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Pre-service teachers' perceptions of the use of artificial intelligence (AI) in mathematics learning

Suci Amalia[1*], Siti Nur Indah[1], Ghea Marsha[1], Chaliza Shabina Pulungan[1], Arfika Putri[1]
[1]Universitas Asahan, Sumatera Utara, Indonesia
[*]Correspondence: amaliasuci838@gmail.com
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Abstract
The excessive use of Artificial Intelligence (AI) carries the potential to foster technological dependency, diminish independent thinking skills, and increase the risk of accepting information that may not be valid—particularly when such information is not subjected to proper verification. In the field of education, the application of AI contributes significantly to enhancing the quality of lesson planning. This technology enables prospective teachers to develop instructional materials more effectively and efficiently, provides access to a diverse range of learning resources, and facilitates the creation of lesson plans that are better tailored to the specific characteristics of students. Furthermore, the use of AI can stimulate creativity and innovation in the development of instructional strategies. This study aims to gather the perspectives of pre-service teachers regarding the use of AI in education by examining their personal experiences and views on its application in lesson planning. Through this approach, the researcher gains a deeper understanding of the meanings, attitudes, and subjective experiences of the respondents within a real-world context. The research instrument consists of an open-ended questionnaire, developed by the researcher and distributed via Google Forms.
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Introduction

The development of digital technology has significantly affected various aspects of life, including education. One of the technologies advancing rapidly today is artificial intelligence (AI). The emergence of AI, particularly generative artificial intelligence (GenAI) tools such as ChatGPT, Gemini, and Copilot, has created new opportunities to support teaching and learning activities. These technologies can assist in preparing instructional materials, developing learning media, and designing more effective and efficient learning experiences. Through their ability to generate various forms of content based on user prompts, AI tools can help teachers design learning activities that meet students' needs (van den Berg & du Plessis, 2023).

The use of artificial intelligence in education also contributes to improving the quality of instructional planning. AI enables pre-service teachers to prepare instructional materials and lesson plans more efficiently, explore alternative learning resources, and develop learning designs that better reflect students' characteristics. Furthermore, AI can encourage creativity and innovation in the development of teaching strategies. For example, ChatGPT can support instructional planning, foster critical thinking, and broaden access to information and knowledge resources.

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Despite these benefits, the implementation of AI in education presents several challenges. Excessive reliance on AI may lead to technological dependence, weaken independent thinking, and increase the risk of accepting inaccurate information without adequate verification. Ethical concerns, personal data protection, and academic integrity have also become important issues as AI use in educational activities continues to grow. These challenges highlight the importance of examining pre-service teachers' perceptions of AI adoption, as they will play a strategic role in integrating technology into future teaching practices. Understanding their perceptions can provide insights into the opportunities, challenges, and levels of readiness associated with using AI responsibly and professionally (Manga et al., 2026).

Previous studies have examined the use of AI in education, but most have focused on technology acceptance, teacher readiness, and the implementation of AI in teaching and learning. Research specifically investigating pre-service teachers' perceptions of AI use in instructional planning remains relatively limited, particularly in Indonesian higher education institutions. This gap warrants further investigation. Given that pre-service teachers will play an important role in the future use of educational technology, understanding their perceptions is essential. The findings can provide a basis for designing competency development programs, strengthening AI literacy, and formulating policies that support the effective, ethical, and sustainable use of AI in education (Kumar Kanvaria & Ritika, 2024).

Based on this background, this study aims to analyze pre-service teachers' perceptions of using artificial intelligence (AI) in instructional planning. The analysis examines several aspects, including perceived benefits, ease of use, challenges encountered, and students' readiness to integrate AI into the preparation of instructional materials and lesson plans. This study is expected to contribute to research on AI integration in teacher education and provide useful insights for higher education institutions in developing policies and AI literacy enhancement programs that address the needs of future educators in the digital era. Thus, AI can be used more effectively to improve learning quality while maintaining ethical standards, professionalism, and academic responsibility (Zhou, 2024).

Method

This study employed a descriptive qualitative approach to understand and describe pre-service teachers' perceptions of the use of artificial intelligence (AI) in instructional planning based on their experiences and perspectives. This approach enabled the researchers to gain a deeper understanding of respondents' meanings, attitudes, and subjective experiences within their actual contexts.

The qualitative method was selected because perceptions are complex and subjective in nature. Therefore, the data consisted of respondents' written descriptions and verbal explanations, which were subsequently analyzed interpretively. The analysis aimed to provide a comprehensive account of pre-service teachers' perceptions of AI use in instructional planning.

