

Analysis of AI Literacy Competencies of Elementary School Teacher Education Students in Designing Elementary School Mathematics Learning

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Abstract. The rapid development of Artificial Intelligence (AI) has brought significant changes to the world of education and requires prospective teachers to possess adequate AI literacy competencies. This study aims to analyze the AI literacy competence of PGSD students UPGRIS in designing elementary school mathematics learning. The research uses a descriptive quantitative approach with a survey method. Data were collected thru a questionnaire given to PGSD students who are taking the elementary school mathematics learning course. The research instrument measures five aspects of AI literacy competence, namely understanding the basic concepts of AI, the ability to use AI applications, the ability to critically evaluate AI outputs, awareness of the ethical use of AI, and the ability to integrate AI into the design of elementary school mathematic. The data were analyzed using descriptive statistics in the form of percentages and average scores. The research results show that the AI literacy competence of PGSD students is in the high category with an average achievement of 77.61%. The ability to integrate AI into mathematics learning achieved the highest score of 82.75%, while the ability to critically evaluate AI outputs achieved the lowest score of 70.60%. These findings indicate that students are well-prepared to utilize AI to support the design of mathematics learning, although their critical thinking skills in evaluating AI outputs still need improvement. This research contributes to the development of AI literacy in teacher education and serves as a foundation for strengthening the curriculum and AI literacy training for prospective elementary school teachers.

Keywords: artificial intelligence literacy, PGSD students, elementary school mathematics learning, digital competence, prospective elementary school teachers, educational technology.

INTRODUCTION

The development of artificial intelligence (AI) in recent years has brought significant changes to various sectors of life, including education. The presence of generative technologies such as ChatGPT, Gemini, Claude, and Copilot not only changes the way individuals access information but also influences the learning process, curriculum development, assessment, and even lesson planning. UNESCO (2023) emphasizes that AI has great potential to improve the quality of education thru personalized learning, increased teacher efficiency, and the provision of more adaptive learning resources. In line with this, various countries are beginning to integrate AI into their education systems to prepare human resources capable of adapting to the demands of the 21st-century digital transformation. This condition shows that mastery of AI-related competencies is no longer an additional requirement, but rather an essential competency for future educators.

In the context of primary education, the digital transformation driven by AI development requires teachers to have the ability to utilize technology critically, creatively, and responsibly. However,

prospective elementary school teacher students often still face significant obstacles, such as limited understanding of the ethical aspects of using AI platforms and a lack of practical skills in integrating that technology into innovative learning module designs (Septyanun et al., 2025). This competency gap becomes crucial considering that the effectiveness of using AI-based tools, such as ChatGPT, MagicSchool, or EduAide, heavily relies on teachers' pedagogical literacy in designing adaptive and differentiated learning (Priantini et al., 2026). This becomes increasingly important considering that basic education is the foundation for developing literacy, numeracy, and higher-order thinking skills. Therefore, teacher education programs, including the Elementary School Teacher Education Study Program (PGSD), play a strategic role in preparing prospective teachers with adequate AI literacy competencies to face educational challenges in the digital era.

One of the fields of study that greatly needs pedagogical innovation based on technology is mathematics. This subject is often considered challenging by students, so the integration of AI-based tools has the potential to facilitate the

personalization of the learning experience thru the presentation of more visual, interactive, and targeted materials according to the individual needs of the students (Dewi et al., 2025, p. 914). The utilization of the AI application allows PGSD students to design mathematics learning scenarios that support the development of computational thinking skills, data analysis, and structured problem-solving. Although the potential is quite promising, the effectiveness of this integration highly depends on the extent to which students can apply computational thinking and a human-centered mindset in developing teaching materials (Yosiana et al., 2025). AI offers new opportunities thru its automation capabilities in creating learning media that is creative, communicative, and aligned with the elementary school curriculum (Fatonah et al., 2025), and facilitating the pedagogical integration of technology to support the development of more contextual teaching materials (Novianty et al., 2026).

