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Coding and Artificial Intelligence Learning to Improve Elementary School Students' Digital Literacy

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Abstract: The rapid advancement of digital technology has transformed the educational landscape and increased the need to strengthen digital literacy among elementary school students. In the Society 5.0 era, students are expected not only to use technology but also to understand, evaluate, and apply it responsibly. This study aims to analyze the role of coding and artificial intelligence learning in enhancing the digital literacy of elementary school students. A Systematic Literature Review method was employed by examining 11 scientific articles published between 2021 and 2026. Data were collected from various academic databases and analyzed using content analysis and thematic analysis to identify patterns, trends, and key findings related to the implementation of coding, AI, and digital literacy in elementary education. The findings indicate that coding and AI learning positively contribute to the development of students' digital literacy, computational thinking, critical thinking, creativity, problem-solving abilities, and other essential 21st-century skills. Coding activities help students understand the fundamental logic of digital technologies, while AI-based learning supports more adaptive, interactive, and personalized learning experiences. However, several challenges remain, including limited technological infrastructure, unequal access to digital resources, and insufficient teacher competence in integrating coding and AI into classroom instruction. The study concludes that coding and AI learning have significant potential to improve elementary school students' digital literacy and prepare them for future technological challenges. Therefore, strengthening teacher professional development, improving technological infrastructure, and developing supportive curricula are essential to ensure the effective and sustainable implementation of coding and AI education in elementary schools.

Keywords: Artificial Intelligence, Coding Learning, Digital Literacy, Elementary School

Introduction

The development of digital technology in the era of the Industrial Revolution 4.0 and Society 5.0 has driven significant changes in various aspects of life, including education. Digital transformation requires students not only to be able to use technology, but also to have the ability to understand, evaluate, and utilize technology critically and responsibly (Devi & Winangun, 2024). In the context of basic education, this ability is known as digital literacy, which is one of the essential competencies for preparing the younger generation to

face future challenges. Digital literacy is no longer limited to the ability to operate technological devices, but also encompasses critical thinking, digital communication, collaboration, creativity, and technology-based problem-solving skills (Salama et al., 2025). The results of the literature review indicate that strengthening digital literacy from elementary school is an urgent need to reduce the gap in students' digital skills and increase their readiness to face increasingly rapid technological developments (Egok, 2024).

One approach currently receiving attention in strengthening digital literacy is coding learning. Coding learning provides students with the opportunity to understand basic computer programming concepts through activities that train logic, creativity, and systematic thinking skills (Muhammad & Rahmaniar, 2025). Coding is not only oriented towards the ability to create computer programs, but also serves as a means of developing computational thinking, which involves the ability to identify problems, recognize patterns, abstract, and design structured solutions (Hamidi, 2026). A systematic review conducted by Nur & Nurhafidzah, (2025) showed that coding learning in elementary schools contributes to improving logical thinking, creativity, problem-solving, and 21st-century skills. Furthermore, the implementation of coding through platforms such as Scratch, Code.org, robotic coding, and unplugged coding has been shown to increase student engagement in the learning process.

Strengthening digital literacy is also increasingly relevant with the development of artificial intelligence (AI) technology. The presence of AI has transformed various sectors of life, including education, through various innovations such as adaptive learning, intelligent tutoring systems, learning analytics, and the development of interactive learning media (Gerasela, 2026). In the context of basic education, AI can be utilized to create a more personalized learning experience tailored to the needs of each student. Ginting, (2025) explains that the integration of AI in learning enables the creation of a more contextual learning ecosystem through the use of adaptive learning, intelligent tutoring systems, and augmented reality, which can strengthen students' learning processes. AI also functions as a digital literacy enhancer because it encourages students to understand how technology works and use it productively and responsibly (Itsnaini, 2025).

In line with these developments, the Indonesian government has begun to focus on implementing coding and artificial intelligence in primary education as part of its efforts to prepare competitive human resources for the digital era (Yanti, 2026). The integration of coding and AI is seen as a strategic step in developing 21st-century skills, including creativity, critical thinking, communication, collaboration, and digital literacy (Meiliyanthi, 2025). Muklason et al., (2023) state that introducing programming from elementary school age can be a new form of digital literacy that helps students understand technology more deeply and become more than just passive users. Coding learning also provides a fun learning experience through exploratory and project-based activities that align with the developmental characteristics of primary school children.