The study was conducted in the Mathematics Education Study Program at Universitas Asahan. The participants were students enrolled in this program. Data were collected online using a Google Forms questionnaire distributed to the respondents. The study was conducted during the second semester of the 2025/2026 academic year.

In qualitative research, participants are selected according to the research objectives rather than being described exclusively in terms of a population and sample, as is common in quantitative research. The participants in this study were active sixth-semester students in the Mathematics Education Study Program at Universitas Asahan who had experience with or an understanding of the use of artificial intelligence (AI) in academic activities, particularly instructional planning.

The research instrument was an open-ended questionnaire developed by the researchers and distributed through Google Forms. The instrument was designed around five main aspects related to pre-service teachers' perceptions of AI use in instructional planning, namely:

Table 1. Research Aspects and Indicators

Aspect	Indicator
General perceptions of AI	Students' understanding of AI
Perceived benefits of AI use	The extent to which AI provides benefits in designing learning activities
Challenges of AI use	Concerns and risks associated with AI use
Effective learning strategies in the context of AI use	How teachers can respond to AI integration while maintaining effective learning outcomes

Data were collected using an open-ended questionnaire distributed online through Google Forms. The questionnaire link was shared with students who met the research criteria through various communication platforms, including WhatsApp, LINE, and email. Each respondent completed the questionnaire independently and voluntarily, without any coercion.

The data were analyzed using the qualitative data analysis model developed by Miles, Huberman, and Saldaña, which consists of three main stages: data condensation, data display, and conclusion drawing and verification. Data condensation involved selecting and organizing information relevant to the research objectives, followed by presenting the data systematically and drawing conclusions from the findings.

Through this analytical approach, the study aimed to develop a comprehensive and in-depth understanding of pre-service teachers' perspectives on the use of AI in instructional planning.

Data trustworthiness was maintained through theoretical triangulation, which involved comparing the research findings with relevant theories and previous studies. Researcher discussions were also conducted to support the validity and consistency of the interpretations. All research procedures were carried out systematically to enhance the credibility and trustworthiness of the findings.

Results and Discussion

Artificial intelligence has transformed many aspects of various fields in recent years. In education, this development has generated diverse perspectives among pre-service teachers. The following findings are based on responses collected through the Google Forms questionnaire distributed to the participants.

1. Pre-Service Teachers' Perspectives on Artificial Intelligence (AI)

   At present, most students are familiar with AI and have had experience using it. The pre-service teachers in this study described AI in several ways:

   a. AI is an intelligent support tool that can make teachers' and students' work easier. For example, it can help users find learning materials, create questions, and explain lessons quickly. It is also a technology that enables people to complete various tasks more efficiently.
   b. AI is perceived as a quick and convenient way to obtain answers or information.
   c. In education, AI can assist teachers in preparing instructional materials, developing learning media, creating assessment questions, and helping students understand learning content more easily.

2. Concerns Regarding the Use of AI in Instructional Planning

   Most participants acknowledged both the convenience and the potential risks of using AI. The perceived benefits included facilitating the development of learning media and generating ideas for instructional activities. However, the primary concern was excessive dependence on AI, which could weaken creative thinking and prevent teachers from adequately addressing students' actual learning needs.

   One participant expressed this concern as follows:

   "Yes, I have several concerns and challenges regarding the use of AI in instructional planning. One of my main concerns is excessive dependence on AI. The information provided by AI is not always accurate, so teachers need to verify it. Furthermore, excessive AI use may cause teachers or students to become too dependent on technology, reducing their creativity and critical thinking skills."

3. Strategies for Maintaining Effective Learning Amid Widespread AI Use, Particularly for Homework

   In the current digital era, it is difficult to deny that students are increasingly familiar with AI and may use it in their learning activities, even if their knowledge of different AI tools remains limited. For example, some students may already be familiar with Meta AI, which is integrated into WhatsApp. In the coming years, access to AI may become even easier as the technology continues to develop and becomes more widely available through digital platforms and social media.

   Consequently, simply telling students not to use AI may be ineffective. More appropriate instructional strategies are needed to ensure that learning remains meaningful and effective. Most pre-service teachers suggested designing assignments that require students to explain their reasoning and problem-solving processes rather than merely submit final answers.

   One participant stated:

   "As a future teacher, I do not think AI needs to be prohibited, but it should be used wisely. To ensure that students continue thinking independently, I would ask them to explain how they arrived at their answers rather than simply write down the results. This would help me determine whether they genuinely understand the material or have merely copied answers from AI."

   Another participant explained:

"I would ask students to present their work in front of the class without bringing their books and to solve problems themselves. This way, students would still need to study and understand the material, even if they had used AI."

