

Artificial Intelligence Integration in Learning Transformation in the Digital Era

Citra Putri Afilia¹✉ and Muhammad Qadhrizbullah²

Universitas PGRI Yogyakarta, Yogyakarta, Indonesia¹; Universitas Ahmad Dahlan, Yogyakarta, Indonesia²

ABSTRACT

The development of Artificial Intelligence (AI) has driven significant transformations in education, particularly in learning processes within the digital era. The utilization of AI offers various opportunities to create learning environments that are more adaptive, personalized, and responsive to students' needs. This study aims to analyze the role of AI in learning transformation, identify challenges in its implementation in education, and formulate strategies for integrating AI to improve learning quality and strengthen students' competencies. The study employed a qualitative approach using a library research method by reviewing scientific articles, books, conference proceedings, and policy documents published in the last five years. The findings indicate that AI integration contributes to the development of more flexible, interactive, and personalized learning through the use of chatbots, generative AI, learning analytics, and adaptive learning systems. Furthermore, AI supports the enhancement of twenty-first-century competencies, including critical thinking, creativity, communication, collaboration, and digital literacy. However, AI implementation still faces several challenges, such as limited technological infrastructure, unequal digital competencies among educators, and issues related to ethics and data privacy. Therefore, strengthening digital competencies, developing AI literacy, and establishing policies and ethical guidelines are necessary to support inclusive, innovative, and sustainable learning transformation.

Keywords: *Artificial Intelligence, Digital Literacy, Educational Transformation, Learning, Twenty-First-Century Competencies.*

CORRESPONDING AUTHOR:

Citra Putri Afilia
Universitas PGRI Yogyakarta, Yogyakarta, Indonesia
contact: citra49@gmail.com

ARTICLE HISTORY

Received : June 20, 2025
Final Revised : November 28, 2025
Accepted : December 15, 2025
Published : December 30, 2025

1. | INTRODUCTION

The development of digital technology has encouraged transformation in various sectors of life, including the education sector. The technological revolution marked by the emergence of artificial intelligence (AI) has brought fundamental changes to the way of learning, teaching, and managing the educational process. AI is no longer seen as a mere technological innovation, but has become part of the education ecosystem that is able to support personalized learning, improve the efficiency of education management, and expand access to more adaptive and interactive learning resources (Chen et al., 2020; Wang et al., 2024).

The use of AI in education is gaining more attention as various applications based on machine learning, chatbots, learning analytics, and generative AI are developed that are able to help students and educators in the learning process (Tlili et al., 2023; Ghimire et al., 2024). Various studies show that AI integration allows the learning process to take place more flexibly, personalized, and responsive to the individual needs of learners so as to increase the effectiveness of learning and the overall learning experience (Zawacki-Richter et al., 2019; Wang et al., 2024).

The transformation of education in the digital era also requires a change in the learning paradigm. 21st century learning no longer focuses on one-way knowledge transfer, but leads to the development of critical thinking skills, creativity, communication, collaboration, and the ability to solve complex problems. These competencies are important capital for students in dealing with the dynamics of life and technological developments that take place very quickly (Ali et al., 2020; Cholilah et al., 2023). Therefore, the education system needs to develop a learning approach that is able to integrate digital technology in a meaningful way and encourage students to become lifelong learners.

In this context, AI has great potential to support learning transformation. Various AI-based learning platforms are able to provide material recommendations that suit students' learning needs, provide automatic feedback, and assist educators in evaluating learning more efficiently (Karyadi, 2023; Shiddiq, 2020). In addition, curriculum development in the digital era has also begun to accommodate technological literacy, data literacy, and digital literacy as essential competencies that students need to possess (Kim et al., 2021; UNESCO, 2021).

The development of AI has also encouraged the transformation of curriculum and learning to be more relevant to future demands. The curriculum in the digital era is required to be more adaptive, flexible, and competency-oriented so that it is able to prepare students to face social and technological changes that take place dynamically (Liriwati, 2023; Suharyo et al., 2023). The implementation of AI-based learning also opens up opportunities for the creation of more inclusive learning through the provision of learning resources that are widely accessible and tailored to the characteristics of students (Yahya et al., 2023; Rosyidi & Firdaus, 2024).

Nevertheless, the use of AI in education is inseparable from various challenges. Gaps in technology infrastructure, uneven digital competence of educators, and low AI literacy are still obstacles in the process of implementing this technology in various education units (Sukma et al., 2020; Karyadi, 2023). In addition, the use of AI also raises various ethical issues related to data security, privacy, algorithmic bias, academic integrity, and the potential dependence of students on technology (Porayska-Pomsta et al., 2024; UNESCO, 2023).

Therefore, the integration of AI in education requires comprehensive planning through strengthening educators' digital competence, developing adaptive policies, and drafting ethical guidelines for the use of AI in the learning process (UNESCO, 2021; Porayska-Pomsta et al., 2024). With proper management, AI can be a strategic instrument in supporting learning transformation and improving the quality of education in the digital era. Based on this description, this study aims to analyze the role of AI in learning transformation, identify various challenges in its implementation in education, and formulate AI integration strategies to improve the quality of learning and strengthen the competencies of students in the digital era.

