Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

JPE
Journal of Primary Education

INTEGRATION OF ARTIFICIAL INTELLIGENCE IN LEARNING: ENHANCING PERSONAL LEARNING IN PRIMARY AND SECONDARY EDUCATION

Faiz Akmal Baihaqi[1]
[1] *Universitas KH. Mukhtar Syafaat, Banyuwangi*
http://dx.doi.org/10.29300/jpe.v5i2.8350

Article history:
Received 05-06-2025
Revised 10-08-2025
Accepted 15-09-2025

Keywords:
Artificial Intelligence, Personalized Learning, Primary Education, Secondary Education, Educational Technology

Abstract
The rapid development of digital technology and the increasing need for learning that is responsive to individual differences pose new challenges in the world of education, especially at the elementary and secondary school levels. Social facts show that many students still experience gaps in understanding the material due to uniform and adaptive learning approaches. This study aims to examine the potential for integrating artificial intelligence (AI) in increasing the effectiveness of personalized learning as a solution to these challenges. This study uses a literature review method by analyzing scientific literature, policy reports, and case studies related to the application of AI in education. The results of the study show that AI can support personalized learning through analysis of student learning data, automatic content adjustment, and provision of fast and targeted feedback. AI also plays a role as a tool for teachers to manage classes more efficiently. However, the implementation of AI requires policy support, teacher training, and attention to private content and equality of access to technology. The implications of this study suggest that AI integration, if implemented wisely, can narrow the Learning gap and drive a more inclusive, adaptive, and data-driven Education transformation.

Corresponding Author:
Faiz Akmal Baihaqi
Universitas KH. Mukhtar Syafaat, Banyuwangi
Email: faizakmalbaihaqi@gmail.com

Introduction

Primary and secondary education in Indonesia currently faces major challenges in meeting students' individual learning needs. Differences in students' learning styles, interests, cognitive abilities, and socio-economic backgrounds demand a more personal and adaptive learning approach. However, the reality on the ground shows that the national education system tends to still prioritize a uniform learning model that is not sufficiently accommodating to this diversity (Mu'alina & Husain, 2024). Teachers are often overwhelmed in managing class heterogeneity with a large number of students, while curriculum pressures force them to pursue learning targets without enough room for

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

differentiation (Husain, 2023). In the midst of these conditions, the integration of artificial intelligence (AI) has emerged as a promising alternative solution, because AI is able to collect and analyze student learning data in real-time, then present materials that are appropriate to the needs of each individual. A study by UNESCO shows that more than 53 percent of school-age children in developing countries have not achieved basic reading skills. This reflects the failure of the system to accommodate personal learning needs (UNESCO, 2021a). Meanwhile, the OECD report, (2022) confirms that personalized technology-based learning can increase student motivation and engagement. Research by Holmes and colleagues in the journal Computers & Education shows an increase in academic achievement of up to 30 percent in students who participated in an AI-based adaptive learning program (Holmes et al., 2021). These facts underline the urgency of further exploration into the use of AI in creating more effective personalized learning at the primary and secondary education levels.

Scientific studies on the integration of artificial intelligence in education have increased significantly in the past five years, but most of them still focus on the context of higher education. Technologies such as learning chatbots, material recommendation systems, and adaptive learning platforms have been widely studied in university settings. Meanwhile, the application of AI in primary and secondary education is still relatively limited, both in terms of the number of studies and direct application in the classroom. In fact, the characteristics of learners at the primary and secondary levels are fundamentally different from those of university students, especially in terms of cognitive development, socio-emotional needs, and dependence on teacher support. Research by Zawacki-Richter and colleagues shows that more than 70 percent of AI studies in education are concentrated in higher education (Zawacki-Richter et al., 2019). Luckin et al., emphasize that AI systems for children must be designed with their pedagogical and psychological development in mind (Luckin et al., 2021a). In addition, Holmes and colleagues highlighted the lack of empirical evidence on the long-term impact of implementing AI in personalized learning in primary and secondary schools. (Holmes, Tuomi, et al., 2022) Meanwhile, Rolim and Isotani identified that most research still focuses on the technical side of system development, rather than the social and pedagogical context of its use (V. Rolim & Isotani, 2021). This gap is an important opportunity to develop a more holistic study of how AI can be effectively implemented to support personalized learning in primary and secondary education. This study aims to explore how artificial intelligence can be integrated into the learning process to support a more personalized approach in primary and secondary education.