AI literacy is a set of competencies that includes a deep understanding of technology mechanisms, technical skills in operating artificial intelligence-based tools, and sensitivity to the ethical implications and limitations of algorithms in educational decision-making (Daher, 2025, p. 4). AI literacy has also become an important concept that is starting to receive widespread attention in educational research. AI literacy not only includes technical understanding of software but also involves critical abilities in content selection, validating the accuracy of mathematical concepts, and applying adequate pedagogical controls to prevent cognitive dissonance in students (Hayuhantika et al., 2026). Furthermore, comprehensive AI literacy for prospective teachers includes technical skills in operating generative platforms to support the creation of personalized and adaptive learning media (Setyaningrum et al., 2026). This capacity allows educators to guide students in achieving higher cognitive levels, such as creativity and collaboration, thru the use of appropriate aids (Ng et al., 2023, p. 148). In teacher education, AI literacy is viewed as a new competency that prospective teachers need to possess in order to wisely integrate technology to enrich students' learning experiences, while also understanding the limitations of the algorithmic systems used in instructional contexts (Black et al., 2024, p. 23072; Chiu et al., 2024).

Various previous studies have examined the use of AI in teacher education and mathematics education. These studies show that the integration

of AI literacy can support the development of computational thinking and problem-solving skills, which are crucial in facilitating innovative mathematics learning for students (Maleni et al., 2025). The use of ChatGPT, for example, can assist prospective elementary school teachers in designing more dynamic mathematics lessons, but the main challenge lies in their ability to validate the accuracy of the mathematical logic produced by the algorithm to ensure it aligns with the child's cognitive development (Ginting, 2025). Moreover, the risk of cognitive dependence on automation tools often triggers literacy bias that leads to a decline in the intellectual autonomy of prospective teachers in evaluating the substance of the material. Recent research emphasizes that although technical skills such as prompt engineering facilitate learning design, their integration without reinforcing pedagogical control and ethical awareness can lead to neglecting the validity of mathematical logic and essential curriculum standards (Ginting, 2025; Hayuhantika et al., 2026). This gap indicates that the development of AI competencies for PGSD students cannot solely focus on operational aspects, but must also include reflective abilities to mitigate algorithmic risks and ensure that technology remains a supporting tool, not a replacement, for the professional role of teachers (Daher, 2025, p. 4; Maryati et al., 2026). These findings indicate that AI has great potential to support the professional competencies of prospective teachers in designing learning.

Nevertheless, the existing studies are still dominated by research on perceptions, attitudes, technology acceptance, and the experiences of AI use by prospective teachers. Most of the research focuses on education students in general or prospective mathematics teachers at the secondary level, while studies specifically analyzing the AI literacy competence of PGSD students in the context of designing elementary school mathematics learning are still relatively limited. Additionally, research linking the dimensions of AI literacy with the pedagogical abilities of prospective teachers in designing mathematics learning that aligns with the characteristics of elementary school students has not been widely found. Thus, empirical understanding of the extent to which AI literacy competence among PGSD students supports their ability to design mathematics learning still requires further study.

This condition indicates a significant research gap that needs to be addressed. Previous research generally highlights the benefits of AI in the

learning process or evaluates the level of technology acceptance among prospective teachers, but has not comprehensively examined AI literacy competence as a pedagogical asset in designing elementary school mathematics lessons. In fact, the ability to design lessons is one of the core competencies that prospective teachers must possess. On the other hand, the increasing use of generative AI in academic activities creates a need to ensure that prospective teachers are not only able to use AI but also understand its limitations, information validity, ethical aspects, and pedagogical implications of its use in mathematics teaching.

The novelty of this research lies in its specific focus on analyzing the AI literacy competencies of PGSD students in designing elementary school mathematics learning. Unlike previous studies that primarily examined perceptions or general use of AI, this research connects the dimension of AI literacy with a specific pedagogical context, namely the design of elementary school mathematics learning. Thus, this research is expected to provide a conceptual contribution in the form of a deeper understanding of the relationship between AI literacy and the pedagogical competencies of prospective teachers, while also offering practical contributions to the development of a teacher education curriculum that is responsive to the AI era.

