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THE USE OF ARTIFICIAL INTELLIGENCE AS A PERSONAL TUTOR IN EDUCATION: A LITERATURE REVIEW ON PERSONALISATION AND ADAPTATION OF LEARNING MATERIALS BASED ON STUDENT DATA ANALYSIS

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Abstract

The development of artificial intelligence (AI) technology has brought significant changes to the education sector, particularly in efforts to create more personalised and adaptive learning systems. This study aims to examine the use of AI as a personal tutor in education through a literature review approach that focuses on two main aspects, namely personalisation and adaptation of learning materials based on student data analysis. Using a literature review method from various reliable academic sources, this study analyses the role of AI in understanding student learning behaviour, adjusting learning content, and providing data-based automatic feedback. The results of the study show that the application of AI tutors can improve the effectiveness, efficiency, and relevance of the learning process while expanding access to quality education. However, issues of data ethics and privacy, algorithmic bias, and digital infrastructure readiness are important challenges that need to be addressed. This study emphasises that the integration of AI in education must be oriented towards human-machine collaboration by balancing technological, pedagogical, and ethical aspects in order to create a sustainable and humanistic learning experience.

Keywords: artificial intelligence, personal tutor, personalised learning, material adaptation, student data analysis, adaptive learning.

Introduction

In this era of rapid digital transformation, artificial intelligence (AI) has become one of the main pillars driving change in various sectors of human life, including education. The application of AI in the context of education is not limited to the use of digital applications or online learning platforms, but has entered a more advanced stage, where AI-based systems are able to understand, analyse, and respond to individual learning needs dynamically (Ramadhani & Syahputra, 2024) . This marks a paradigm shift in education from a conventional, uniform learning model to a personalised approach that emphasises the diversity of students' abilities and characteristics. In this context, AI acts as a "personal tutor" that can guide students based on their individual profiles and learning progress (Syamsuriah & Rahman, 2025) .

The emergence of the AI tutor concept is the result of a combination of *machine learning*, *natural language processing*, and *learning analytics*, which enable the system to learn from student data and automatically adjust teaching materials. The advantage of AI in performing large-scale data analysis provides opportunities for the world of education to understand student learning behaviour more deeply than conventional methods (Putri & Santoso, 2024) . Thus, AI not only acts as an educational tool but also as an intelligent entity capable of providing an adaptive and personalised learning experience. This shift has direct implications for the role of educators and modern teaching models.

On the other hand, the need for personalisation in learning arises from the awareness that each student has a different learning style, pace of understanding, and preferences. Traditional education systems, which tend to be homogeneous, often fail to accommodate these differences, leading to gaps in learning achievement (Aslan & Hifza, 2020) . AI is here to fill that void by providing a data-driven approach, where every student interaction is recorded and generates information that can be used to tailor content and learning strategies. By analysing student behaviour data, AI systems can recommend materials, provide feedback, and adjust the level of difficulty based on individual needs (Putri & Santoso, 2024) .

The application of AI as a personal tutor is not only relevant in formal education but also in self-directed *learning*. Amidst growing interest in online learning and the need for *lifelong learning*, AI can help individuals manage the pace, direction, and goals of their learning flexibly. Various modern learning platforms, such as Coursera, Duolingo, Khan Academy, and ChatGPT for Education, have utilised AI technology to provide material recommendations and explanations tailored to users' learning patterns. Thus, AI brings a more interactive and contextual learning experience compared to traditional approaches (Putra & Dewi, 2024) .

However, despite AI's immense potential in education, implementation challenges remain significant. One of the main issues is ensuring that AI systems can deeply understand pedagogical contexts, rather than relying solely on data analysis. Effective teaching does not only depend on logic and algorithms, but also involves empathy, motivation, and social interaction. Therefore, the development of AI tutors must focus not only on technological sophistication, but also on their compatibility with humanistic values in the learning process (Lee & Kim, 2025) .

Ethical issues and student data privacy are also important concerns in the use of AI in education. Since AI tutoring systems work by continuously analysing student data, the potential for misuse or leakage of personal data needs to be anticipated through strict data protection policies. Additionally, algorithmic bias in AI systems is a separate concern as it can affect fairness and objectivity in the learning process (Zafrullah et al., 2024) . Therefore, the implementation of AI must be accompanied by principles of transparency, accountability, and ethics in system development.