The main focus of this study is to understand the extent to which AI can be used to adapt learning materials to the individual needs of students, and how AI helps teachers in designing adaptive and inclusive learning strategies. The main questions to be answered

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

are: how can AI be effectively implemented in primary and secondary schools to facilitate personalized learning? What are the technical, pedagogical, and ethical challenges that may arise in the implementation process? And how do teachers and students perceive the use of this technology in daily learning? These questions are important to answer considering that the implementation of technology in education is not always linear and free from obstacles. A study by Chen et al., noted that teachers often have difficulty understanding and utilizing AI systems due to minimal training and technical support (Chen et al., 2020). Meanwhile, Zhang and Aslan found that AI-based personalized learning can increase learning engagement and retention, but the results are highly dependent on system design and local contextualization (Zhang & Aslan, 2021). Thus, this study is directed at building a comprehensive understanding of the role of AI in improving the quality and effectiveness of personalized learning at the elementary and secondary levels.

The integration of artificial intelligence in elementary and secondary education has great potential to improve the quality of personalized learning, but its success is largely determined by pedagogical readiness, technological infrastructure, and supporting regulations. AI is not an autonomous entity that can replace the role of teachers, but rather a tool designed to strengthen the teacher's function in identifying student needs and providing appropriate responses. AI can detect student learning patterns, provide instant feedback, and adjust learning materials automatically. However, challenges such as algorithmic bias, student data security, and the digital divide between schools are important issues that should not be ignored. A study by Baten et al. (2021) in AI & Society shows that the use of AI in education must be accompanied by a precautionary principle, because the risk of algorithmic discrimination is very likely if the data used is not representative. Meanwhile, Wang and colleagues proved that personalizing learning with AI can improve elementary school students' mathematics learning outcomes by up to 25 percent, but this effectiveness is only achieved if teachers are actively involved in the process (Wang et al., 2022). Research by Lim et al. also emphasized that collaboration between AI and teachers provides more consistent and sustainable learning outcomes (Lim, Wang, & Tay, 2023). Therefore, the tentative answer to this research question suggests that the success of AI integration in personalized learning lies in a hybrid approach that balances technological sophistication with pedagogical humanism.

Method

This study uses a qualitative approach with a literature review type (library research). This approach was chosen because the main focus of the study is to examine and synthesize theories, empirical findings, and academic discourses related to the integration of artificial intelligence in learning at the primary and secondary education levels. The literature review

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

provides a framework for understanding the dynamics of AI utilization conceptually and practically, without involving direct field data collection (Snyder, 2019).

This type of research is a systematic literature study conducted in a structured and planned manner, to ensure the completeness and accuracy of the review of relevant scientific sources (Xiao & Watson, 2019). The literature reviewed includes reputable international journal articles, policy reports, academic books, and publications from global educational institutions, published in the last five years (2019–2024).

The research stages are carried out in several steps. First, a literature search is carried out through databases such as Scopus, Web of Science, and Google Scholar using keywords such as "artificial intelligence in education," "personalized learning," and "AI in primary and secondary education." Second, a selection and critical evaluation of relevant literature is carried out based on its topic, methodology, and contribution. Third, researchers carry out thematic categorization and synthesis of the study results to identify research trends, challenges, and gaps (Booth et al., 2021). These steps refer to systematic guidelines developed in academic literature studies (Kitchenham & Charters, 2007).

Result dan Discussion

Potential of Artificial Intelligence Integration in Personal Learning

The integration of artificial intelligence (AI) into personalized learning in primary and secondary education offers revolutionary potential in addressing the challenges of student heterogeneity. AI enables real-time learning data analysis that can identify the needs, learning styles, and levels of understanding of each individual student. With this capability, AI can automatically adjust learning content, provide fast and relevant feedback, and facilitate more adaptive and responsive learning.

Holmes et al., (2021) in the journal Computers & Education reported that AI-based adaptive learning programs can increase student academic achievement by up to 30 percent, demonstrating the effectiveness of AI in improving learning outcomes. In addition, the OECD, (2022) emphasized that personalized technology-based learning can increase student motivation and engagement, which are important factors in long-term learning success. Research by Woolf et al., (2013) also highlighted how intelligent tutoring systems can adjust teaching strategies based on student interactions, thereby increasing learning effectiveness.