Based on the description, it is important to thoroughly examine how the AI literacy competencies possessed by PGSD students support the process of designing elementary school mathematics learning. This study is expected to provide an empirical picture of the level of AI literacy competence among students, the aspects that need to be strengthened, and its implications for the development of teacher education programs. Therefore, this research is directed to analyze the AI literacy competence of PGSD students in designing elementary school mathematics learning as an effort to support the improvement of the quality of prospective teachers in the era of digital transformation.

Based on that urgency, the problem formulation in this research is as follows: What is the level of AI literacy competence among PGSD UPGRIS students? How competent are PGSD UPGRIS students in utilizing AI to design elementary school mathematics learning? What aspects of AI literacy competence are most dominant and which still need improvement among PGSD UPGRIS students?

The objectives of this research are to: Describe the level of AI literacy competence among PGSD UPGRIS students. Analyze the competence of PGSD UPGRIS students in utilizing AI to design elementary school mathematics learning. Identify the strengths and weaknesses of PGSD UPGRIS students in AI literacy aspects when designing elementary school mathematics learning.

METHODS

This research uses a descriptive quantitative approach with a survey method. The descriptive quantitative approach was chosen because the research aims to obtain a systematic picture of the level of Artificial Intelligence (AI) literacy competence of students in the Elementary School Teacher Education Study Program (PGSD) in designing elementary school mathematics learning. Thru this approach, the researcher can describe the actual condition of students' AI literacy competence based on empirical data obtained from respondents without manipulating the research variables.

The participants in this study are students of the Elementary School Teacher Education Program (PGSD) at PGRI Semarang University (UPGRIS) who are currently taking the elementary school mathematics learning course. This criterion was chosen because the students have experience in developing learning devices and are familiar with the use of digital technology in the learning process.

The sampling technique used is purposive sampling, which involves selecting respondents based on specific criteria relevant to the research objectives. The number of respondents involved 135 PGSD UPGRIS students who met the research criteria. The characteristics of the respondents collected include gender, semester, experience using AI (ChatGPT, Gemini, Copilot, and other AI applications), as well as the frequency of AI use in academic activities.

Research data were collected using a questionnaire as the main instrument. The questionnaire was developed based on indicators of AI literacy competence, which include: (1) understanding basic AI concepts, (2) ability to use AI applications, (3) ability to critically evaluate AI outputs, (4) awareness of ethics and responsibility in AI usage, and (5) ability to integrate AI into the design of elementary school mathematics learning.

The research instrument uses a five-point Likert scale, namely: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly

Agree (5). Before use, the instrument was validated by experts in the field of educational technology and mathematics education to ensure content validity. In addition, a reliability test was conducted using the Cronbach's Alpha coefficient to determine the consistency level of the instrument.

As supporting data, the research also uses documentation, in the form of examples of mathematics learning tools prepared by students, such as Teaching Modules, Lesson Plans (RPP), or Student Worksheets (LKPD). This documentation is used to strengthen the interpretation of survey results related to the implementation of AI literacy in learning design.

The obtained data were analyzed using descriptive statistics. The analysis was conducted thru several stages, namely: (1) data tabulation, (2) calculation of scores for each AI literacy competency indicator, (3) calculation of mean, percentage, and standard deviation, and (4) interpretation of competency levels based on the predetermined categories.

The category of AI literacy competence can refer to the following intervals:

Table 1. Category of AI literacy competence

Score Range	Category
81–100	Very High
61–80	Hight
41–60	Medium
21–40	Low
0–20	Very Low

The results of the analysis are presented in the form of tables and diagrams to provide a clearer picture of the AI literacy competency level of PGSD students in designing elementary school mathematics learning. Furthermore, these results are interpreted with reference to AI literacy theory and relevant previous research.

