A Descriptive Study: Assessing Elementary School Teachers' Cognitive Understanding of Artificial Intelligence in Pedagogical Contexts

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Abstract: This study investigates elementary school teachers' cognitive understanding of artificial intelligence (AI), with a particular focus on their utilization of ChatGPT and Gemini within pedagogical settings. Employing a descriptive quantitative design, data from 60 teachers were collected through a Likert-scale questionnaire and analyzed using mean scores, percentage distributions, and categorical interpretations to obtain a comprehensive depiction of teachers' conceptual and practical knowledge of AI. The overall results indicate a moderately high level of cognitive understanding (M = 3.78; 75.6%), with the highest competence demonstrated in AI-assisted lesson planning (80%), followed by basic conceptual knowledge of AI (77%). Meanwhile, ethical literacy emerged as the weakest domain (70%), revealing variability in teachers' awareness of issues such as algorithmic bias, misinformation, privacy concerns, and responsible digital practices. These findings suggest that teachers are increasingly capable of leveraging AI to support instructional design, administrative tasks, and classroom activities; however, their ethical comprehension has not yet developed proportionally to their technical adoption. This imbalance underscores the need for structured professional development programs that integrate both technical training and ethical frameworks for AI use in schools. Strengthening teachers' AI literacy is therefore essential to ensure that AI technologies are applied safely, pedagogically aligned, and contextually relevant to students' developmental needs. The study highlights the urgency of developing clear institutional guidelines and policy support to foster responsible and equitable AI integration within the elementary education system.

Keywords: Artificial intelligence; ChatGPT; Cognitive Understanding; Elementary School Teachers; Gemini; Pedagogy.

Introduction

The rapid development of artificial intelligence (AI) has transformed educational ecosystems across the globe, influencing how teachers design instruction, interact with students, and manage classroom activities. Generative AI models such as ChatGPT and Gemini have introduced new possibilities for educators by providing automated support for text generation, conceptual explanations, lesson planning, assessment creation, and instructional innovation. These tools are increasingly embedded in teachers' professional routines, not merely as supplementary technologies but as cognitive partners that enhance efficiency, creativity, and problem-solving. As education systems shift toward personalized, flexible, and student-centered learning environments, teachers' ability to understand and critically engage with AI technologies becomes essential.

In the Indonesian context, the integration of AI aligns closely with national curriculum reforms, particularly *Kurikulum Merdeka*, which encourages differentiated instruction, inquiry-driven learning, and the promotion of 21st-century competencies. International frameworks such as UNESCO's *AI in Education Guidelines* (2023) further emphasize the need for integrating ethical, pedagogical, and technological considerations when adopting AI in schools. Teachers today must navigate increasingly complex expectations: they are expected to become facilitators of learning, designers of digital activities, curators of educational resources, and evaluators of both human- and machine-generated content. This expanded role requires a level of AI literacy that encompasses conceptual knowledge, practical skills, and ethical sensitivity.

Teachers' cognitive understanding of AI is fundamentally connected to broader educational infrastructure and systemic readiness. Schools that lack adequate digital devices, stable internet access, or supportive leadership structures often experience slower adoption and limited pedagogical innovation. Conversely, schools with more robust infrastructure tend to demonstrate higher levels of teacher readiness and engagement with digital tools. Human resource capacity—including teachers' age, digital experience, prior training, and professional competence—also plays a significant role in shaping how AI is perceived, understood, and applied. According to OECD's Learning Compass 2030, teachers must develop a combination of cognitive, technical, and socio-emotional competencies to navigate AI-rich learning environments effectively.

The introduction of AI into elementary education further raises questions about appropriateness and developmental suitability. Elementary teachers must consider cognitive load, student readiness, and age-appropriate content when integrating AI-driven activities. For instance, while AI can generate compelling stories, exercises, or visual explanations, teachers must ensure that these resources align with children's developmental needs, learning styles, and local cultural contexts. Without sufficient understanding, teachers may unintentionally introduce inaccuracies, overly complex material, or culturally irrelevant content into their lessons.