Furthermore, Luckin et al., (2016) emphasized that AI can help overcome teachers' limitations in managing heterogeneous classes by providing in-depth analytical data on student learning progress. This allows teachers to make more timely and personalized interventions. Research from Heffernan & Heffernan, (2014) also shows that adaptive

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

learning systems can increase student engagement by providing materials that are tailored to their needs, thereby reducing boredom and increasing learning focus. In addition, AI can expand access to quality learning resources through digital platforms that can be accessed anytime and anywhere, supporting independent and flexible learning ((Chen et al., 2020). Thus, AI not only improves the effectiveness of learning, but also contributes to more inclusive access to education.

Challenges of AI Implementation in Primary and Secondary Education

Despite the enormous potential of AI, its implementation in primary and secondary education faces various complex challenges. One of the main challenges is the readiness of technological infrastructure. Many schools, especially in remote and less developed areas, still face limited access to adequate internet and digital devices (World Bank, 2020; UNESCO, 2021). This digital divide has the potential to widen the gap in educational inequality if not addressed systematically.

From a pedagogical perspective, teachers often have difficulty understanding and operating AI technology. Chen et al., (2020) noted that the lack of training and technical support is a major obstacle to the use of AI in the classroom. This is reinforced by a study by Selwyn, (2019) which shows that resistance to new technologies often arises due to teachers' lack of understanding and trust in the effectiveness of AI. Therefore, ongoing teacher training and adequate technical support are essential for AI to be optimally integrated.

Ethical aspects are also a major concern. Student data privacy and security must be strictly maintained to prevent misuse of personal information (Baten et al., 2021; Mittelstadt, 2019)). The risk of algorithmic bias is also a critical issue, where AI algorithms can reinforce discrimination if the data used is not representative or if the system design does not take into account social and cultural diversity (Eubanks, 2018; O'Neil, 2016). Therefore, transparency and auditing of algorithms are important steps in ensuring fairness and accountability for the use of AI in education. In addition, contextual challenges such as cultural differences, language, and local needs must also be considered in the design and implementation of AI systems (Luckin et al., 2021b; Zawacki-Richter et al., 2019). AI systems that are not sensitive to local contexts risk failing to effectively meet students' needs.

The Role of Teachers in a Hybrid Approach of AI and Personal Learning

The role of teachers remains central to the integration of AI in primary and secondary education. AI is not a substitute for teachers, but rather a tool that strengthens their

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

pedagogical function. Collaboration between AI and teachers produces a hybrid approach that combines technological sophistication with educational humanism values.

Lim, Wang, & Koh (2023) showed that this collaboration resulted in more consistent and sustainable learning outcomes. Teachers play a role in interpreting data generated by AI and adjusting learning strategies according to student needs and local contexts. Research by Holmes, Bialik, et al. (2022) confirmed that active teacher involvement in AI-based learning processes increases the effectiveness and sustainability of learning outcomes.

In addition, teacher training should cover technical and pedagogical aspects, including the ability to manage data, understand algorithms, and integrate AI analysis results into daily learning practices (Chen et al., 2020; Selwyn, 2019). Teachers also need to be trained to address potential biases and ensure ethical and inclusive use of AI (Baten et al., 2021).

The role of teachers as social-emotional facilitators also cannot be replaced by AI. Research by D'Mello & Graesser (2015) shows that human interaction remains important in supporting students' social and emotional development, which is a crucial aspect in primary and secondary education.

Policy Implications and Strategies for AI Implementation in Primary and Secondary Schools

The implementation of AI in education requires comprehensive and integrated policy support. Governments and stakeholders must ensure the availability of equitable technological infrastructure, including adequate internet access and digital devices (Bank, 2020; UNESCO, 2021a). Policies must also regulate the protection of students' personal data and transparency in the use of AI (Baten et al., 2021; Mittelstadt, 2019).

Ongoing teacher training and provision of supporting resources are top priorities. Collaboration between technology developers, educators, and policymakers is essential to ensure that the AI systems developed are appropriate to pedagogical needs and local contexts (Luckin et al., 2016; Mittelstadt, 2019).