From an educational policy perspective, the presence of AI as a personal tutor opens up opportunities to strengthen the equity and quality of learning, especially in areas with limited teaching staff. AI can provide basic instructions, exercises, and feedback that help students learn independently, while teachers continue to play the role of facilitators and mentors. This hybrid model is believed to improve the efficiency of the education system without eliminating the essence of the teacher's role as a social and moral agent in the learning process. Furthermore, from a pedagogical perspective, AI helps realise the concepts *of differentiated instruction* and *adaptive learning*, both of which are rooted in constructivism theory and *the learner-centred approach* (Bhutoria, 2024) . In this approach, students are no longer passive recipients but become active subjects involved in determining the course of the learning process. AI plays a role in mapping students' initial abilities, identifying difficulties, and providing material relevant to individual needs. This makes the learning process more efficient and effective because each student receives treatment appropriate to their ability level (Sari et al., 2025) .

AI's ability to predict learning outcomes also expands the scope of analysis in educational evaluation. Through *predictive analytics* techniques, the system can identify patterns of student underachievement before they become serious problems and offer timely interventions. This data-driven approach positions evaluation not merely as an administrative process, but as a continuous effort to improve learning outcomes (Wijaya & Setiawan, 2024) . Thus, the integration of AI into learning systems brings added value not only in terms of teaching, but also in terms of evaluation and educational decision-making.

Furthermore, the personalisation offered by AI can increase student motivation and engagement. When the material presented is relevant to students' interests and abilities, they tend to feel more challenged and participate actively. In educational psychology, this is in line with *self-determination* theory, where autonomy and relevance of learning are important factors in building intrinsic motivation. This aspect is important to ensure that the presence of AI does not make learning mechanistic, but still maintains human values (Susanto & Nugroho, 2010) .

However, the application of AI as a personal tutor cannot be considered a complete replacement for human teachers. Social interaction, emotional guidance, and character values still require the presence of humans in the educational process. Therefore, AI should be seen as a partner or intelligent assistant that helps enrich the learning experience, not replace the role of educators. Collaboration between humans and machines will be the most ideal model for the future of adaptive and inclusive education.

Therefore, this study attempts to examine in depth the use of AI as a personal tutor with a focus on two main aspects, namely personalisation and adaptation of learning materials based on student data analysis.

Research Method

This study uses a literature review method that aims to identify, analyse, and synthesise various previous research results related to the use of artificial intelligence as a personal tutor in education, particularly in the context of personalisation and adaptation of learning materials based on student data analysis. The research data was obtained from credible scientific sources such as reputable international journals (e.g., Scopus, IEEE, Springer, and Elsevier), conference proceedings, and recent research reports relevant to the topic (Eliyah & Aslan, 2025) . The literature collection process was carried out systematically by searching for related keywords such as artificial intelligence in education, intelligent tutoring system, adaptive learning, and personalised learning systems. Data analysis was conducted using a thematic approach to identify patterns, research gaps, and the direction of development of the AI tutor concept and its application in the context of modern education (Randolph, 2009) . This method was chosen because it provides a comprehensive understanding based on the synthesis of scientific results from various perspectives and disciplines that support the research topic.

Results and Discussion

AI as a Personal Tutor in Education

The development of artificial intelligence (AI) technology in the last decade has brought fundamental changes in various fields of life, including in the world of education. Among the many applications of AI, one that has attracted the most attention from researchers and education practitioners is the concept of AI as a personal tutor or *AI-based personal tutor*. This concept stems from the idea that AI not only functions as an administrative tool or information provider, but is also capable of taking an active role in directing, guiding, and adjusting learning according to individual needs (Widodo, 2024) . With the ability to analyse student learning behaviour data, AI can provide specific guidance, individual feedback, and even understand recurring error patterns, enabling it to provide personalised and contextual solutions (Jauhari, 2010) .

AI as a personal tutor emerged from the evolution of *the Intelligent Tutoring System (ITS)*, which has been developed since the early 1980s. ITS functions to simulate the role of human teachers through analysis of user interactions with digital learning materials. With the development of computing capabilities and machine learning algorithms, ITS systems have evolved to become more sophisticated in recognising student characteristics and adjusting teaching approaches. This system works by combining three main components: student model, *domain model* (learning material model), and *tutoring model* (teaching strategy). The three interact with each other to create a learning experience tailored to each student's profile (Jaidan & Jauhari, 2015) .