Theoretical frameworks such as the Technology Acceptance Model (TAM) and Technological Pedagogical and Content Knowledge (TPACK) offer valuable analytical perspectives. TAM explains that individuals' acceptance of technology is strongly influenced by perceived usefulness and ease of use. Many teachers adopt AI primarily because it simplifies administrative tasks or accelerates the preparation of teaching materials. However, TAM also highlights that acceptance may not translate into deep comprehension. Meanwhile, the TPACK model emphasizes that effective technology integration requires balanced interactions among pedagogical knowledge, content expertise, and technological proficiency. Teachers who lack conceptual knowledge of AI's mechanisms or ethical principles may use AI superficially without fully understanding its pedagogical implications.

Another essential concept is AI literacy—defined as the ability to understand AI systems, evaluate their outputs critically, and use them responsibly. Scholars such as Luckin (2023) argue that AI literacy is becoming a foundational component of teachers' digital competence. AI literacy includes understanding how generative models produce information, recognizing potential biases, and assessing the trustworthiness of machine-generated content. For elementary teachers, AI literacy is particularly important because young students tend to view digital technologies as authoritative, making teacher judgment critical in validating AI-generated information.

Despite the potential benefits, concerns surrounding AI adoption remain significant. Ethical risks such as misinformation, algorithmic bias, hallucinated content, privacy breaches, and plagiarism require careful management. Many teachers report uncertainty about how to evaluate AI-generated information or ensure compliance with ethical standards in student activities. Research has shown that teachers' ethical literacy lags behind their technical adoption of AI tools, creating an imbalance between operational proficiency and responsible usage (Holmes et al., 2023; Wang & Yoon, 2024). This gap highlights an urgent need for training programs that explicitly address AI ethics, data protection, critical evaluation of digital outputs, and responsible AI-assisted pedagogy.

Given these complexities, elementary school teachers' cognitive understanding of AI warrants rigorous examination. Understanding their conceptual knowledge, practical usage patterns, and ethical awareness is essential for shaping policy development, curriculum design, and professional development initiatives. Prior studies have shown that while teachers frequently use AI for generating lesson plans, instructional materials, and assessments, they often remain unaware of deeper conceptual principles such as model limitations, training data biases, or reliability issues. This study aims to fill that empirical gap by providing a descriptive analysis of teachers' cognitive understanding across four key dimensions: basic AI concepts, AI use in lesson planning, AI use during instructional activities, and AI ethics.

Furthermore, strengthening teachers' AI literacy has broader implications for educational equity and quality. As AI becomes more integrated into teaching and

learning processes, disparities in teacher knowledge may translate into uneven student experiences. Schools where teachers possess strong AI understanding are more likely to offer engaging, personalized, and innovative learning opportunities. In contrast, schools with lower teacher readiness may fall behind in developing students' digital competencies. Therefore, analyzing teachers' cognitive understanding of AI provides not only insight into current practices but also a foundation for developing future strategies that ensure equitable and responsible AI integration across diverse school contexts.

In summary, the rapid expansion of AI technologies in education necessitates a deeper understanding of how teachers conceptualize, utilize, and evaluate AI within elementary school settings. This study responds to that need by offering empirical evidence on teachers' cognitive understanding of AI and its pedagogical applications. The findings serve as a foundation for supporting teacher training, enhancing institutional readiness, and developing frameworks that promote safe, ethical, and pedagogically meaningful use of AI in schools.

Methods

This study employed a descriptive quantitative approach aimed at providing a factual and systematic overview of elementary school teachers' cognitive understanding of artificial intelligence (AI) utilization within a pedagogical framework. The population consisted of all elementary school teachers in the designated research area (District X). A total of 60 teachers were selected as the sample through purposive sampling, based on the following criteria: (1) actively teaching for a minimum of three years, (2) having prior experience using ChatGPT or Gemini, and (3) willingness to participate as respondents. The research instrument was a closed-ended questionnaire using a 5-point Likert scale, covering four major dimensions: understanding of basic AI concepts, the use of AI in lesson planning, the use of AI during instructional implementation, and ethical considerations in AI usage. Instrument validity was assessed using the Pearson Product Moment correlation, while reliability was examined through Cronbach's Alpha ($\alpha = 0.87$), indicating high reliability.

