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Elementary School Students' Readiness to Adopt Artificial Intelligence (AI)-Based Learning

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Anggun Yulianti[1*], Noening Andrijati[2], Nanik Wijayati[3], Decky Avrilianda[4]

[1,2,3,4]Elementary Education Program, Postgraduate School, Universitas Negeri Semarang, Semarang, Indonesia
Corresponding Email: *anggunyulianti08@students.unnes.ac.id

Abstract

This research will focus on the evaluation of elementary school students' readiness to use AI for their learning process through three significant factors, namely dimensions of readiness, factors affecting readiness, and conditions for infrastructure and ecosystem of schools. The type of this research is a literature review that utilizes qualitative methods. This data collection is done based on ten scientific articles from national and international journals, sourced from the Google Scholar, Scopus, ERIC, and Sinta databases. The data were collected by documentation, and data analysis was done using content analysis and thematic synthesis. From the research findings, it is evident that the readiness for AI integration among primary level pupils entails three related constructs; cognitive (knowledge of AI), affective (attitudes, motivation, self-confidence), and behavioral (interaction skills with AI technologies). While internal variables (teacher attitudes, TPACK) strongly positively impact AI integration ($\beta = 0.791$), external variables (government policies, technological infrastructure, community involvement) indirectly impact AI usage via internal variables ($\beta = 0.217$). Less than a third of teachers (28%) currently adopt AI in teaching, whereas the majority (82%) stick to conventional instructional techniques. These results indicate that the readiness of students will not take place without ensuring the readiness of teachers and that both need to work in harmony with each other for internal capacity building and equal external support. The conclusion drawn from this study is that the level of readiness of elementary school students to adopt learning based on artificial intelligence has only started and that they are not consistent yet. The application of AI in elementary schools largely relies on enhancing teacher competencies, equal infrastructure, and developing policies that consider ethics, privacy, and social justice. More studies should be conducted concerning rural areas and tools to measure readiness in Indonesia.

Keywords: Student Readiness, Learning, Artificial Intelligence, Elementary School

INTRODUCTION

Artificial intelligence has drastically changed the appearance of education within the last decade worldwide (Agustina & Suharya, 2024). Apart from research and academic activities, artificial intelligence has made its entry into elementary education via different devices such as adaptive learning software, intelligent tutoring systems, and customized learning programs. As pointed out by Holmes (2019), implementing artificial intelligence in education is not just a trend but rather a revolution that everyone should accept. However, although artificial intelligence implemented into the process of elementary education creates multiple advantages that promote the improvement of the learning process, there is no possible way to ignore some challenges. In this regard, AI implemented into the educational process gives a teacher the opportunity to customize their lesson for each particular pupil, give instant feedback, and decrease their workload (Di Battista et al., 2023; Zawacki-Richter et al., 2019). Still, there are multiple issues associated with artificial intelligence as a teaching tool, as they relate not only to the technology used but also to teachers and pupils' preparedness since they are the main participants in the process (Crompton & Burke, 2022).

It cannot be considered as one dimension only or a very simplistic notion. According to Dai et al. (2020), research reveals that elementary school learners' readiness to adapt to AI learning comprises three aspects which should develop equally. The first dimension is cognitive, which encompasses students' understanding of basic AI concepts, how simple algorithms work, and familiarity with AI applications in daily life. The second dimension is affective, which includes a positive attitude toward technology, motivation to learn, and self-confidence in using AI-based tools. The third dimension is behavioral, namely students' ability to interact effectively with AI systems, including operating devices, following procedures, and adapting to digital interfaces. These three dimensions form a holistic readiness only when all are met simultaneously.

Findings from fieldwork research point out an interesting yet alarming irony associated with AI literacy of elementary school-aged children. Ng et al. (2021) discovered that familiarity of children with digital technology devices, such as smartphones, and social media does not always imply AI literacy of the youth. Most children, who are adept at using digital technology, do not know the way AI operates, the potential risks of its functioning, and how to make critical judgments of the outputs produced by algorithms (Manalu, 2024). Thus, the contrast between usage frequency and AI literacy shows that education remains indispensable in developing children's readiness to the challenges of modern times.