The most important component in an AI tutor is *the student model*, which stores and updates information related to the student's knowledge, abilities, learning style, and emotional responses during the learning process. With this model, the AI system can predict the student's next behaviour and determine the most appropriate learning intervention. For example, if a student shows difficulty in understanding a particular mathematical concept, the AI tutor can provide additional explanations, change the level of difficulty of the questions, or display visual illustrations according to the student's learning preferences. This adaptive process makes the learning experience more effective and efficient because each student receives treatment tailored to their needs (Chen & Wang, 2025) .

In practice, the concept of AI as a personal tutor is implemented in various forms, ranging from interactive learning applications to *natural language processing* (NLP)-based conversation systems. NLP technology enables AI to understand human language and communicate naturally with students, making interactions between humans and machines more intuitive (Adeshola & Adepoju, 2025) . Real-world examples of this technology can be found on platforms such as ChatGPT for Education, Duolingo Max, and Khanmigo, developed by Khan Academy. All of these platforms use large language models (LLMs) to provide explanations, answer questions, and offer learning guidance just like human tutors (Nuraeni & Hidayat, 2025) .

Furthermore, the ability of AI tutors to provide immediate feedback is one of their main advantages over conventional learning methods. In traditional education systems, feedback is often delayed because it depends on the time and capacity of teachers to assess students' work. In contrast, AI can analyse students' answers instantly and provide appropriate explanations, whether in the form of text, images, or videos. This rapid feedback not only helps students correct their mistakes immediately but also reinforces a reflective and continuous learning experience (Ouyang et al., 2024) .

In addition to providing feedback, AI tutors also play a role in creating *learning paths* tailored to students' previous learning outcomes. With machine learning algorithms, AI can identify which materials have been mastered and which topics require repetition or a different approach. For example, if the system detects that a student understands concepts more quickly with visual aids, the system will prioritise the presentation of graphics- or animation-based content in the next session. This approach reflects the philosophy *of mastery learning*, where students do not move on to new topics before they have fully mastered the old material (A. Pratama & Sari, 2025).

The application of AI tutors also introduces the concept *of data-driven education*, which emphasises the importance of using student data for educational decision-making. Through *big data analytics*, AI can discover patterns of learning behaviour that were previously difficult for teachers to detect. For example, the system can identify when students tend to lose focus, how long they spend on a particular

subject, or how consistent they are in completing tasks. This information can be used to develop more targeted learning interventions, increase motivation, and prevent *learning gaps*. However, in the context of implementation, there is debate about the extent to which AI can replace the functions of human teachers (Kusumawardhani & Santoso, 2019) . Although AI excels in terms of efficiency, consistency, and analytical capabilities, there is a human dimension to learning that cannot be fully replicated by machines. Empathy, intuition, and emotional communication are important aspects of education that remain the main strengths of human teachers. Therefore, AI should not be positioned as a replacement, but rather as *a pedagogical assistant* that complements the role of educators by providing data and recommendations that aid the learning process (Y. Pratama & Sari, 2024) .

The use of AI tutors also requires adequate digital literacy from both teachers and students. Without the ability to understand how the system works and interpret the analytical results it produces, the benefits of AI will not be optimal. Teachers need to be trained to read the data provided by AI and use it to design more relevant learning strategies, while students need to understand the role of AI as a supportive learning partner, not just a passive tool (Hidayat & Nurhayati, 2024) . Therefore, the integration of AI into education must be accompanied by strengthening human resource capacity and educational policies that support the ethical and inclusive application of technology.

From a pedagogical perspective, AI tutors contribute to the development of adaptive and constructivist learning paradigms. In this approach, students are viewed as active subjects who construct their knowledge through learning experiences relevant to their context. AI acts as a facilitator that provides learning resources according to individual needs. For example, through *learning analytics*, the system can recommend readings, videos, or simulations that are appropriate for the student's current level of understanding. Thus, AI supports the creation of a more personalised, efficient, and meaningful learning model (Kestin & Dervan, 2025) .

In addition to pedagogical benefits, AI also has great potential in improving access to quality education, especially in areas with limited teaching staff. Through an AI tutor system integrated with an online platform, students in remote areas can obtain learning guidance equivalent to those in big cities. This shows how AI can play a role as a tool for educational equality, while strengthening the principles of fairness and inclusiveness in the national education system. This innovation is important for developing countries facing challenges of regional educational disparities (Létourneau et al., 2025) .

