistic analysis, the survey items were categorized into four primary dimensions: (1) Academic Utility and Productivity, (2) Literacy and Perceived Ease of Use, (3) Integration of 21st-Century Competencies (4Cs), and (4) Self-Efficacy alongside Digital Ethics. A summary of the mean scores for each respective dimension is detailed in Table 2.

Table 2. Illustrates the comprehensive summary of scores categorized by perceptual dimensions

Point	Research Dimensions	Average Score	Interpretation
1	Academic Utilization & Productivity	3,75	High
2	Literacy & Ease of Use (TAM)	3,61	High
3	Implementation of 21st Century Skills (4C)	3,75	High
4	Self-Efficacy & Digital Ethics	3,80	High

Discussion

The findings of this study indicate that prospective Madrasah Ibtidaiyah teachers exhibit highly positive perceptions regarding the integration of Artificial Intelligence (AI) in educational settings, as reflected by the high scores across all evaluated dimensions. This positive attitude may be explained through the Technology Acceptance Model (TAM), which emphasizes that users are more likely to adopt a technology when they perceive it as useful and easy to use. The results suggest that AI technologies are viewed not only as efficient tools for completing academic tasks but also as valuable resources that enhance learning productivity and support instructional activities. This perception may stem from the increasing accessibility of generative AI platforms, such as ChatGPT, Gemini, and

DeepSeek, which enable students to obtain information rapidly, organize ideas efficiently, and receive immediate assistance in completing academic tasks.

In the Academic Utilization and Productivity dimension ($M = 3.75$), respondents perceived AI as an effective means of reducing routine academic workloads and improving learning efficiency. This finding may be attributed to AI's capability to automate repetitive tasks, provide instant feedback, and facilitate access to diverse learning resources. Consequently, students are able to allocate more time to higher-order cognitive activities, including pedagogical planning, problem-solving, and creative instructional design. Similar findings have been reported in previous studies, which indicate that AI adoption in higher education positively influences students' learning experiences, self-efficacy, and academic performance.

Furthermore, the high score obtained in the 4C dimension demonstrates that AI is perceived not merely as a technological innovation but also as a pedagogical resource that supports the development of Critical Thinking, Creativity, Collaboration, and Communication. The interactive and adaptive characteristics of generative AI encourage students to explore multiple perspectives, evaluate information critically, generate innovative ideas, and engage in collaborative learning processes. Therefore, AI has the potential to strengthen essential 21st-century competencies that are increasingly required in teacher education programs.

These findings imply that integrating AI into Madrasah Ibtidaiyah teacher education programs may not only improve students' technological readiness but also foster the development of pedagogical and professional competencies required for future educational environments.

Notwithstanding the generally positive perceptions toward AI adoption, the Literacy and Ease of Use dimension recorded the lowest mean score ($M = 3.61$) among all measured dimensions. From the perspective of the Technology Acceptance Model (TAM), this finding is particularly noteworthy because Perceived Ease of Use (PEOU) is a fundamental determinant influencing users' perceptions of usefulness and their intention to adopt a technology. Although respondents acknowledged the benefits of AI in supporting academic activities, they may still encounter difficulties in effectively operating AI tools, formulating appropriate prompts, and critically evaluating AI-generated outputs. Consequently, high Perceived Usefulness does not automatically translate into high Perceived Ease of Use, especially when users possess limited AI literacy and technical competencies.

Several factors may explain the relatively lower score in this dimension. First, variations in students' digital literacy and prior experience with AI technologies may influence their confidence in using AI effectively. Second, although generative AI platforms are increasingly accessible, the ability to formulate precise prompts, verify information accuracy, and utilize AI ethically requires specific competencies that may not yet be fully developed among prospective teachers. Third, limited formal training on AI integration

in teacher education programs may contribute to uncertainty regarding the appropriate and effective use of AI in educational context. Therefore, strengthening AI literacy and improving technical self-efficacy are essential to enhancing students' Perceived Ease of Use and promoting more sustainable AI adoption in education.

Conclusion

The present research concludes that undergraduates in the Madrasah Ibtidaiyah Teacher Education department exhibit high levels of readiness and favorable perceptions regarding the implementation of Artificial Intelligence (AI) as a strategic tool for 21st-century learning. AI is perceived as a catalyst for academic efficiency, effectively reducing administrative workloads and stimulating pedagogical advancements aligned with 4C skills. Most significantly, the study reveals a high degree of ethical literacy among students, evidenced by their rigorous verification of AI-produced data, which serves to safeguard the epistemological integrity of Islamic educational frameworks.

Consequently, teacher education institutions (TEIs) must provide the necessary support to accommodate these elevated acceptance levels. It is recommended that universities and academic departments methodically integrate the AI-TPACK framework into compulsory coursework, thereby mitigating technical discrepancies in the formulation of AI-driven instructional strategies.

For future research, scholars are encouraged to investigate the effectiveness of AI integration using broader and more diverse samples across different teacher education programs and educational levels. Further studies may also employ longitudinal or mixed-method approaches to examine how AI literacy, TPACK competencies, and perceived ease of use influence the long-term acceptance and pedagogical utilization of Artificial Intelligence in educational settings. Additionally, future research should explore the impact of structured AI training programs on enhancing prospective teachers' technological readiness and instructional competencies in the era of digital education.

Declarations

Author contribution statement

Writer 1 conceptualized the study, developed the methodology, and wrote the original draft. Writer 2 conducted the formal analysis, distributed the digital questionnaires, and contributed to data curation. Writer 3 critically reviewed, edited the manuscript, and supervised the research. All writers have read and agreed to the published version of the manuscript.

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Data availability statement

The raw data supporting the conclusions of this article will be made available by the corresponding author upon reasonable request, adhering to the confidentiality agreements stated in the informed consent.

Declaration of interests statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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