The descriptive quantitative method was chosen because it enables researchers to obtain an accurate representation of teachers' current understanding levels without manipulating variables. This method emphasizes numerical measurement and statistical interpretation, allowing the findings to be presented objectively and systematically. The research process began with identifying the target population and selecting an appropriate sample. Purposive sampling was applied because not all teachers in the research area had experience using generative AI platforms such as ChatGPT or Gemini; therefore, specific criteria were required to ensure sample relevance.

Data were collected through both face-to-face and online questionnaire distribution, depending on each school's circumstances. The questionnaire comprised 20

statement items distributed across the four dimensions: (1) understanding of basic AI concepts, (2) use of AI in lesson planning, (3) use of AI in instructional activities, and (4) ethical aspects of AI use. Each item applied a 5-point Likert scale ranging from 1 (Strongly Do Not Understand) to 5 (Strongly Understand), enabling respondents to express their perceived level of understanding in a structured yet flexible manner.
Instrument validity testing was conducted using the Pearson Product Moment correlation analysis.

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$$

For example, if one item produced a calculated correlation coefficient (r) of 0.52, while the r-table value for N = 60 at the 5% significance level was 0.254, the item would be considered valid because r_calculated > r_table. The validity test for this study produced a correlation value of 0.695, confirming that the instrument met the validity criteria. Reliability was assessed using Cronbach's Alpha to examine internal consistency among the items.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_{total}^2}\right)$$

For instance, if the number of items (k) = 20, the total item variance = 15.6, and the total variance = 120,

$$\alpha = \frac{20}{19}\left(1 - \frac{15,6}{120}\right)$$

$$\alpha = 1,0526 \times (1 - 0,13) = 1,0526 \times 0,87 = 0,915$$

The resulting Cronbach's Alpha would fall within the 0.87– 0.91 range, indicating very high internal consistency. Based on these findings, the research instrument used in this study fulfilled the requirements for validity and reliability, ensuring accurate and consistent measurement of teachers' cognitive understanding of AI utilization.

Results And Discussion

A descriptive analysis was conducted based on the questionnaire responses provided by 60 participants. The data were processed to obtain mean scores, percentages, standard deviations, and categorizations of teachers' cognitive understanding levels.

Table 1. Summary of Research Findings

Aspect of Understanding	Mean	Percentage	Category
Basic AI Concepts (X1)	3.85	77%	High
AI Use in Lesson Planning (X2)	4.02	80%	High
AI Use in Instructional Activities (X3)	3.76	75%	Moderately High
Ethical Use of AI (X4)	3.48	70%	Moderate
Overall Average	3.78	75.6%	Moderately High