However, the implementation of AI as a personal tutor must also consider ethical and social responsibility aspects. The use of large amounts of student data raises concerns about privacy, security, and algorithmic bias. If AI algorithms are not carefully designed, learning recommendation results can create discrimination or reinforce existing inequalities (Fitriani & Pratama, 2024) . Therefore, the application

of AI in education needs to be regulated by clear ethical guidelines, including transparency in data collection, students' right to access their data, and independent audit mechanisms for the algorithms used.

In the future, collaboration between humans and AI in education will be the key to successful digital learning. The role of teachers will shift to that of facilitators and guides who use data and recommendations from AI to design more effective learning experiences. Meanwhile, AI will focus on analysis and personalisation, helping to identify the specific needs of each student. The combination of the two creates synergy between technology and human values, bringing education towards a new model that is more adaptive, data-oriented, and student-centred (Zerkouk et al., 2024) .

Thus, AI as a personal tutor is not merely a technological innovation, but a paradigmatic transformation in the world of education. AI does not only automate the learning process, but also revolutionises the way humans understand learning itself. The combination of AI's analytical capabilities with a humanistic pedagogical approach will open up new opportunities for the emergence of a generation of independent, adaptive, and highly competitive learners. To achieve this goal, cross-disciplinary collaboration between educators, technology developers, researchers, and policymakers is needed to ensure that the integration of AI in education is effective, ethical, and sustainable.

Personalisation and Adaptation of Materials Based on Student Data Analysis

In the context of modern AI-based education, personalisation and adaptation of learning materials are key elements that determine the effectiveness and relevance of the learning process. Personalisation of learning refers to the ability of the system to adjust content, methods, and learning speed to suit the unique characteristics of each student (Liliana et al., 2021) . Meanwhile, learning adaptation refers to the system's ability to adjust to changes in students' needs, preferences, and performance over time. The synergy between these two concepts results in a learning experience that is dynamic, responsive, and contextual—a condition that is difficult to achieve through traditional educational approaches (Rokhmawati et al., 2025) .

The main role of AI in personalising learning lies in its ability to analyse large amounts of student data at high speed. The data collected can include evaluation results, participation patterns, task completion times, learning styles, and even emotional indicators such as student engagement or boredom levels. Through an analytical approach known as *learning analytics* and *educational data mining*, AI systems process this data to map each student's learning profile. This profile then becomes the basis for the system to provide appropriate learning materials, feedback, and recommendations, creating an experience that approximates individualised learning (Ramadhani & Syahputra, 2024) .

The concept of material adaptation in AI systems stems from the idea that not all students learn in the same way. Some students find it easier to understand concepts

through visualisation, while others prefer a verbal or kinesthetic approach. By identifying these learning styles, AI can adjust its material presentation strategies, for example by replacing text with video, adding interactive simulations, or gradually increasing the complexity of questions. This type of adaptation allows each student to learn in the format that is most effective for them, improving understanding and extending knowledge retention (Syamsuriah & Rahman, 2025) .

In addition to learning styles, adaptations can also be made based on individual speed and ability. AI can predict the time a student needs to master a particular topic and adjust the pace of learning. If the system detects that a student has mastered a concept faster than average, the system can introduce more challenging material (Putri & Santoso, 2024) . Conversely, if a student experiences difficulties, AI will provide repetition with a different approach. This approach is in line with the principle *of mastery learning*, which aims to ensure that every student achieves an optimal level of mastery before moving on to the next topic (Putra & Dewi, 2024) .

The application of data-driven personalisation focuses not only on cognitive aspects but also on affective and motivational ones. Several AI systems have been developed to recognise students' facial expressions, tone of voice, or typing patterns to detect levels of stress or boredom. Based on these findings, AI can adjust the material to make it more interesting, provide virtual breaks, or insert gamification elements to maintain learning motivation. Thus, personalisation is not limited to adjusting teaching materials, but also includes efforts to build a holistic and enjoyable learning experience (Lee & Kim, 2025) .

The AI-based personalisation process involves the use of machine learning algorithms such as *collaborative filtering*, *reinforcement learning*, and *predictive analytics*. *Collaborative filtering* is used to recommend new material based on the learning patterns of students with similar characteristics. *Reinforcement learning* allows the system to learn from past interactions and improve teaching strategies for optimal results, while *predictive analytics* helps predict the difficulties students may encounter with certain topics. The combination of these three approaches makes AI systems increasingly capable of understanding complex learning dynamics and adjusting interventions in real-time (Zafrullah et al., 2024) .