The research was conducted thru several stages, namely: Literature study and preparation of research instruments. Validation of instruments by experts. Distribution of questionnaires to PGSD UPGRIS students. Collection of documentation on mathematics learning tools. Data processing and analysis. Interpretation of research results and preparation of the research report. This method was chosen because it aligns with the research objectives, which focus on mapping and analyzing the AI literacy competency levels of PGSD students in the

context of designing elementary school mathematics learning. With a descriptive quantitative approach, the research is expected to produce empirical information that can serve as a basis for developing curricula and AI literacy enhancement programs for prospective elementary school teachers.

RESULTS AND DISCUSSION

Level of AI Literacy Competence of PGSD Students

Table 1. AI Literacy Competency Levels of PGSD Students

Indicator	Percentage (%)	Category
Understanding of basic AI concepts	76.25	Hight
Ability to use AI applications	78.30	Hight
Ability to evaluate AI outputs	70.60	Hight
Ethical awareness of AI usage	80.15	Hight
Ability to integrate AI into mathematics learning	82.75	Very Hight
Average AI Literacy Competence	77.61	Hight

The research results indicate that the AI literacy competence of PGSD students is generally in the high category with an average achievement of 77.61%. This finding shows that students have a fairly good ability to understand, use, and utilize AI technology to support academic activities as well as the design of elementary school mathematics learning. This aligns with previous research showing that mastery of numeracy and technological literacy in prospective educators is a crucial foundation for developing creative and relevant problem-posing (Utomo, 2023, p. 3364). However, there is variation in achievement across indicators, indicating that although students are technically proficient, their understanding of specific pedagogical aspects of mathematics still requires strengthening to align with AI-based teacher competency standards.

Interestingly, the ability to integrate AI into mathematics learning received the highest score compared to other indicators. This condition indicates that students are not only using AI as an information-seeking tool but are also starting to utilize it to help design learning devices, develop

materials, and create more innovative learning activities. 477 This utilization aligns with findings that applied training can increase prospective teachers' confidence in integrating technology into evaluation and a more interactive mathematics learning process (Wulansari et al., 2025). However, pedagogical aspects remain a crucial consideration, as demonstrated by findings that technological mastery is often not matched by adequate maturity in teaching strategies (Zuhdiah et al., 2025).

On the contrary, the ability to evaluate AI output received the lowest score, although it still fell within the high category. These findings suggest that some students still need to improve their critical thinking skills in examining the accuracy, relevance, and validity of the information generated by AI systems before using it in their learning.

Illustration of Findings

In general, the pattern of AI literacy competencies among students can be described as follows.



Figure 1. AI literacy competency pattern of students

The illustration shows that students are relatively more prepared in the aspect of AI application compared to the aspect of critically evaluating the results provided by AI.

Students' Competence in Utilizing AI to Design Elementary School Mathematics Learning

The competence of students in utilizing AI to design elementary school mathematics learning can be seen in Table 2.

Table 2. Summary of AI Utilization Competencies in Designing Elementary School Mathematics Learning

Observed Aspects	Category
Utilization of AI for the development of mathematics materials	Hight
Utilization of AI for the preparation of learning devices	Hight
Utilization of AI for designing learning activities	Hight
Integration of AI in elementary school mathematics learning	Very Hight

The research results show that students have been able to utilize various AI applications to assist in the process of planning mathematics lessons. AI is used to search for material references, compile example questions, create learning illustrations, and even help design activities that match the characteristics of elementary school students. In line with this, the use of this technology reflects AI's role as a learning support, not a substitute for independent thinking skills in formulating complex instructional scenarios (Apif, 2026). However, challenges arise when students are confronted with the effectiveness of AI-generated time organization and instructional step allocation, which are often unrealistic when applied directly in a real classroom. This gap between the technical convenience offered by AI and the reality of pedagogical implementation calls for a more comprehensive AI-TPACK framework to ensure the intellectual autonomy of prospective teachers is maintained (Ferdinanda et al., 2026).