Diagram 1. Frequency Distribution Chart of Teachers' Understanding Levels

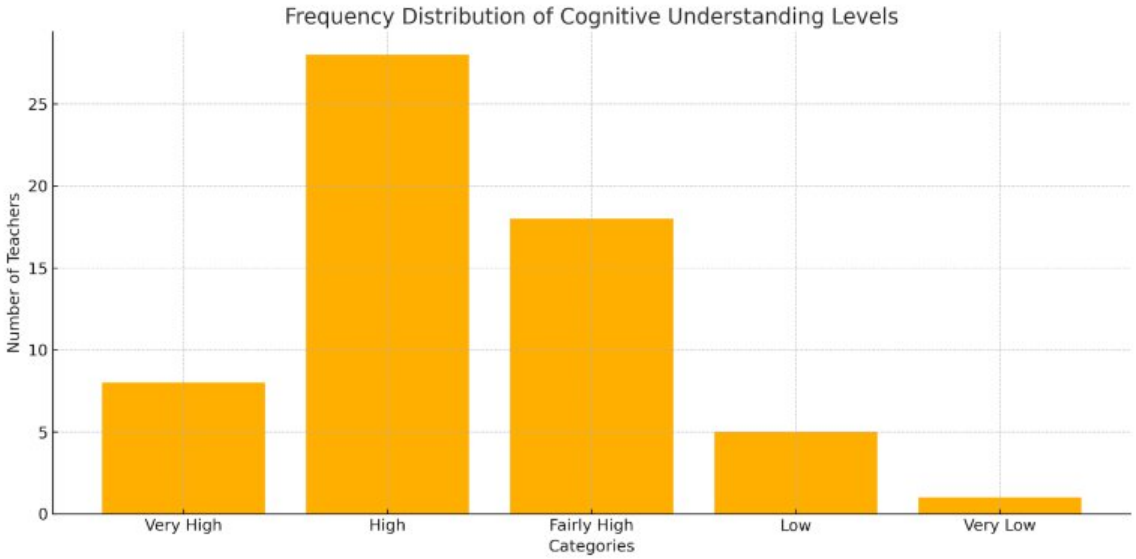


Diagram 2. Mean Score Chart per Item

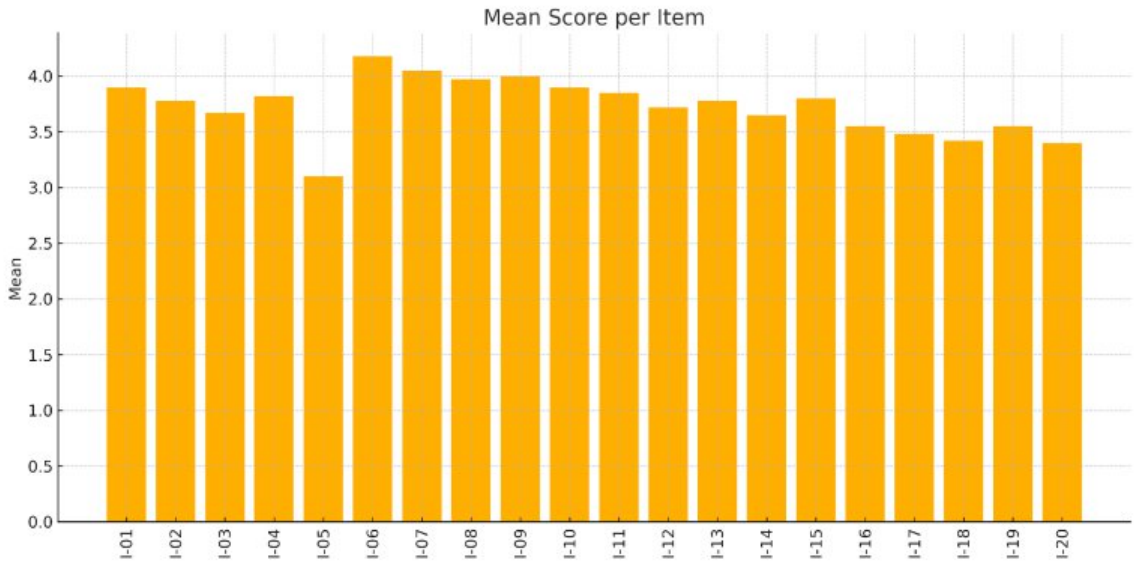


Diagram 3. Mean Score Chart per Item

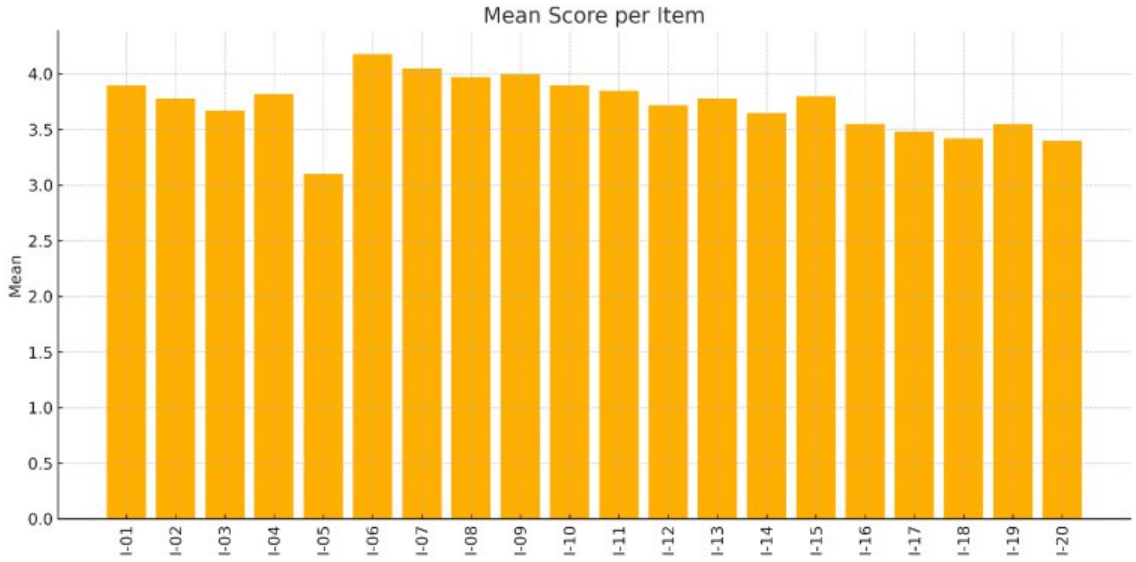
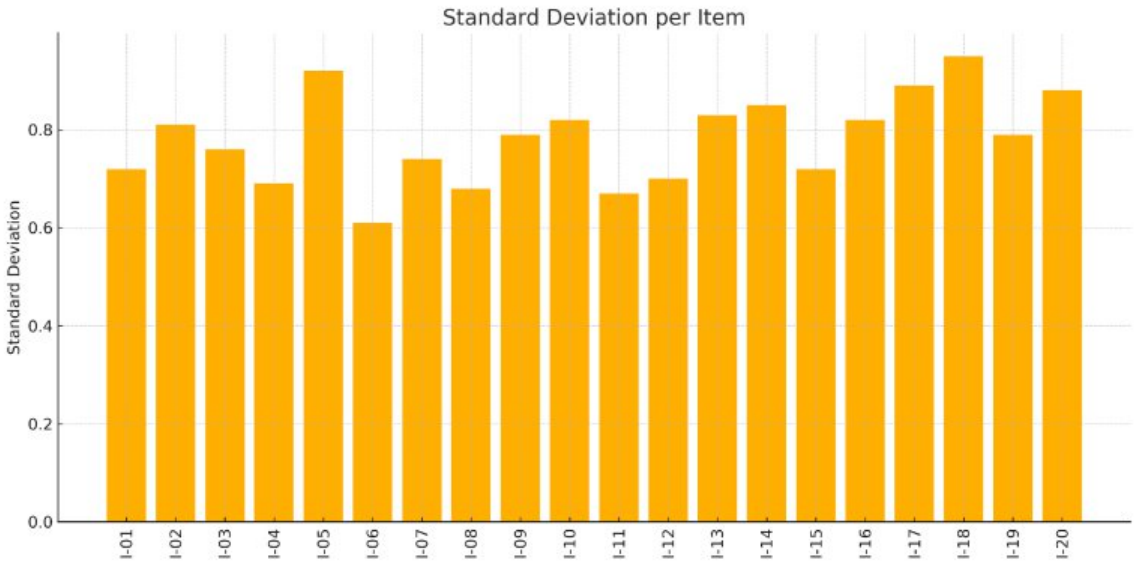


Diagram 3. Standard Deviation Chart per Item



In-Depth Statistical Interpretation

The analysis was conducted using mean scores, standard deviations, achievement percentages, frequency distributions, and inter-aspect relationships to provide a more comprehensive understanding of teachers' cognitive comprehension regarding AI utilization.