In addition to coding and AI, various digital learning innovations have also demonstrated positive contributions to improving students' digital literacy. Research by Zulqadri & Nurgiyantoro, (2023) found that the use of web-based interactive multimedia

can improve elementary school students' digital literacy skills through more engaging, interactive, and contextual learning. These findings demonstrate that utilizing digital technology in learning can be an effective means of improving learning quality while simultaneously building students' digital competencies from an early age.

Despite its potential, the implementation of coding and AI learning in elementary schools still faces various challenges. Several studies have revealed that limited technological infrastructure, gaps in teachers' digital competencies, unequal internet access, and a lack of teaching materials tailored to the characteristics of elementary school students are obstacles to implementing technology-based learning (Karengga, 2025; Salasa & Mutia, 2026; Sesmiarni, 2025). Furthermore, the development of AI has also raised various issues related to digital ethics, data security, and school readiness to integrate technology sustainably (Nur & Nurhafidzah, 2025; Salama et al., 2025), Therefore, a more in-depth study is needed to determine how coding and artificial intelligence learning can contribute to improving elementary school students' digital literacy.

Based on the above description, this study aims to analyze various research findings on coding and artificial intelligence learning in improving digital literacy in elementary school students through a literature review approach. This study is important to provide a comprehensive overview of the benefits, opportunities, and challenges of implementing coding and AI in elementary education. The results indicate that coding and artificial intelligence learning has the potential to improve digital literacy, computational thinking skills, creativity, problem-solving abilities, and various 21st-century skills needed by students to face future technological developments.

Methodology

This study uses a library research method with a Systematic Literature Review (SLR) approach to systematically review various studies that discuss coding learning and artificial intelligence (AI) in improving the digital literacy of elementary school students. The research data is in the form of secondary data obtained from scientific articles indexed in the Google Scholar, Garuda, ERIC, SINTA, Scopus, and DOAJ databases. The literature search process was carried out using keywords such as *coding learning* , *artificial intelligence* , *digital literacy* , computational *thinking* , and *elementary school* . The selected articles were limited to publications from 2021–2026, available in *full text* , and relevant to the research topic. Literature selection was carried out through the stages of identification, screening, feasibility assessment, and determining the final articles that met the inclusion criteria. Based on this process, 11 scientific articles were obtained which were used as the main sources in the research analysis.

Data analysis was conducted using content analysis and thematic analysis techniques. Each article was analyzed based on the research objectives, methods used, and key findings related to the implementation of coding, artificial intelligence, and digital literacy in elementary schools. Furthermore, data with similar meanings were grouped into key themes to identify patterns of relationships, similarities, and differences in the research results. Research validity was maintained through source triangulation by comparing

findings from different articles to obtain a more comprehensive and objective synthesis. All data used came from openly accessible scientific publications, allowing the research process to be replicated by other researchers. Because this study only used secondary data from published documents and did not directly involve human or animal subjects, it did not require ethical *clearance*.

Results and Discussion

Based on the results of a literature study of eleven articles discussing coding and artificial intelligence (AI) learning in the context of basic education, a synthesis of research results was obtained as presented in Table 1.

Table 1. Synthesis of Research Results on Coding and Artificial Intelligence Learning to Improve Elementary School Students' Digital Literacy