Furthermore, the success of adaptation and personalisation also depends on the quality of the data used. Incomplete, inaccurate, or biased data can cause the AI system to provide incorrect recommendations. Therefore, the data collection and processing must be carried out in a standardised, transparent, and ethical manner. Data sources must reflect the diversity of students' backgrounds, including social, cultural, and economic factors that may influence learning styles. This is important to prevent algorithmic bias that could disadvantage certain groups in digital education systems (Bhutoria, 2024) .

From a pedagogical perspective, personalisation and adaptation of data-driven materials reinforce the principle of *student-centred learning*. In this model, learning is

designed to give students more autonomy in determining the direction, pace, and form of learning. AI plays an important role as a facilitator that provides flexible yet targeted learning paths, where each student can access learning resources according to their personal needs (Sari et al., 2025) . Thus, AI not only replaces the administrative functions of teachers but also strengthens the pedagogical dimension by providing more relevant and contextual learning.

The application of AI-based personalisation also has an impact on the role of teachers in the classroom. Teachers no longer act as the main source of knowledge, but rather as analysts and mentors who interpret learning outcome data to provide more meaningful guidance. With the support of analytical reports from AI systems, teachers can identify patterns of student difficulties and design differentiated learning strategies. This collaboration between teachers and AI has the potential to increase the efficiency of the teaching and learning process while maintaining a human touch in education (Wijaya & Setiawan, 2024) .

In addition to enriching the learning process, data from personalisation and adaptation can be used as a basis for more holistic educational evaluation. AI can assess not only final results such as exam scores but also the process students undergo during learning. Indicators such as participation levels, task completion times, and learning consistency can be part of a more objective and development-oriented formative assessment system (Susanto & Nugroho, 2010) . In this way, learning is no longer just about assessing academic intelligence, but also measuring students' perseverance, consistency, and motivation to learn. However, despite these advantages, the implementation of personalisation and adaptation of data-based materials faces serious challenges related to privacy and information security. The collection of massive amounts of student data raises concerns about potential misuse, commercialisation, or leakage of personal data. Therefore, clear and strict data protection policies are needed, including regulations on data ownership rights, mechanisms for obtaining consent for data use, and ethical supervision of AI system developers. Without a strong ethical framework, the application of AI in education risks causing undesirable social impacts (Widodo, 2024) .

In addition to ethical challenges, infrastructure and equitable access to technology are also important issues in the implementation of AI-based personalisation. In many developing countries, disparities in access to digital devices, internet connectivity, and competent human resources remain major obstacles. This shows that the success of adaptive learning systems is not only determined by technological sophistication, but also by the readiness of the educational ecosystem as a whole. Therefore, the application of AI in learning needs to be accompanied by policies on infrastructure equity and the improvement of digital literacy at all levels of education (Jauhari, 2010) .

In the future, personalisation and adaptation of learning based on student data analysis is predicted to be a key component of 21st-century education. With the

development of *deep learning* technology and large language models, AI's ability to understand human learning behaviour and context will continue to improve. This opens up opportunities for the creation of a truly adaptive, inclusive, and sustainable learning ecosystem, where each student can learn in the best way according to their potential. However, the success of this vision heavily depends on striking a balance between technological sophistication and the principles of humanity that lie at the core of educational practice.

Conclusion

The use of artificial intelligence (AI) as a personal tutor in education shows great potential in realising more effective, adaptive, and learner-centred learning. Through data analysis and machine learning capabilities, AI can tailor material, methods, and learning pace to individual student characteristics. AI tutors act not only as conveyors of information, but also as facilitators capable of providing real-time feedback, detecting learning difficulties, and predicting future learning needs. This personalised and adaptive learning reinforces the principles of modern data-driven education, where every pedagogical decision is supported by empirical evidence from student behaviour and learning outcomes. Thus, AI enables the creation of a more inclusive and meaningful learning experience, while also increasing the efficiency of the learning process in various educational contexts.

Despite offering various advantages, the application of AI in education is not without ethical, technological, and policy challenges. Student data privacy, the risk of algorithmic bias, and digital infrastructure limitations are issues that must be anticipated so that AI implementation is fair and responsible. Furthermore, AI cannot completely replace the role of teachers as educators who provide social, emotional, and moral guidance. Therefore, the synergy between technology and humanistic values is key to the development of a sustainable AI tutoring system. Future education must be directed towards collaboration between artificial intelligence and humans, with AI acting as a strategic partner to strengthen analytical skills, creativity, and the potential of learners in the digital age.

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