The biggest problem with the current literature regarding AI readiness in elementary schools is the difference between their geographical location and context. Casal-Otero et al. (2023), in their systematic literature review, found that most of the studies were conducted in developed nations like the US, Germany, and South Korea, or even urban settings of developing nations. However, regions in developing nations, such as Indonesia, remain almost entirely ignored in empirical and theoretical discussions about AI readiness in elementary education institutions. It is highly possible that factors unique to their region, such as poor internet connectivity, absence of proper equipment, lack of skilled teachers, and insufficient family involvement, will lead to a completely different pattern of results from what has already been established (Zahrah, 2025).

Commitment to meeting the needs of the digital era has been shown by the government of Indonesia through policies supporting the incorporation of AI into the curricula. Specifically, Indonesian Ministry of Basic and Middle Education has made coding and AI compulsory subjects in the Merdeka Curriculum and also released an academic article on AI learning in primary and secondary schools (Iddian, 2025). Nevertheless, according to Prihatin (2025), there is evidence of significant challenges in implementing these policies in practice,

especially for schools situated away from urban areas. One of the causes for failure in achieving equality in student preparedness includes the unavailability of a standard curriculum, poor training of teachers, and unequal distribution of technological facilities in different regions. As reported by Santosa et al. (2025), in their study on how teachers view AI, despite having a favorable attitude towards AI technology, technopedagogical competency is one of the main reasons for slow implementation of AI in elementary education.

An analysis of the gaps above shows that there has not been any literature review conducted thus far that has systematically integrated the findings related to the readiness of elementary school children to adopt AI-based learning from three different perspectives. First, the cognitive, affective, and behavioral dimensions as a comprehensive analytical framework. Second, the factors influencing this readiness, both from the students' internal perspective and external factors such as family, teachers, and school infrastructure. Third, the implications for developing regions with characteristics distinct from the locations that have traditionally dominated the literature. This gap serves as the primary justification for the need to conduct a comprehensive literature review to develop a theoretical framework that can serve as a foundation for future empirical research and policy.

Based on the background and identification of research gaps outlined above, this literature review aims to analyze the readiness of elementary school students to adopt AI-based learning as described in the national and international literature. This study is expected to serve as a foundation for future researchers in designing empirical studies and to provide evidence-based recommendations for policymakers in the education sector.

DISCUSSION

Table 1 presents the results of an analysis of 10 relevant articles, from both national and international journals, which were collected from various database sources. The findings are presented in a table containing the following components: author name and year, study title, research objectives, research methods, and research findings.

Table 1. Article Analysis

No	Researcher	Title	Objective	Method	Findings
1	Salsabila & Asyifah (2025)	Transforming the Role of Teachers in the AI Era: An Analysis Critical to Competence Professionals	Analyzing Changes in Teachers' Roles, Professional Competencies, and Training Needs in the AI Era in Indonesia	Descriptive qualitative research with case studies; interviews, observations, and document analysis; and	Only 28% of teachers actively use AI in their teaching, while 82% still rely on traditional teaching methods traditional. The

No	Researcher	Title	Objective	Method	Findings
		and Needs Training in Indonesia		30 teachers from 5 provinces.	digital skills gap is a major obstacle. The three areas where training is most needed are: integrating AI into lesson plans (84%), utilizing digital platforms (79%), and the ethical use of AI (75%). A practical, contextual, and sustainable training approach is needed.
2	Yulianto et al. (2025)	Modeling the Determinants of AI Integration in Primary Mathematics Education: A Structural Equation Modeling Analysis	Examining the internal and external determinants of AI integration in mathematics education at the elementary school level.	PLS-SEM (second-order structural equation modeling); 516 elementary school mathematics teachers in Jakarta.	Internal factors (teacher attitudes and TPACK competencies) have a strong direct effect on AI utilization ($\beta = 0.791$; $p < 0.001$). External factors (policy support, infrastructure, and parent and community involvement) exert an indirect influence through an internal mediator ($\beta = 0.217$; $p < 0.001$). The model explains 78.1% of the variance in AI utilization. Teacher readiness is the most

No	Researcher	Title	Objective	Method	Findings
					significant factor. 78.1% of the variance in AI adoption. Teacher readiness is the most critical factor.
3	Raharjo & Rohmadi (2025)	Artificial Intelligence in Indonesian Education: A Critical Review of Ethical Considera-tions, Implementa-tion Challenges, and Educational Management Perspectives	Identifying ethical dilemmas and practical challenges associated with the integration of AI in Indonesian education and proposing context-specific solutions.	Critical literature review; content and thematic analysis; 2020-2024.	Key ethical issues: student data privacy, algorithmic bias, and academic integrity. Implementation challenges: infrastructure gaps (especially in remote areas), low digital literacy among teachers and students, and policy gaps (no comprehensive national guidelines yet). A holistic strategic management approach, teacher capacity-building, and the formulation of policies that prioritize equity are needed.
4	Ali (2025)	A Literature Review Using a Scoping Review Approach: Trends in the Use of AI in Elementary	Mapping trends in the use of AI in elementary school education in Indonesia.	Scoping review; 10 articles from Google Scholar and SINTA (2015-2025).	The most widely used AI technologies: educational chatbots, adaptive learning systems, and machine learning-based applications. The