No	Researchers and Years	Research Focus	Key Findings
1	Fadiana et al., (2025)	Coding and AI training to improve digital literacy	Digital literacy increased by 52.5%; digital knowledge by 41.9%; computational thinking by 47.5%; and AI understanding by 68.2%. Eighty-seven percent of participants were able to integrate Scratch and AI into their learning.
2	Nasution & Aslan, (2025)	Integration of coding and AI in elementary school curriculum	The integration of coding and AI can enhance 21st-century skills such as critical thinking, creativity, collaboration, and digital literacy.
3	Awaluddin & Hadi, (2025)	Challenges and opportunities for integrating coding and AI in elementary school	Coding and AI learning enhances students' creativity, computational thinking, and technological literacy.
4	Ginting, (2025)	AI-based digital literacy for contextual learning	AI supports adaptive learning and personalization of learning, thereby strengthening students' digital literacy.
5	Widyawati et al., (2025)	Implementation of AI coding sheets in elementary school	Improve digital literacy, critical thinking skills, creativity, learning motivation, and student engagement in learning.
6	El Akbar et al., (2025)	Digital literacy, coding, and AI training	Improving the ability to use digital technology, self-confidence in utilizing technology, and producing digital learning tools.
7	Rustiyana, (2025)	AI integration in coding curriculum	AI enhances learning effectiveness through personalization, cognitive scaffolding, and strengthening students' communication skills.
8	Situmorang et al., (2025)	The role of schools in improving AI digital literacy	AI digital literacy improves students' conceptual understanding, digital skills, and readiness for the digital era.
9	Prasetyo & Patmisari, (2024)	Technology-based learning media	The use of technological media improves students' ability to operate digital devices and supports the development of digital literacy.

No	Researchers and Years	Research Focus	Key Findings
10	Celik et al., (2024)	The impact of learning coding and AI	The research shows that coding and AI contribute to improving digital literacy, critical thinking, creativity, problem solving, and 21st-century skills.

Based on the synthesis of research results in Table 1, four main themes can be identified that consistently emerge in various studies, namely: (1) increasing students' digital literacy, (2) developing computational and critical thinking skills, (3) increasing creativity and 21st century skills, and (4) implementation challenges in the form of limited infrastructure, teacher competency, and gaps in access to technology.

Coding and Artificial Intelligence Learning Improves Elementary School Students' Digital Literacy

The synthesis of various studies shows that coding and artificial intelligence learning has a significant contribution to improving the digital literacy of elementary school students. Digital literacy is no longer defined solely as the ability to use technological devices, but rather includes the ability to understand, access, evaluate, process, and produce information through digital media effectively and responsibly. Coding learning provides students with hands-on experience in understanding how technology works through simple programming activities, while artificial intelligence introduces students to smart technologies that are increasingly used in everyday life. Research findings by Fadiana et al. (2025) showed a 52.5% increase in digital literacy after implementing coding and AI training. These results indicate that technology-based learning can improve students' understanding of digital concepts while building their ability to utilize technology productively. This finding is supported by research by Prasetyo and Patmisari (2024) which shows that the use of technology-based learning media can help students master basic digital skills that form the foundation for developing digital literacy at the next level. Furthermore, research by Situmorang et al. (2025) explains that the application of artificial intelligence in the school environment has a positive impact on improving students' understanding of technological concepts and digital skills. Thus, learning coding and AI can be an effective means of preparing students to face the increasingly complex demands of a digital society.

Coding and AI Learning Develops Computational and Critical Thinking Skills

One of the most dominant findings in various studies is the improvement of students' computational thinking and critical thinking skills through coding and AI learning. Computational thinking skills include the process of identifying problems, analyzing patterns, developing algorithms, and systematically generating solutions. This ability is crucial in the digital age because it helps students understand how technology works and solve problems logically. Research by Fadiana et al. (2025) showed a 47.5% increase in computational thinking skills after participants received Scratch-based coding training.

These results indicate that programming activities can train students to think in a structured and systematic way. Similar findings were also found by Awaluddin and Hadi (2025), who stated that coding and AI learning can improve computational thinking skills and technological literacy in elementary school students. Furthermore, research by Widyawati et al. (2025) showed that project-based AI coding learning encourages students to solve various problem-solving challenges independently and collaboratively. This process indirectly trains students' critical thinking skills because they are required to analyze problems, find alternative solutions, and evaluate the results of their work.

