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THE ROLE OF ARTIFICIAL INTELLIGENCE IN PERSONALIZING THE LEARNING PROCESS

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Abstract: Artificial intelligence is increasingly transforming education by enabling learning environments to respond more precisely to the individual needs, abilities, interests, and progress of students. Traditional instructional models often provide the same content, pace, and assessment approach to all learners, despite substantial differences in prior knowledge and learning speed. Artificial intelligence-based systems can address this limitation by analyzing learner data, adapting educational materials, generating individualized feedback, recommending appropriate tasks, and identifying areas in which additional support is required. The purpose of this study is to analyze the role of artificial intelligence in personalizing the learning process and to identify its main educational benefits, limitations, and conditions for effective implementation. A qualitative literature-based approach was used to review contemporary research on adaptive learning, intelligent tutoring systems, learning analytics, generative artificial intelligence, and personalized education. The analysis indicates that AI-supported personalized learning can improve flexibility, learner engagement, academic performance, and access to timely feedback. At the same time, the effective use of AI requires pedagogical supervision, reliable data, teacher competence, protection of student privacy, and attention to algorithmic bias. Artificial intelligence should therefore be viewed not as a replacement for teachers but as a tool that strengthens their ability to provide differentiated and learner-centered instruction. The study concludes that a human-centered model combining teacher expertise with AI-supported personalization offers one of the most promising approaches to improving the quality and effectiveness of contemporary education.

Keywords: artificial intelligence, personalized learning, adaptive learning, education, intelligent tutoring systems, learning analytics, digital pedagogy, individualized instruction.

Introduction

One of the major challenges in education is the fact that students do not learn in identical ways. Learners differ in their previous knowledge, motivation, cognitive abilities, interests, learning pace, language background, and need for support. Nevertheless, traditional classroom instruction is often organized around a common curriculum, common timetable, and relatively uniform learning activities.

This creates a pedagogical problem. An instructional task that is appropriate for one student may be too difficult for another and insufficiently challenging for a third. When the level of instruction does not correspond to the learner's current level of understanding, motivation and academic performance may decline.

Personalized learning attempts to overcome this difficulty by adapting educational content, teaching strategies, pacing, and feedback to individual learner needs. Although personalized

education existed long before artificial intelligence, AI has significantly expanded the possibilities for implementing it at scale.

Artificial intelligence can process large amounts of educational data and detect patterns that may be difficult for teachers to identify continuously in large groups of students. AI systems can estimate the learner's level of knowledge, identify recurrent errors, recommend appropriate activities, adapt task difficulty, and provide immediate feedback [1].

The OECD has described personalized learning as one of the important areas in which human and artificial intelligence can complement each other. Contemporary systems already use learner data to adjust feedback, tasks, and elements of the curriculum, while future approaches are increasingly expected to consider broader characteristics such as motivation, self-regulation, and emotional factors [2].

The rapid development of generative artificial intelligence has further expanded this potential. AI systems can now generate explanations at different levels of complexity, create exercises, simulate dialogue, provide examples, and respond to students' questions in natural language.

However, access to advanced technology does not automatically result in effective learning. Recent evidence emphasizes that generative AI may improve task performance without necessarily improving learning if students use it simply to outsource cognitive work [3]. Personalization should therefore remain grounded in clear pedagogical objectives.

The aim of this study is to analyze the role of artificial intelligence in personalizing the learning process, identify the main mechanisms through which AI can support individualized education, and examine the conditions necessary for its responsible and effective use.

Materials and Methods

This study used a qualitative analytical review approach.

Recent scientific publications and international reports addressing artificial intelligence in education, adaptive learning, personalized learning, intelligent tutoring systems, learning analytics, generative AI, teacher–AI collaboration, and ethical issues were examined.

The analysis focused on several dimensions of AI-supported personalization: adaptation of content difficulty, individual learning pathways, automated feedback, identification of learning difficulties, learner engagement, teacher support, competency development, and educational assessment.

Attention was also given to the potential risks associated with the implementation of artificial intelligence, particularly data privacy, algorithmic bias, excessive dependence on technology, unequal access, academic integrity, and reduction of independent cognitive effort.

The reviewed evidence was interpreted from a pedagogical perspective, with emphasis on the interaction between artificial intelligence, teachers, and learners rather than technology alone.

Results

The analysis demonstrates that one of the strongest educational applications of artificial intelligence is its ability to adapt instruction according to individual learner performance.

Traditional educational systems frequently move an entire group through the curriculum at approximately the same pace. Artificial intelligence makes it possible to create more flexible learning trajectories.

For example, when a learner demonstrates difficulty with a particular concept, an adaptive system may provide additional explanation, simpler examples, prerequisite exercises, or more practice before allowing progression to the next level.