No	Researcher	Title	Objective	Method	Findings
		School Education			use of AI has been shown to boost student motivation and engagement, as well as assist teachers in developing instructional materials and assessments. Challenges: the digital divide, data privacy, and teacher readiness.
5	Kuang et al. (2025)	Exploration of an Interdisciplinary Teaching Model in Primary Schools Supported by Generative Artificial Intelligence	Exploring the application of generative AI in interdisciplinary learning models in elementary schools.	Conceptual and theoretical study.	Generative AI can dynamically generate interdisciplinary learning materials tailored to students' progress and interests. AI serves as an intelligent assistant that provides real-time feedback, creates multimodal content (text, images, audio, simulations), and supports formative assessment and student development. The teacher's role shifts from that of an information provider to that of a facilitator and resource

No	Researcher	Title	Objective	Method	Findings
					integrator.
6	Bachtiar et al. (2024)	AI-Driven Learning: Transforming Educational Landscapes for the Future	Equipping educators with AI-powered tools to enhance teaching practices and student learning outcomes.	Training and mentoring (Community Service) for 50 vocational and senior high school teachers in Bogor; a descriptive qualitative approach.	AI plays a role in creating an inclusive and adaptive learning environment, facilitating collaborative learning, providing real-time feedback, and supporting teachers in designing digital-based lesson plans. Key challenges include infrastructure limitations, a lack of teacher training, and the digital divide.
7	Faresta (2024)	AI-Powered Education: Exploring the Potential of Personalised Learning for Students' Needs in Indonesia Education	Exploring the potential of AI to support students and teachers in personalized learning in Indonesia.	Systematic literature review.	AI-powered personalized learning effectively accommodates students' preferences and learning styles while improving academic performance. The Indonesian government has incorporated AI into its National AI Strategy Framework. Frameworks such as the Personalized Learning Plan

No	Researcher	Title	Objective	Method	Findings
					(PLP) and IDEE are necessary for ethical and effective integration. Challenges include a lack of focus on the development of practical skills, data bias, privacy concerns, and students' discomfort with AI-based assessments.
8	Siagian & Sofiyah (2024)	The Implementation of Artificial Intelligence in Developing the Learning Abilities, Competencies, and Creativity of Elementary School Students in the Digital Age	Examining the application of AI in developing elementary school students' learning abilities, competencies, and creativity in the digital age.	Literature review.	AI can enhance personalized learning, provide real-time feedback, and assist teachers in evaluating student progress. An example of its implementation is the educational game "Math Space Adventure" for teaching fractions, which improved learning outcomes by 32.79%. Challenges include data privacy, security, and the role of teachers in guiding students in the use of technology. Integrity and

No	Researcher	Title	Objective	Method	Findings
					ethical standards are essential in the use of AI.
9	Pardamean et al. (2022)	AI-Based Learning Style Prediction in Online Learning for Primary Education	Developing and assessing the impact of an AI-based learning style prediction model in an online learning portal for elementary school students.	An experiment using a collaborative filtering model based on matrix factorization; involving 322 elementary school students in grades 4-6 across three provinces in Indonesia.	The AI model developed performed well (RMSE 0.9035). There was a significant improvement in student learning outcomes between the pretest and posttest ($p < 0.05$). This model is capable of predicting learning styles without the need for a questionnaire, making it more objective. There has been a shift in students' learning styles from in-person learning to online learning.
10	Hastungkara & Triastuti (2019)	Application of E-Learning and Artificial Intelligence in Education Systems in Indonesia	Exploring the potential and impact of AI implementation in e-learning, as well as the readiness of factors influencing the education system and ICT in Indonesia.	Descriptive qualitative study using a constructivist approach; analysis of secondary data.	AI can create adaptive learning environments that tailor the pace of learning to the individual needs of students. The implementation of AI in e-learning in Indonesia faces challenges related to infrastructure (internet access, devices), human resources (teacher

No	Researcher	Title	Objective	Method	Findings
					competencies), and a learning culture that favors face-to-face interaction. Technical training for teachers and infrastructure improvements are needed.