Coding and AI Learning Supports 21st Century Skill Development

Research findings also indicate that learning coding and artificial intelligence contributes to the development of 21st-century skills, including creativity, collaboration, communication, and problem-solving. These skills are essential competencies for students to face the challenges of the Industrial Revolution 4.0 and Society 5.0. Nasution and Aslan (2025) stated that integrating coding and AI into the elementary school curriculum can strengthen students' critical thinking, creativity, collaboration, and digital literacy skills. Coding learning provides students with the opportunity to create simple digital products such as animations, educational games, and interactive simulations. These activities encourage students to think creatively while developing communication skills through presentations of their work. Furthermore, research by Rustiyana (2025) shows that the use of AI in learning can improve students' communication and presentation skills better than conventional learning. This occurs because AI enables a more personalized learning process, allowing students to learn according to their individual needs and pace. Thus, the integration of coding and AI not only improves technical skills but also supports the development of students' social and emotional competencies.

Challenges of Implementing Coding and Artificial Intelligence Learning in Elementary Schools

Despite its numerous benefits, the implementation of coding and artificial intelligence learning in elementary schools still faces various challenges. Studies show that limited technological infrastructure is the most frequently encountered obstacle. Not all schools have adequate computer equipment, internet connections, or access to digital learning applications to support coding and AI learning. In addition to infrastructure, teacher competency is also a major challenge. Research by Awaluddin and Hadi (2025) shows that many teachers still lack an adequate understanding of coding and AI, thus experiencing difficulties integrating these technologies into their learning. Similar findings were also presented by Situmorang et al. (2025), who emphasized the importance of ongoing training for teachers to effectively implement digital technology. Furthermore, Ginting (2025) highlighted challenges related to data privacy and the ethical use of AI in education. As the use of artificial intelligence technology increases, schools need to ensure that student data is protected and that technology is used responsibly. Therefore, the successful implementation of coding and AI learning requires policy support, increased teacher

capacity, adequate infrastructure, and the development of ethical guidelines for technology use in schools.

Implications of Coding and Artificial Intelligence Learning for Improving Digital Literacy

Based on the overall research results analyzed, it can be concluded that coding and artificial intelligence learning have very positive implications for improving the digital literacy of elementary school students. This learning helps students develop the ability to use technology productively, think critically, solve problems, collaborate, and create simple digital innovations. Furthermore, the integration of coding and AI also contributes to preparing the younger generation to face the increasingly rapid technological developments. Through systematically designed learning tailored to the characteristics of elementary school students, coding and AI can be an effective means of developing a generation that is adaptive, creative, and has strong digital competencies. Therefore, the integration of coding and artificial intelligence learning needs to be continuously developed as part of the strategy to improve the quality of basic education in Indonesia towards the realization of the Golden Generation 2045.

Conclusion

Based on the findings of this literature review, coding and artificial intelligence (AI) learning play a significant role in enhancing the digital literacy of elementary school students. The integration of these two approaches not only enables students to understand and utilize digital technology more effectively but also fosters computational thinking, critical thinking, creativity, collaboration, communication, and problem-solving skills that are essential for the 21st century. Coding and AI-based learning encourage students to move beyond being passive users of technology and become active creators capable of developing innovative digital solutions. The findings of this review have important implications for elementary education. Integrating coding and AI into the curriculum can serve as an effective strategy for preparing students to meet the demands of an increasingly digital society and workforce. Furthermore, these approaches can contribute to the development of future-ready learners who are adaptable, innovative, and responsible in their use of technology. Therefore, educational stakeholders should prioritize the provision of adequate technological infrastructure, continuous professional development programs for teachers, and curriculum frameworks that support the integration of coding and AI learning from an early age.

Despite its potential, the successful implementation of coding and AI education still faces challenges, including disparities in technology access, limited resources, and variations in teacher readiness. To address these issues, collaboration among governments, schools, communities, and educational institutions is essential to create an inclusive and sustainable digital learning ecosystem. For future research, empirical studies involving larger and more diverse samples are recommended to examine the long-term effects of coding and AI learning on students' digital literacy and academic achievement. Further

investigations may also explore effective instructional models, assessment strategies, and teacher professional development programs that can support the successful implementation of coding and AI education in elementary schools. Through these efforts, coding and AI learning can become a transformative educational approach that equips future generations with the competencies needed to thrive in the digital era.

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