By contrast, a student who demonstrates mastery can receive more complex tasks instead of repeating material that has already been understood.

This principle can be represented as a continuous cycle:

learner activity → data analysis → identification of learning needs → adaptive educational response → new learner activity.

The cycle allows the educational environment to change according to learner progress rather than remaining fixed.

A systematic review of research on AI-mediated personalized learning pathways found that adaptive technologies represent one of the dominant approaches in the field. The review of 78 studies published between 2019 and 2024 also identified growing interest in generative language models as tools for creating personalized learning experiences [4].

Another important application is intelligent tutoring.

Intelligent tutoring systems attempt to reproduce selected functions of individual tutoring by analyzing learner responses and providing personalized guidance.

Instead of simply indicating whether an answer is correct or incorrect, an AI-based tutor may identify the type of misunderstanding and provide a targeted explanation.

For example, two students may both answer a mathematics problem incorrectly, but for different reasons. One may misunderstand the mathematical concept, whereas the other may know the concept but make an arithmetic error. A personalized system can theoretically distinguish between these patterns and provide different feedback.

This type of feedback is pedagogically important because correction is most effective when it addresses the cause of the error rather than the error alone.

Artificial intelligence can also support personalization through learning analytics.

Digital learning environments generate information about response accuracy, task completion, time spent on activities, frequency of attempts, sequence of actions, and patterns of engagement.

When analyzed responsibly, these data can help identify students who require additional support.

For example, a learner whose scores remain acceptable but who requires significantly more attempts and time than peers may be experiencing difficulties that are not immediately visible through final grades alone.

AI-based analysis can alert the teacher to such patterns.

This does not mean that the algorithm should make the final educational decision. Instead, AI can function as an early diagnostic support tool while the teacher interprets the information in its broader pedagogical context.

Personalization can also improve the pacing of learning.

Some students require more time to develop conceptual understanding, while others progress rapidly. Fixed instructional pacing may disadvantage both groups.

AI-supported systems can allow students to spend additional time on difficult areas and progress more rapidly through familiar material.

Evidence from higher education suggests that personalized adaptive learning can have positive effects on academic outcomes. A recent scoping review reported increased academic performance in a majority of the reviewed studies, although the magnitude and consistency of effects varied across educational contexts [5].

Artificial intelligence can also personalize the format in which information is presented.

A learner struggling with a textual explanation may benefit from an alternative example, simplified description, visual representation, dialogue, step-by-step explanation, or practice activity.

Generative AI expands this ability because it can reformulate information rapidly in response to learner requests.

For example, a student may ask:

"Explain this concept in simpler language."

The same learner may then request:

"Give me a practical example."

or:

"Now ask me three questions to check whether I understood it."

Such interaction creates a more responsive learning environment than static digital content.

Another important finding is the potential of AI to support formative assessment.

Traditional assessment frequently occurs after a unit has been completed. By that point, misconceptions may already have become established.

AI-supported systems can continuously assess learner responses and provide immediate feedback.

This creates opportunities for assessment **for learning**, rather than assessment only **of learning**.

Personalization may therefore become a continuous process rather than an intervention that occurs only after examination results are available.

AI can also assist teachers with differentiated instruction.

In large classrooms, it can be difficult for one teacher to create separate tasks for different ability levels, continuously monitor every student's progress, and provide individualized feedback.

AI can reduce some of this workload by helping generate differentiated exercises, identify common misconceptions, summarize student progress, and recommend areas requiring teacher attention.

This represents a hybrid model in which technology manages some repetitive analytical tasks while the teacher retains responsibility for pedagogical judgment.

The OECD describes such human–AI collaboration as an important direction for personalized education [2].

Discussion

The findings suggest that artificial intelligence can substantially expand the practical possibilities of personalized learning.

However, the educational value of personalization depends on what is being personalized and why.

Personalization should not simply mean giving every learner different digital content. Effective personalization requires understanding the student's current knowledge, educational objectives, difficulties, and developmental needs.

An AI system may know that a student answered five questions incorrectly, but the teacher may know that the student has recently experienced language difficulties, anxiety, low confidence, or problems outside the classroom.

This illustrates a fundamental limitation of purely data-driven personalization.

Educational data provide valuable signals, but they do not represent the complete learner.

For this reason, the most effective model is likely to be a hybrid human–AI approach.

Artificial intelligence can process information rapidly, detect patterns, provide immediate responses, and adapt activities. Teachers contribute professional judgment, empathy, contextual understanding, motivation, ethical responsibility, and meaningful human interaction.

The objective should therefore not be to remove teachers from the learning process but to increase their capacity to respond to individual learners.

Another important issue is cognitive engagement.

Generative AI can produce answers, essays, summaries, explanations, and solutions within seconds. This can support learning when students use AI as a tutor, feedback provider, or thinking partner.