Dimensions of Elementary School Students' Readiness for AI-Based Learning

Based on the analysis of ten research studies, the students' readiness for adopting AI-assisted learning in elementary schools involves three interdependent aspects: cognitive, affective, and behavioral. This statement corresponds with the theory offered by Dai et al. (2020), who claim that it is impossible to evaluate an individual's readiness for the AI era based solely on the level of his/her cognitive skills. The researchers emphasize that any assessment should involve such characteristics as motivation, positive attitude, and confidence in utilizing new technologies. In their experimental study, Pardamean et al. (2022) prove that AI-assisted learning style prediction models positively influence students' academic performance. It means that the development of behavioral readiness (the capability to work with AI systems) occurs concurrently with cognitive and affective improvements.

Moreover, according to Ali's (2025) results from the scoping review, the application of AI technologies, such as chatbots, adaptive learning technologies, and machine learning apps, in the educational process is predominantly prevalent among elementary schools. In addition to the need for conceptual knowledge, the use of such technologies presupposes the development of students' affective skills, including curiosity and intrinsic motivation, as well as their behavioral skills while working with the interface. Such results can be confirmed by Siagian & Sofiyah (2024), who revealed that the integration of AI through educational activities such as Math Space Adventure helped to increase students' learning efficiency by up to 32.79%. This result cannot be achieved without the affective and behavioral involvement of learners. Hence, the development of elementary students' readiness should be implemented from an integrative perspective.

Factors Influencing Elementary School Students' Readiness to Adopt AI

The review of ten papers suggests that the variables affecting the readiness of elementary school children may be classified into two major groups: internal variables and

external variables. Internal variables encompass the attitude of teachers toward AI technologies, teachers' TPACK (Technology Pedagogical Content Knowledge) skills, as well as the motivation and self-confidence of students themselves. According to the findings of Yulianto et al. (2025) in the SEM study with 516 elementary school mathematics teachers from Jakarta, internal variables play an extremely significant role in determining the utilization of AI technology in education ($\beta = 0.791$; $p < 0.001$). The results support the TAM theory proposed by Davis & Granić (2024), indicating that the perceptions of usefulness and usability of technology play a key role in its acceptance. To put it simply, the readiness of the former is dictated by that of teachers.

On the other hand, external influences such as policy supports, the provision of technology infrastructure, and parental/community participation will also be influential but their impact is more of an indirect one because it is dependent on internal influences. According to the study of Yulianto et al. (2025), external influences significantly impacted the adoption of AI only through internal influences ($\beta = 0.217$; $p < 0.001$). This conclusion conforms to the concept presented by the ecological model developed by Bronfenbrenner as adapted by Tong & An (2024) using the E-TPACK framework which postulates that the surrounding environment of an individual (family, school, policy) defines his/her readiness based on the internalization of individual potentials.

State of Infrastructure and School Ecosystem Support

According to an analysis of ten sources, the condition of technological infrastructure and the environment of the school ecosystem in Indonesia, especially in rural areas, poses a great challenge in terms of the readiness of the students attending primary schools in such regions. According to Hastungkara & Triastuti (2019), the factors responsible for creating problems in using AI in e-Learning in Indonesia include the digital divide, restrictions regarding hardware capabilities, and cost of access. In their critical review, Raharjo & Rohmadi (2025) further argue that along with physical infrastructural barriers, lack of digital literacy among both the students and teachers forms another major problem. It is stated that only about 45% of teachers in Indonesia possess digital competencies according to the national requirements as found by Salsabila & Asyifah (2025).

This finding is further emphasized by Faresta (2024), who points out that there are structural barriers to the incorporation of AI in Indonesian education, such as the lack of attention toward skill development, bias in data, and concerns about student privacy and security in data. Furthermore, Bachtiar et al. (2024) in their community service work have

discovered that the problem faced by teachers from SMK-SMAK Bogor is that they still lack sufficient training to access and use AI technologies.

Implications of the Findings for Elementary School Students' Readiness to Adopt AI

According to the above-mentioned discussion, there are several significant implications that policymakers, educators, and future researchers can take into consideration. Firstly, the readiness of elementary learners cannot be considered separately from the readiness of their teachers. In this case, professional development opportunities for teachers have to be sustainable and contextualized with special attention to TPACK competencies along with AI literacy skills. According to Salsabila & Asyifah (2025), there are three main directions of teacher training that should include integrating AI into the curriculum (84% of teachers need it), digital tools (79%), and AI ethics (75%).