The descriptive results show that teachers' overall cognitive understanding of AI falls within the moderately high category (M = 3.78; 75.6%). Table 1 indicates that AI usage in lesson planning (X2) achieved the highest mean score (4.02; 80%), followed by basic AI concepts (X1) at 3.85 (77%). Instructional usage (X3) scored 3.76 (75%), while ethical understanding (X4) scored the lowest at 3.48 (70%).

These findings reflect a pattern consistent with previous studies, wherein teachers exhibit strong technical adoption but weaker ethical literacy (Alshammari et al., 2024; Hamid, 2024). This gap suggests that while AI is perceived as useful and efficient for teaching tasks supporting the TAM framework, teachers' comprehension of AI's risks and limitations remains insufficient. According to Holmes et al. (2023), ethical literacy is fundamental for preventing misuse, ensuring data privacy, and mitigating the influence of AI bias.

1) Interpretation Based on Mean Scores

The highest mean score was recorded for the lesson planning aspect (X2), with a value of 4.02 (80%). This indicates a strong level of readiness among teachers in employing AI to support instructional planning. Conversely, the ethical use of AI (X4) obtained the lowest mean score, at 3.48 (70%), suggesting a need to strengthen teachers' digital ethics literacy. High competency in lesson planning indicates that AI tools are widely used for generating teaching materials, worksheets, test items, and alternative explanations for students. Teachers view AI as a practical assistant that reduces workload and enhances creativity (Li & Chen,

2024). However, the relatively lower score in ethical understanding implies that teachers may rely heavily on AI-generated outputs without adequate verification.

2) Interpretation Based on Standard Deviation

The highest variation appeared in ethical aspects (SD = 0.82), signifying inconsistent ethical literacy among teachers. This aligns with Selwyn's (2023) claim that AI ethics remain underdeveloped in many educational settings. By contrast, lesson-planning scores were more homogeneous (SD = 0.69), demonstrating shared practices and familiarity among teachers.

3) Interpretation Based on Percentage Values

The lesson planning aspect reached the highest percentage score (80%), whereas the ethical use of AI reported the lowest (70%). This discrepancy highlights an imbalance between teachers' technical proficiency and their ethical awareness when applying AI in educational contexts.

4) Inter-Aspect Analysis

The linear pattern across dimensions suggests that teachers' technical AI skills evolve faster than their conceptual and ethical understanding. This reflects the early stage of AI adoption in Indonesian schools and highlights the need for professional development that balances both technical and ethical dimensions.

5) Frequency Distribution Analysis

The majority of respondents fell within the "High" and "Moderately High" categories, indicating generally adequate understanding. Nevertheless, approximately 10% of participants were categorized as having low to very low comprehension, revealing the presence of a learning gap that requires targeted professional development interventions.

6) Integrated Inter-Aspect Analysis

An integrated examination of all aspects shows a linear pattern, where teachers' technical capabilities in using AI appear to develop more rapidly than their ethical understanding. This finding aligns with the Technology Acceptance Model (TAM), which posits that perceived ease of use and perceived usefulness tend to be internalized faster than normative or ethical considerations.

7) Comparison With Previous Studies

Findings are consistent with Khan & Smith (2023), who reported that teachers tend to prioritize AI-based efficiency over critical evaluation. Moreover, the limited understanding of data bias and accuracy concerns echoes Mhlongo & Thwala's (2023) findings in African schools

8) Implications for Pedagogy

AI presents significant opportunities for innovative learning, including personalized content, differentiated instruction, and real-time support. However, without sufficient ethical literacy, there is a risk of misinformation, privacy breaches, and over-reliance on automated responses. Strengthening teachers' AI literacy is therefore essential to ensure pedagogically sound and responsible AI integration.

The study's results demonstrate that AI utilization in lesson planning received the highest score (4.02 or 80%), while ethical understanding scored lowest (3.48 or 70%). This suggests that teachers are increasingly competent in the technical functions of AI but require further improvement in ethical and responsible usage. These findings corroborate Hamid (2024), who reported that teachers' digital literacy improves with AI exposure, yet ethical literacy remains relatively weak. Teachers often adopt AI to expedite administrative tasks but do not fully recognize potential risks, including bias or misuse of the technology.