However, it can reduce learning when students simply ask the system to complete intellectual tasks on their behalf.

The OECD Digital Education Outlook 2026 stresses that successful completion of a task using generative AI does not automatically mean that meaningful learning has occurred [3]. Educational use of AI should therefore be designed so that students remain cognitively active.

For example, instead of asking an AI system simply to solve a problem, students may be encouraged to produce their own solution first and then compare it with AI-generated feedback.

Similarly, rather than requesting an entire essay, learners can use AI to receive questions about their argument, identify weaknesses in a draft, or request explanations of difficult concepts.

In such cases, AI supports thinking instead of replacing it.

Personalization also has implications for learner motivation.

When tasks are consistently too difficult, students may become discouraged. When tasks are too easy, boredom may occur.

Adaptive systems can potentially maintain an appropriate level of challenge by adjusting task difficulty based on performance.

This approach may support engagement, particularly when learners receive visible evidence of progress.

Nevertheless, excessive algorithmic control may also reduce learner autonomy if every educational decision is made automatically.

Students should therefore gradually learn to participate in decisions about their own learning goals, strategies, and progress.

This connects AI-supported personalization with self-regulated learning.

The long-term educational objective is not simply to create a system that understands what the learner needs. It is also to help learners understand what they themselves need.

Data privacy represents another important concern.

Personalized learning systems may collect substantial information about student performance, behavior, and interaction patterns.

If such data are stored or processed without adequate safeguards, educational personalization can create privacy and security risks.

UNESCO emphasizes the importance of a human-centered approach to generative AI in education, including appropriate regulation, data protection, age-appropriate use, and development of human capacity [6].

Algorithmic bias must also be considered.

An AI system makes recommendations based on data and models. If the underlying data contain historical inequalities or do not adequately represent different groups of learners, recommendations may be inaccurate or unfair.

For example, an algorithm that repeatedly assigns easier work to a student because of earlier low performance could unintentionally create a self-reinforcing cycle of low expectations.

Teachers should therefore remain able to question and override algorithmic recommendations.

Equity is equally important.

AI-supported personalized learning has the potential to expand access to individualized assistance, but it may also widen existing educational inequalities if advanced technologies are accessible only to well-resourced institutions or students.

Personalization must therefore be accompanied by policies that address infrastructure, connectivity, accessibility, teacher preparation, and digital competence.

Teacher competence is particularly important.

Artificial intelligence cannot improve education if teachers do not understand when, why, and how to use it.

Teachers need not become computer scientists, but they require sufficient AI literacy to evaluate outputs, recognize limitations, protect student data, design appropriate learning activities, and identify situations in which human intervention is necessary.

The OECD and European Commission's 2026 AI literacy framework similarly emphasizes that learners need the knowledge, skills, and attitudes required to understand, critically evaluate, and responsibly use AI systems [7].

The role of the teacher therefore becomes more rather than less important in a personalized AI environment.

Teachers increasingly function as designers of learning experiences, interpreters of learner data, facilitators of critical thinking, and guardians of educational and ethical standards.

Limitations

The present study is based on published research and international reports and does not include original experimental data.

Research on AI-supported personalized learning is developing rapidly, and technologies examined in current studies may change significantly within a short period.

Another limitation is that studies use different educational levels, AI systems, assessment methods, and definitions of personalization, which makes direct comparison difficult.

Many investigations also focus on short-term academic outcomes rather than long-term knowledge retention, critical thinking, learner independence, or social development.

Further longitudinal and comparative studies are needed to evaluate how AI-supported personalization affects learners over extended periods.

Research should also examine the effectiveness of personalized AI systems across different socioeconomic, linguistic, and cultural contexts.

Conclusion

Artificial intelligence has significant potential to transform personalized learning by allowing educational activities to respond more dynamically to individual student needs.

AI systems can analyze learner performance, identify difficulties, adapt task complexity, create individualized learning pathways, provide immediate feedback, and assist teachers in monitoring student progress.

These capabilities can make education more flexible and responsive than traditional one-size-fits-all models.

However, personalization should not be understood as a fully automated educational process.

Artificial intelligence cannot replace the pedagogical judgment, empathy, motivation, cultural understanding, and ethical responsibility of teachers.

The most promising model is therefore a human-centered partnership in which artificial intelligence provides analytical and adaptive support while teachers retain responsibility for educational decisions.

Effective implementation also requires attention to privacy, fairness, transparency, digital equity, academic integrity, and AI literacy.

AI should help learners think more effectively rather than think on their behalf.

When implemented within a sound pedagogical framework, artificial intelligence can support a shift from standardized instruction toward a more flexible learning environment in which students receive appropriate support, challenge, feedback, and opportunities to progress according to their individual educational needs.

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