Nevertheless, participants also emphasized that not every student who uses AI simply copies answers or cheats. One participant noted:

"It is not necessarily true that all students simply copy from AI or use it to cheat. Some students also use AI as a learning aid while studying."

These responses suggest that pre-service teachers favor approaches that emphasize students' reasoning, understanding, and accountability while allowing AI to serve as a supplementary learning resource.

4. Differences in the Quality of Instruction Planned With and Without AI Assistance

Technology-assisted instruction may differ from instruction planned without technological support. Similarly, AI-assisted instructional planning can offer different possibilities from conventional planning. Most participants perceived that AI could improve instructional planning because it provides teachers with additional ideas and resources, particularly when they struggle to develop new teaching activities. However, they also recognized that high-quality instruction does not result from AI use alone.

One participant stated:

"Yes, the quality can differ. AI can help teachers prepare instructional plans more quickly, provide various ideas and learning resources, and offer a wider range of teaching methods. However, the best quality still depends on teachers' ability to adapt their plans to students' needs, characteristics, and circumstances. Therefore, AI should be used as a support tool, not as a replacement for teachers."

Another participant added:

"In my opinion, there is a difference because AI-assisted instruction can be much more varied and save teachers time on administrative tasks. However, the quality will only truly improve when teachers use AI as a personal assistant rather than simply copying and pasting its output without making any adjustments."

Overall, the responses indicate that participants view AI as a useful tool for improving the efficiency and variety of instructional planning. At the same time, they emphasize that teachers must critically evaluate AI-generated content and adapt it to their students' needs to ensure meaningful and effective learning.

Artificial intelligence (AI) plays a supportive role in learning, as the findings of this study indicate that most students perceive AI as offering substantial benefits. The findings suggest that AI is a technology that accelerates work processes, facilitates teachers' tasks, and helps students understand learning materials more easily. However, the convenience experienced by teachers, particularly in developing instructional media and identifying ideas for learning activities, may lead to overreliance on AI. Such dependence may undermine creative thinking and reduce teachers' attention to students' actual learning needs.

In the current era, it is undeniable that many people are familiar with AI, including students, who are likely to know about and use AI tools, even if their knowledge of the available tools remains limited. For example, students may be familiar with Meta AI, which is integrated into WhatsApp. In the coming years, students may become acquainted with a wider range of AI tools through advertisements appearing on their social media feeds. Therefore, instructions

such as "do not use AI" may have little lasting effect, making it necessary to develop appropriate learning strategies. One possible approach is not to prohibit AI entirely but to encourage its responsible use. To ensure that students continue to think independently, teachers can ask them to explain how they arrived at their answers rather than merely write down the results. Future teachers can also ask students to solve problems and explain their reasoning in front of the class.

Technology-assisted learning inevitably differs from learning without technological support, and the same applies to AI-assisted learning. Most students reported that AI-assisted instruction could produce better outcomes because teachers can use AI as a supporting tool when they run out of ideas. Nevertheless, high-quality learning cannot be attributed solely to the presence of AI. The quality of instruction also depends on teachers' professional judgment, their ability to adapt instructional materials to students' needs, and their capacity to implement learning activities effectively.

These findings are consistent with the study by Kumar Rao and Nag (2026), which reported that AI can support instructional design, facilitate the development of teaching strategies, and accelerate teachers' preparation of instructional materials. However, AI should not be used as a replacement for teachers but rather as a supporting tool.

The findings also align with the study by Tarwanto et al. (2026), which explained that generative AI can assist teachers in developing lesson plans, providing feedback, and generating engaging ideas for learning activities. Nevertheless, the authors emphasized the challenges associated with technological dependence and the importance of using AI appropriately, ensuring that teachers remain the primary decision-makers in instructional planning.

Furthermore, the use of AI in mathematics learning should be linked to the development of students' critical thinking and mathematical reasoning skills. Mathematics education aims not only to produce correct answers but also to develop students' abilities to understand problems, select appropriate solution strategies, construct arguments, and evaluate the validity of solutions. Therefore, the use of AI should not lead students to focus exclusively on final answers. Dilling and Herrmann (2024), in their study examining the use of ChatGPT to support pre-service mathematics teachers in constructing geometric proofs, demonstrated that interactions with AI should be understood as a process requiring both technological understanding and the ability to evaluate AI-generated responses. Their study also identified limitations in some pre-service teachers' understanding of how AI works. These findings suggest that AI use should be accompanied by appropriate guidance to ensure that pre-service teachers not only know how to use the technology but also understand its limitations. In instructional practice, students can be asked to compare alternative solutions generated by AI, identify errors in mathematical procedures, and justify their evaluations based on relevant mathematical concepts or theorems. In this way, AI can serve as a means of strengthening mathematical reasoning rather than replacing the thinking process itself.