These findings indicate that AI is beginning to be viewed as a learning partner that can support students' creativity in developing more engaging and interactive lessons. In addition to helping with time efficiency, the use of AI also allows students to access a variety of alternative learning strategies that can be tailored to their individual needs.

These findings indicate that AI is increasingly being viewed as a learning partner that can support students' creativity in designing more engaging and interactive learning experiences. In addition to helping with time efficiency, the use of AI also allows students to obtain various alternative learning strategies that can be tailored to the needs of learners.

However, the documentation of the learning tools shows that some students still tend to accept AI outputs directly without making adequate

modifications. Therefore, reflective and critical thinking skills need to be strengthened so that the use of AI does not diminish the quality of lesson planning.

Aspects of AI Literacy that Become Strengths and Weaknesses for Students

Table 3. Aspects of AI Literacy that are Strengths and Weaknesses of Students

Ranking	AI Literacy Aspects	Percentage
1	Integration of AI in mathematics learning	82.75
2	Ethical awareness of AI usage	80.15
3	Use of AI applications	78.30
4	Understanding basic AI concepts	76.25
5	Evaluation of AI outputs	70.60

Based on the research findings, the ability to integrate AI into mathematics learning has become a major strength of PGSD students. The students have shown good readiness in utilizing AI technology to support the preparation of learning tools, development of materials, and provision of more varied learning resources.

In addition, awareness of the ethical use of AI also shows positive results. Most students understand the importance of using AI responsibly and recognize the need to maintain academic integrity when utilizing this technology.

On the other hand, the ability to evaluate AI outputs is an aspect that still needs improvement. This condition indicates that students are not yet fully accustomed to verifying the information generated by AI. In the context of elementary school mathematics education, this ability is very important because undetected conceptual or procedural errors can impact the quality of the designed learning.

CONCLUSION

Based on the research results, it can be concluded that the Artificial Intelligence (AI) literacy competence of PGSD UPGRIS students in designing elementary school mathematics learning is in the high category with an average achievement of 77.61%. This finding indicates that the students have a fairly good ability to understand the basic concepts of AI, utilize various AI applications, evaluate information

generated by AI, apply ethical principles in its use, and integrate AI technology into the process of designing mathematics learning in elementary schools. The results indicate that PGSD students have relatively good readiness to face the demands of educational transformation in the digital era.

The aspect that shows the highest achievement is the ability to integrate AI into elementary school mathematics learning. These findings show that students have been able to utilize AI technology not only as a source of information but also as a supporting tool in preparing teaching materials, designing learning activities, developing media, and producing more innovative and adaptive learning devices. This ability becomes an important asset for prospective teachers in creating more engaging learning experiences that meet the needs of 21st-century learners.

On the other hand, the ability to critically evaluate AI outputs is the aspect with the lowest achievement compared to other indicators, although it still falls within the high category. This condition indicates that some students still need to improve their ability to verify the accuracy of information, assess the relevance of content to learning objectives, and identify potential errors or biases that may arise from AI outputs. Therefore, strengthening critical and reflective thinking skills is an important need in the development of AI literacy for future teachers.

This research provides theoretical implications that AI literacy is not only related to technical skills in using technology but also encompasses pedagogical, ethical, and evaluative abilities that are integrated in the learning design process. These findings reinforce the view that AI literacy competence is an important part of teachers' professional competence in the era of digital transformation.

Practically, the research results can serve as a foundation for the PGSD study program in designing curricula, training, and competency development programs focused on strengthening AI literacy. Integrating AI literacy materials into mathematics learning, educational technology, and learning device development courses can help students utilize AI more effectively, critically, and responsibly. Thus, PGSD graduates are expected not only to use AI technology as a learning aid but also to make appropriate pedagogical decisions so that the use of AI can make a tangible contribution to improving the quality of mathematics learning in elementary schools.

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