2. | RESEARCH METHOD

This research uses a qualitative approach with the library research method. Literature study is a research method that is carried out through searching, collecting, studying, and analyzing various relevant literature sources to gain a comprehensive understanding of a particular phenomenon or problem. This approach was chosen because the research focuses on a conceptual study of the integration of Artificial Intelligence (AI) in education, learning transformation in the digital era, as well as various opportunities and challenges in its implementation in improving the quality of learning and student competence. Through literature studies, researchers can identify the development of thought, find various theoretical perspectives, and synthesize the results of previous research related to the use of AI in education.

The data sources in this study consist of secondary data obtained from various scientific literature, including national and international journal articles, seminar proceedings, scientific books, reports of international institutions, and education policy documents relevant to the research theme. The literature used is limited to publications for the 2020–2024 period so that the resulting discussion reflects the latest developments regarding the use of AI in the field of education and learning transformation in the digital era. Literature search is carried out systematically through scientific databases and academic search engines, especially Google Scholar, using keywords such as artificial intelligence in education, generative artificial intelligence, digital transformation in education, digital literacy, twenty-first century skills, AI ethics in education, and educational technology. The selection of sources is carried out based on the relevance of the topic, the credibility of the publisher, the novelty of the publication, and the suitability of the substance with the focus of the research.

Data collection techniques are carried out through identification, selection, classification, and documentation of various literature sources that have met the research inclusion criteria. The collected literature is then read critically to find concepts, theories, empirical findings, and arguments related to the role of AI in supporting the learning process, developing student competencies, educators' digital competencies, as well as ethical and governance aspects of the use of AI in education. Furthermore, the data is analyzed using content analysis techniques through the stages of data reduction, data presentation, interpretation, and conclusion drawn. In the reduction stage, information obtained from various literature is selected and focused on the main themes of the research. The next stage is to present data in a descriptive and systematic manner so that the relationship between concepts can be understood in its entirety. Furthermore, the researcher interprets and synthesizes the various findings obtained to produce a comprehensive understanding of the integration of AI in education. Through this procedure, this research is expected to be able to provide an in-depth conceptual overview of AI-based learning transformation and offer an academic foundation for the development of educational policies and practices in the digital era.

3. | RESULTS AND DISCUSSION

The development of Artificial Intelligence (AI) has become one of the main factors driving educational transformation in the digital era. Advances in information and communication technology have changed the educational paradigm from teacher-centered learning to more flexible, adaptive, and student-centered learning. In this context, AI is no longer understood simply as a technological innovation, but as an instrument that can support improving the quality of the learning process through more effective data management, personalization of learning, and the provision of various more interactive learning resources (Chen et al., 2020; Wang et al., 2024). These developments show that the use of AI in education has entered an increasingly widespread implementation phase and is an important part of the transformation of the modern education system.

The integration of AI in education allows for the creation of more personalized learning that is responsive to the needs of students. Various AI-based systems are able to analyze the abilities, characteristics, and learning development of individual students so that learning materials, learning activities, and evaluation forms can be adjusted to the needs of each student (Zawacki-Richter et al., 2019; Wang et al., 2024). These conditions suggest that AI has the potential to reduce the uniform approach to learning and replace it with a more adaptive learning experience. In addition, AI is also able to provide feedback quickly and continuously so that students can make improvements to their learning process independently.

The development of generative AI has also expanded the use of AI in the learning process. The presence of chatbots, virtual assistants, and various generative AI-based applications provides opportunities for learners to obtain learning support more flexibly without being limited by space and time (Tlili et al., 2023; Ghimire et al., 2024). These

various technologies can be used to help students understand the material, obtain additional explanations, compile learning summaries, and develop critical thinking skills through more dynamic interactions. On the other hand, the use of generative AI can also help educators in developing learning tools, developing learning media, and producing a variety of questions and evaluation materials more efficiently (Kasneci et al., 2023).

The transformation of AI-based learning is in line with the demands of 21st century education that emphasizes mastery of high-level thinking competencies, creativity, communication, collaboration, and problem-solving skills. Education is no longer oriented to information mastery alone, but is directed at the ability of students to manage, analyze, and utilize information to produce various innovative solutions (Ali et al., 2020; Cholilah et al., 2023). Therefore, the integration of AI in learning needs to be seen as part of efforts to strengthen 21st century competencies and develop human resources that are adaptive to technological changes.

The use of AI in learning is also closely related to strengthening digital literacy, data literacy, and technology literacy. Literacy is a fundamental competency needed by students to be able to actively participate in the digital society. UNESCO (2021) emphasizes that education in the digital era requires the ability of students to understand, evaluate, and utilize technology responsibly. The development of digital literacy is becoming increasingly important because AI presents various forms of information that must be interpreted critically and ethically. Thus, the integration of AI in learning is not only oriented towards mastery of technology, but also on the formation of reflective and responsible thinking skills in utilizing technology.