Another implication concerns the importance of developing pre-service teachers' ability to integrate mathematical knowledge, pedagogical knowledge, and technological knowledge. Gurl et al. (2025), in their study of ChatGPT as a lesson-planning assistant for pre-service secondary mathematics teachers, provide a relevant context for understanding how AI can be incorporated into instructional planning. In this regard, successful AI use depends not

only on students' ability to formulate prompts but also on their capacity to establish learning objectives, select appropriate instructional materials, and evaluate the quality of the resulting lesson plans. Pre-service teachers can use AI to generate alternative learning activities and subsequently assess their alignment with learning outcomes, students' characteristics, and planned assessment methods. This approach enables them to benefit from AI's efficiency without relinquishing their active role in pedagogical decision-making. Accordingly, teacher education programs should provide structured opportunities for AI use through lesson-planning assignments, teaching practice, and critical reflection on the outputs generated.

Furthermore, strategies for responsible AI use should be supported by clear instructional and assessment policies. Teachers can distinguish between tasks designed to develop foundational skills independently and those that allow AI to be used as an exploratory tool. For assignments in which AI use is permitted, students can be required to identify the parts of their work that were assisted by AI, verify the information obtained, and explain why they accepted or rejected the generated responses. Meanwhile, individual competence can still be assessed through oral explanations, in-class problem-solving activities, or the application of mathematical concepts to unfamiliar problems. Zhuang and Zhang (2025) found that pre-service mathematics teachers' perceptions of generative AI use may evolve as they gain experience with the technology and develop their prompting skills. Their study also emphasized the importance of structured guidance and feedback from mathematics educators. These findings reinforce the view that AI integration should be implemented through carefully designed instructional practices rather than through unrestricted access or blanket prohibitions without appropriate guidance. In the context of the present study, pre-service teachers should be prepared to establish AI-use guidelines that uphold academic integrity while providing opportunities to develop digital literacy and mathematical reasoning.

Overall, the findings of previous studies further support the understanding that AI has the potential to assist in mathematics instructional planning and implementation, although its benefits depend on users' competencies and the instructional designs in which it is employed. AI can expand the range of teaching strategies, accelerate the preparation of instructional materials, and provide alternative approaches to problem-solving. Nevertheless, this technology has inherent limitations, and its outputs must be evaluated in terms of mathematical accuracy, pedagogical relevance, and alignment with students' actual learning needs. Therefore, pre-service teacher education should foster the ability to use AI critically, reflectively, and responsibly. Within this framework, teachers should not be positioned as passive users of technology but as professional decision-makers who direct AI toward achieving instructional objectives. It is important to emphasize that the present study examines students' perceptions of AI use; consequently, the benefits they report should not be interpreted as direct evidence that AI improves learning outcomes. Further research involving observations of teaching practice, analyses of instructional plans, and assessments of mathematical reasoning is needed to investigate more comprehensively how AI use relates to the quality of mathematics teaching and learning.

Conclusion

Based on the research findings, pre-service teachers hold positive perceptions of the use of artificial intelligence (AI) in mathematics learning. AI is considered useful for

developing instructional materials and learning media more quickly, easily, and diversely. However, students also recognize the risks of overdependence, reduced creativity, and the possibility of inaccurate information, which requires further verification. Therefore, AI should be used as a supportive tool rather than as a replacement for teachers. The wise, critical, and responsible use of AI can improve learning quality while supporting the development of students' thinking skills. Nevertheless, the primary concern identified is excessive dependence on AI, which may undermine creative thinking and cause teachers to overlook students' actual learning needs.

Author Contributions

Suci Amalia contributed to the conceptualization of the study, the formulation of the research objectives, and the development of the conceptual framework concerning the use of *Artificial Intelligence* (AI) in mathematics learning. Siti Nur Indah contributed to the literature review and the development of the research instrument in the form of an open-ended questionnaire. Ghea Marsha contributed to data collection by distributing the questionnaire through Google Forms and organizing the respondents' data. Chaliza Shabina Pulungan contributed to data analysis, theme identification, and the interpretation of students' perceptions regarding the benefits, challenges, and risks of using AI in mathematics instructional planning. Arfika Putri contributed to drafting the manuscript, discussing the research findings, and editing the manuscript to ensure consistency among the research objectives, methods, findings, and conclusions. All authors participated in reviewing the final manuscript and approved the version for publication.

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