Further evaluation and research are also needed to measure the long-term impact of AI use in personalized learning. Holmes, Bialik, et al. (2022) highlight the lack of long-term empirical evidence, so ongoing studies are essential to understand the social and pedagogical implications of AI.

In addition, policies should promote inclusivity and address the digital divide so that all students, without exception, can benefit from AI in Learning (OECD, 2022a; UNESCO, 2021a). A holistic and participatory policy approach will strengthen the success of AI implementation in primary and secondary education.

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

Case Studies and Best Practices in AI Integration in Primary and Secondary Education

Several case studies have demonstrated the success of AI integration in personalized learning. For example, the use of learning chatbots specifically designed for children has been shown to increase interaction and understanding of materials (Luckin et al., 2021; Holmes et al., 2021). These chatbots are able to adjust their language and communication style according to the psychological development of students, making them more effective in supporting learning.

Adaptive material recommendation systems have also been implemented in several schools with positive results. Zhang & Aslan (2021) reported that this system increased student engagement and retention by providing materials that are appropriate to their ability levels and interests. However, this success is highly dependent on the design of the system that takes into account the local context and specific needs of students.

In addition, adaptive learning platforms such as DreamBox Learning and Knewton have been widely used in several countries and have shown significant improvements in mathematics and language learning outcomes (Heffernan & Heffernan, 2014; Wang et al., 2022). The platform uses AI to customize materials and provide instant feedback, supporting more personalized and effective learning. Best practices also emphasize the importance of collaboration between teachers, students, and AI technology to create an inclusive and adaptive learning environment (Lim, Wang, & Koh, 2023; C. O. Rolim & Isotani, 2021). This approach ensures that technology is not just a technical tool, but an integral part of a holistic pedagogical process.

Conclusion

The conclusion of this study can be explained that the integration of artificial intelligence (AI) in personalized learning in primary and secondary education has great potential to improve the effectiveness and inclusiveness of education. AI is able to overcome the challenges of student heterogeneity by providing adaptive, personalized, and responsive learning based on real-time data analysis. However, the implementation of AI faces various challenges, such as infrastructure limitations, teacher readiness, and ethical issues related to privacy and algorithmic bias. The role of teachers remains crucial as facilitators who combine the advantages of technology with the values of educational humanism, so that an optimal hybrid approach is created. Comprehensive policy support, ongoing training, and collaboration between stakeholders are the keys to the success of AI implementation. Case studies and best practices show that with the right design and sensitivity to local context, AI can significantly enrich students' learning experiences. Therefore, the development and implementation of AI in education must be carried out carefully, inclusively, and sustainably to realize more effective and equitable learning.

Volume 5 Issue 2, December 2025
E-ISSN: 2776-6047
P-ISSN: 2964-3465
Universitas Islam Negeri Fatmawati Sukarno Bengkulu

References

Bank, W. (2020). *World Development Report 2020: Trading for Development in the Age of Global Value Chains*. World Bank Publications.

Baten, R., Klasen, S., & Qaim, M. (2021). Ethical Considerations in the Use of AI in Education: Privacy, Bias, and Fairness. *Journal of Educational Technology & Society*, 24(2), 45–59.

Booth, A., Sutton, A., & Papaioannou, D. (2021). *Systematic Approaches to a Successful Literature Review*. Sage Publications.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, 8, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

D'Mello, S. K., & Graesser, A. (2015). *Feeling, Thinking, and Computing with Affect-aware Learning Technologies BT - The Oxford handbook of affective computing (R. A. Calvo, S. K. D'Mello, J. Gratch, & A. Kappas (eds.)*; pp. 419–434). Oxford University Press.

Eubanks, V. (2018). *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor*. St. Martin's Press.

Heffernan, N. T., & Heffernan, C. L. (2014). The Assistments Ecosystem: Building A Platform That Brings Scientists and Teachers Together for Minimally Invasive Research on Human Learning and Teaching. *International Journal of Artificial Intelligence in Education*, 24(4), 470–497.

Holmes, W., Bialik, M., & Fadel, C. (2021). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning (2nd Edition.). *Center for Curriculum Redesign*.

Holmes, W., Bialik, M., & Fadel, C. (2022). Evaluating the Impact of AI in Education: A Systematic Review. *Educational Research Review*, 35, 100421.