From a curriculum perspective, the development of AI encourages the need to transform learning design to be more adaptive and relevant to the changing times. The curriculum in the digital era is required to provide a wider space for the development of competence, creativity, and problem-solving skills through the meaningful use of technology (Liriwati, 2023; Cholilah et al., 2023). Curriculum transformation is not enough to be done through the addition of technology materials alone, but also through changes in learning approaches that allow students to obtain a contextual, collaborative, and problem-solving-based learning experience.

The integration of AI in the curriculum also opens up opportunities for the development of more inclusive learning. The use of technology allows the availability of various learning resources that can be accessed by students with different characteristics and needs. Various AI-based learning platforms are able to provide learning materials in various forms, such as text, audio, video, and interactive simulations that can increase student involvement in the learning process (Kim et al., 2021; Rosyidi & Firdaus, 2024). This condition shows that AI can be a means to expand access to education and support equitable distribution of learning quality.

In addition to these opportunities, the implementation of AI in education still faces a number of challenges. One of the main challenges has to do with the readiness of

technological infrastructure. The use of AI requires the support of digital devices, internet networks, and adequate data management systems. Limited infrastructure can hinder the implementation of AI and create a gap in access to educational technology (Sukma et al., 2020; UNESCO, 2023). Therefore, AI-based education transformation needs to be accompanied by efforts to strengthen infrastructure and equitable access to technology so that the benefits of AI can be felt more widely.

Another challenge is related to the digital competence of educators. The role of educators in the AI era has undergone significant changes. Educators no longer function as the only source of knowledge, but play the role of facilitators, mediators, and mentors in the learning process (Yahya et al., 2023; Suharyo et al., 2023). This condition requires educators to have the ability to select, use, and evaluate various learning technologies appropriately. However, various studies show that educators' digital competencies are still uneven, so various sustainable professional development programs are needed (Karyadi, 2023; Sukma et al., 2020).

In addition to technical competence, the use of AI in education also raises various ethical issues. The use of generative AI can pose risks in the form of plagiarism, misuse of information, dependence on technology, and decreased ability to think independently if it is not balanced with strengthening digital literacy and academic ethics (Porayska-Pomsta et al., 2024; Kasneci et al., 2023). In addition, AI systems also have the potential to produce algorithmic biases that can affect the quality of recommendations and decision-making processes in learning. These problems show that the implementation of AI in education not only requires technological readiness, but also requires strengthening ethical and regulatory aspects.

UNESCO (2023) emphasized that the development of policies for the use of AI in education must pay attention to the principles of fairness, inclusivity, transparency, and the protection of user privacy. In line with this, Porayska-Pomsta et al. (2024) explain that the use of AI in education needs to be directed to strengthen the role of humans in the learning process, not to replace it entirely. Thus, the implementation of AI must be based on the principle of human-centered education that places learners and educators as the main subjects in the educational process.

Based on these findings, it can be understood that the integration of AI in education presents a great opportunity to increase learning effectiveness, expand access to learning resources, and strengthen 21st century competency development. However, the success of its implementation is highly determined by the readiness of infrastructure, digital competence of educators, strengthening AI literacy, and the availability of adequate ethical policies and guidelines. Therefore, AI-based education transformation needs to be carried out in a planned, collaborative, and sustainable manner through synergy between educators, educational institutions, the government, and various other stakeholders. With this approach, AI can be optimally utilized as a strategic instrument to realize learning that is more adaptive, inclusive, and relevant to educational needs in the digital era.

4. | CONCLUSION

The development of Artificial Intelligence (AI) has driven a significant transformation in the world of education. The integration of AI in learning provides a variety of opportunities to create a more adaptive, personalized, and needs-oriented educational process for learners. The use of AI technology allows for more flexible learning through the provision of diverse learning resources, rapid feedback, and the development of more interactive and contextual learning experiences. The presence of AI also contributes to strengthening 21st century competencies, such as critical thinking skills, creativity, communication, collaboration, digital literacy, and problem-solving skills needed to face social change and technological developments in the digital era.

Nonetheless, the implementation of AI in education still faces various challenges that require serious attention. Limited technological infrastructure, uneven digital competence of educators, low AI literacy, and various ethical issues such as data privacy, academic integrity, and potential algorithm bias are factors that can affect the effectiveness of the application of AI in the learning process. Therefore, the use of AI cannot be done partially, but rather requires comprehensive and continuous planning.

Efforts to integrate AI in education need to be supported through strengthening educators' digital competence, developing AI literacy for students, providing adequate infrastructure, and drafting clear policies and ethical guidelines. Through synergy between various stakeholders, AI can be optimally utilized as a strategic instrument to support learning transformation and improve the quality of education that is more inclusive, innovative, and relevant to the demands of the digital era.

Acknowledgment

We gratefully acknowledge the contributions of individuals who supported the completion of this article.

Funding Information

This research did not receive any funding.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Ethical Approval and Originality Statement

Ethical approval was obtained for this study. The manuscript represents original work and has not been previously published, nor is it under consideration by another journal.

Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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