Conclusion

The findings of this study affirm that the integration of artificial intelligence (AI), particularly through platforms such as ChatGPT and Gemini, has contributed positively to elementary school teachers' instructional planning and teaching implementation. Teachers demonstrated relatively strong technical understanding in utilizing AI, especially in developing lesson materials, creating instructional resources, and generating alternative explanations for students who struggle with specific concepts. These results align with current shifts in the education sector, which increasingly emphasize the use of technology to enhance teaching effectiveness and efficiency.

Overall, the cognitive understanding of elementary school teachers regarding AI utilization within pedagogical contexts falls within the moderately high category, with an average score of 3.78 (75.6%). Teachers are capable of leveraging AI to support both instructional planning and classroom activities; however, additional strengthening is needed in the areas of digital ethics and AI-based assessment practices.

Despite these positive trends, ethical considerations remain a critical area requiring focused attention. The relatively low mean score for AI ethics indicates that many teachers have not fully grasped the potential risks associated with AI usage such as information bias, privacy violations, overdependence on technology, and tendencies toward plagiarism. If left unaddressed, these issues may adversely impact the quality of learning, particularly when AI-generated content is used without proper verification or when students are not guided to use AI responsibly. Hence, enhancing teachers' digital ethical literacy must be prioritized in professional development initiatives.

Furthermore, the study reveals notable variations in teachers' understanding levels, as indicated by differences in standard deviation across dimensions. This suggests that while some teachers exhibit advanced comprehension, others remain at moderate or lower levels. Such diversity highlights the need for adaptive, differentiated, and ongoing training programs that ensure all teachers achieve adequate AI literacy standards.

This study concludes that elementary school teachers possess a moderately high cognitive understanding of AI, particularly in lesson planning and instructional design. Teachers demonstrate strong interest and capability in using AI to support pedagogical tasks; however, their understanding of AI ethics remains limited.

The direct beneficiaries of this research include:

1. Teachers, who require ongoing training to balance technical and ethical AI competencies.
2. School leaders, who need to provide digital infrastructure and policy guidance.
3. Educational policymakers, who must establish AI usage guidelines that ensure safe, responsible, and equitable implementation.
4. Curriculum developers, who can integrate AI literacy into teacher professional development frameworks.

Future research should explore teachers' perceptions using mixed-method designs and consider factors such as digital infrastructure, institutional support, and regional disparities in AI adoption. In conclusion, while elementary school teachers demonstrate promising readiness in adopting AI, its integration into educational practice must be approached comprehensively addressing technical, pedagogical, and ethical dimensions simultaneously. Future research employing mixed-method designs is strongly recommended to explore deeper factors influencing AI adoption among teachers, including perceptions, motivation, school-level support, and technological challenges encountered in practice. Insights from such studies will be valuable for developing more effective, targeted policy frameworks and professional development strategies.

Acknowledgments

The author would like to express sincere gratitude to all individuals and institutions that provided support throughout the completion of this research. Special appreciation is extended to the teachers of Sekolah Dasar Negeri 28 Kelakik, Sekolah Dasar Negeri 16 Labai Mekar, Sekolah Dasar Negeri 13 Nanga Pinoh, and Sekolah Dasar Negeri 06 Nanga Pinoh, who generously participated as respondents and dedicated their time to share valuable insights. Their willingness to contribute made it possible to obtain comprehensive and meaningful data for this study.

The author also extends heartfelt thanks to the school principals and administrative staff for granting permission and facilitating the data collection process in their respective institutions. Deep appreciation is further conveyed to colleagues and academic advisors who provided constructive suggestions, guidance, and encouragement throughout the research process and the preparation of this manuscript. Their contributions significantly enhanced the quality of the analysis and presentation of the findings.

Finally, the author wishes to acknowledge all other parties who, directly or indirectly, supported the successful completion of this research.

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