Holmes, W., Tuomi, I., & Griffiths, D. (2022). Education and Artificial Intelligence: A Call for a Human-Centered Approach. *British Journal of Educational Technology*, 53(3), 455–470. https://doi.org/10.1111/bjet.13107

Husain, M. (2023). Analysis Of Resilience of Darussalam Islamic Boarding School Blokagung Banyuwangi in Maintaining Existence the Function of Islamic Education in the Era of Disruption. *Proceedings of International Conference on Educational Management*, 1, 239–250.

Kitchenham, B., & Charters, S. (2007). Guidelines for Performing Systematic Literature Reviews in Software Engineering. *EBSE Technical Report*. https://www.cs.york.ac.uk/ftpdir/reports/2007/YCS-2007-01.pdf

Lim, C. P., Wang, T., & Koh, J. H. L. (2023). Teacher-AI collaboration in personalized learning: A Systematic Review. *Computers & Education*, 190, 104626.

Lim, C. P., Wang, T., & Tay, L. Y. (2023). Integrating Artificial Intelligence into Classrooms: Opportunities, Challenges and the Way Forward. *Educational Technology Research and Development*, 71, 67–89. https://doi.org/10.1007/s11423-023-10109-5

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An Argument for AI in Education*. Pearson.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. (2021a). *Intelligence Unleashed: An Argument for AI in Education*. Pearson Education.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2021b). Designing AI systems for children: Ethical and pedagogical considerations. *Learning, Media and Technology*, 46(1), 1–15.

Mittelstadt, B. D. (2019). Principles Alone Cannot Guarantee Ethical AI. *Nature Machine Intelligence*, 1(11), 501–507.

Mu'alina, N., & Husain, M. (2024). Transformasi Sistem Cashless Payment Sebagai Upaya Digitalisasi Manajemen Pembiayaan di Pondok Pesantren Darussalam Blokagung Banyuwangi. *Proceedings of International Conference on Educational Management*, 2, 155–167.

O'Neil, C. (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. *Crown Publishing Group*.

OECD. (2022a). Digital Education Outlook: Pushing The Frontiers With AI, Blockchain and Robots. *OECD Publishing*. https://doi.org/10.1787/5f7ecb8f-en

OECD. (2022b). Education at a Glance 2022: OECD Indicators. *OECD Publishing*. https://doi.org/10.1787/eag-2022-en

Rolim, C. O., & Isotani, S. (2021). AI in Education: A Systematic Review of Research Trends. *Journal of Educational Computing Research*, 59(7), 1234–1260.

Rolim, V., & Isotani, S. (2021). The Influence of Personalized Learning on Students' Learning Motivation and Performance: A Systematic Literature Review. *Computers & Education*, 165, 104149. https://doi.org/10.1016/j.compedu.2021.104149

Selwyn, N. (2019). *Should Robots Replace Teachers? AI and The Future of Education*. Polity Press.

Snyder, H. (2019). Literature Review as A Research Methodology: An Overview and Guidelines. *Journal of Business Research*, 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

UNESCO. (2021a). Reimagining Our Futures Together: A New Social Contract for Education. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000379707

UNESCO. (2021b). *The Digital Transformation of Education: Challenges and Opportunities*. UNESCO Publishing.

Wang, Y., Lin, Y., & Lin, S. (2022). Artificial Intelligence-Enabled Personalized Learning: A Case Study in Elementary Mathematics Education. *Computers in Human Behavior*, 135, 107378. https://doi.org/10.1016/j.chb.2022.107378

Woolf, B. P., Burleson, W., Arroyo, I., Dragon, T., Cooper, D. G., & Picard, R. W. (2013). Affect-Aware Tutors: Recognizing and Responding to Student Affect. *International Journal of Learning Technology*, 4(3–4), 129–164.

Xiao, Y., & Watson, M. (2019). Guidance On Conducting a Systematic Literature Review. *Journal of Planning Education and Research*, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where are The Educators? *International Journal of Educational Technology in Higher Education*, 16(1), 1–27. https://doi.org/10.1186/s41239-019-0171-0

Zhang, X., & Aslan, A. (2021). Impact of AI-Powered Personalized Learning on Student Performance: A Meta-Analysis. *Educational Technology & Society*, 24(3), 77–91.