Secondly, the creation of technological infrastructure should be matched with stricter regulations aimed at safeguarding students' privacy and data security. As Raharjo & Rohmadi (2025) warn, the introduction of AI could exacerbate inequalities and infringe upon the children's basic rights in the absence of an appropriate ethical code. According to UNESCO, there are five critical ethical principles, namely, equity and inclusiveness, fair algorithms and transparency, privacy and data security, accountability, and prioritization of human wellbeing. Therefore, the Indonesian government should promptly devise a set of guidelines for AI use in elementary education.

CONCLUSION

According to the review of the ten articles examined in this study, alongside a thorough discourse, some important conclusions can be drawn regarding the preparedness of elementary students for AI-based learning.

Second, children's readiness for elementary school involves three interdependent factors, namely the cognitive factor (knowledge about the basics of AI technology, understanding of simple algorithms, and awareness of the usage of AI technology in everyday life), the affective factor (positive attitudes towards technology, motivation to study, and self-confidence when using AI technology tools), and the behavioral factor (skills required for effective interaction with AI technology systems, such as the operation of technological devices and the implementation of digital processes). The three factors cannot be considered in isolation since readiness can only be considered complete when all three factors are developed simultaneously (Dai et al., 2020; Pardamean et al., 2022). Therefore, strategies designed to foster the readiness of children for elementary school should take into account not only the cognitive factor but also the other two factors.

Second, the factors influencing the readiness of elementary school students to adopt AI-based learning consist of internal and external factors. The most dominant internal factor is teacher readiness, which includes a positive attitude toward AI and TPACK (Technological Pedagogical Content Knowledge) competence. Yulianto et al. (2025) demonstrated that internal factors have a very strong direct effect on the utilization of AI in learning ($\beta = 0.791$; $p < 0.001$), which means that student readiness is largely determined by teacher readiness as the main facilitator. Meanwhile, external factors such as policy support, availability of technological infrastructure, as well as parental and community involvement also play an important role, although their influence is indirect through internal mediators ($\beta = 0.217$; $p < 0.001$). The implication is that policies focusing solely on the provision of hardware without being accompanied by the strengthening of teacher and parental capacity will not be optimal in building student readiness.

Third, the condition of infrastructure and school ecosystem support in Indonesia, particularly in rural and underdeveloped areas, remains a serious challenge. Hastungkara & Triastuti (2019) as well as Raharjo & Rohmadi (2025) identified that the internet access gap, limited hardware, low digital literacy among teachers and students, as well as the absence of a comprehensive national guideline on ethics and data security, constitute major barriers. Only about 28% of teachers actively use AI in learning, while 82% still rely on traditional pedagogical methods (Salsabila & Asyifah, 2025). This condition means that the potential of AI for personalized learning cannot be optimally utilized, especially in schools located far from city centers. Therefore, infrastructure development must be accompanied by the strengthening of regulations that protect student data privacy and security, as well as sustainable teacher training.

Fourth, in general, the level of readiness of elementary school students in Indonesia is still at an early stage and uneven. Although several studies have shown that the application of AI through educational game media and adaptive learning systems can significantly increase learning motivation, student engagement, and learning outcomes (Ali, 2025; Siagian & Sofiyah, 2024), widespread adoption remains hindered by infrastructure gaps, lack of teacher training, and immature supporting policies. Faresta (2024) added that challenges such as algorithmic bias, data privacy, and student discomfort with AI-based assessments also require serious attention. Thus, the readiness of elementary school students to adopt AI-based learning cannot be achieved instantly but requires a systematic, collaborative, and sustainable approach.

SUGGESTIONS

Based on the above conclusions, this study makes several recommendations. First, the central and local governments need to immediately develop comprehensive national guidelines on the integration of AI in elementary education, covering aspects such as curriculum, ethics, data privacy, and minimum infrastructure standards. Second, teacher training programs must be designed to be sustainable, contextual, and practice-based, with a focus on integrating AI into lesson plans, utilizing digital platforms, and the ethics of AI use. Third, further research is needed to explore the readiness of elementary school students in rural and 3T (frontier, outermost, and disadvantaged) areas, which have been underrepresented in the literature, as well as to develop valid and reliable readiness measurement instruments tailored to the local Indonesian context.

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