APPLICATION OF AI TOOLS FOR PERSONALIZED LEARNING AND ASSESSMENT

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Abstract

In the educational context, AI tools offer new opportunities for personalized learning and objective assessment. They adapt content to the needs, pace, and level of each student. Through data analysis, AI systems identify knowledge gaps, provide recommendations, and automatically generate exercises and tests. They support teachers by offering automated feedback and evaluation, saving time and effort. Despite numerous advantages, the use of AI requires careful attention to ethical issues and data protection. This article explores the potential of current AI tools in education. A comparative analysis of popular platforms is presented, focusing on their effectiveness, strengths, and limitations. Finally, the article discusses future development perspectives and the need for a responsible and pedagogically grounded approach.

Keywords: *AI; Education; Personalized Learning; AI in Education.*

INTRODUCTION

Nowadays, technologies are evolving at an exceptionally rapid pace, transforming the way we live, work, and learn. Perhaps the most notable change, however, is occurring in the field of education. Digital technologies have become an integral part of the modern learning process, providing not only new opportunities for accessing information, but also greater student engagement and more effective and applicable learning methods.

This transformation not only facilitates the learning process but also promotes the development of new skills that are essential for successful participation in the labor market. Technologies provide opportunities for flexibility and adaptability, while simultaneously supporting both teachers and learners in overcoming the challenges associated with traditional educational models.

There are numerous definitions of artificial intelligence (AI). In the context of this article, it is understood as the ability of a machine to communicate, reason, and act independently in both familiar and novel situations, in a manner that mimics human behavior [1]. In the field of education, AI plays an increasingly significant role, with its primary advantage being the capacity to adapt the learning process to the individual needs of each learner, in addition to facilitating easier access to knowledge.

This study aims to analyze the capabilities of artificial intelligence for personalizing learning and assessment, by reviewing leading AI tools, assessing their applicability and pedagogical effectiveness.

EXPOSITION

Artificial intelligence–based systems possess the capability to analyze vast volumes of data in real time, to identify the individual needs of users, and to deliver content that is aligned with their specific strengths and weaknesses. AI can support learners not only through the adaptation of instructional content, but also by facilitating the development of self-regulated learning skills and the ability to manage one's own learning process. This is made possible through the concept of *intelligent learning*, which considers not only academic achievement, but also the learner's cognitive and emotional states [2].

Studies have shown that the use of AI technologies in education enhances student motivation, facilitates teachers in monitoring progress, and increases the individualization of the learning process [3]. At the same time, automated assessment systems provide objective and timely feedback, reduce grading time, and enable adaptive acquisition of learning content [4].

On the other hand, the widespread implementation of AI in school and university environments raises important issues related to data privacy, algorithmic transparency, and pedagogical accountability [2]. Therefore, the development of ethical frameworks and educational policies is essential to ensure that these technologies are used not only effectively but also responsibly.

1. Personalized learning using artificial intelligence

Personalized learning is an educational approach in which the content, methods, and pace of instruction are adapted to the individual needs, interests, and abilities of each learner [3]. With the advancement of artificial intelligence, this approach has become even more effective and accessible. One of the key transformations brought about by the integration of AI in education is the enhanced potential for personalized learning. Every student requires different amounts of time and specific approaches to master the learning material. Artificial intelligence enables the adaptation of educational resources according to learners' individual needs, preferences, and levels of knowledge.

AI-based systems can analyze how learners perform across various topics, identify their strengths and weaknesses, and provide personalized tasks and exercises. In this way, learning effectiveness is increased, as each learner receives support tailored to their individual learning style and pace. Table 1 lists and briefly describes several popular tools for personalized learning.

Table 1: Personalized Learning Tools

Platform / Tool	Description	Target group
Khan Academy / Khanmigo	An AI assistant that asks questions, explains concepts, and provides adaptive tasks based on learner performance.	Students (from primary to secondary levels), university students
Duolingo	Uses AI to adapt language learning in real time, track progress, and personalize lessons.	All ages (beginners to advanced learners)
Coursera / EdX	Recommended algorithms that suggest suitable courses based on interests, behavior, and previous performance.	Students, professionals, lifelong learners
DreamBox Learning	Adaptive AI mathematics system that personalizes content according to the learner's thinking style and pace.	Students (primarily ages 5–12)
Smart Sparrow	Intelligent platform for personalized learning in the sciences and medicine, which adapts based on learners' responses.	Students

A well-known advantage of AI is that it encourages self-directed learning by providing instant feedback and guidance. This encourages students to explore and solve problems in their own way. This technology can adapt the complexity of materials, offer additional resources, and even motivate learners through gamification and interactive tasks [5].

The process of implementing AI in education involves a series of steps – from identifying needs and selecting appropriate tools to adhering to ethical principles and tracking results. Fig. 1 shows the main stages in this process.

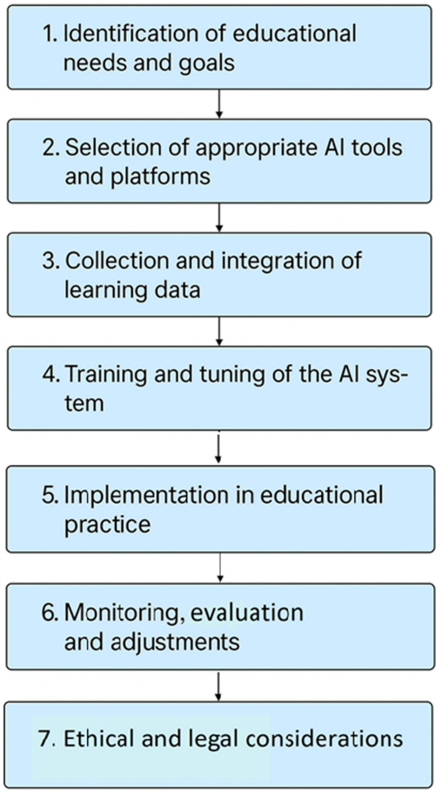

Fig. 1. Stages of implementing AI in personalized learning

The technological capabilities that personalized learning with AI provides do not exclude the role of the teacher in the learning process. On the contrary, AI provides tools with which the teacher can more accurately monitor progress, understand the difficulties of his students and direct his efforts where it is most needed. In this sense, personalized learning becomes a joint process between man and machine, aimed at maximizing the potential of each learner.

2. Basic AI technologies used in education

Artificial intelligence brings together a multitude of technologies that have the potential to fundamentally change the way we teach, learn, and assess in the education system. In the context of personalized learning, AI allows for the creation of a more flexible, adaptive, and effective learning environment. The most commonly used technologies are:

- **Machine Learning (ML)** - this is a "process in which machines 'learn' and improve their performance automatically based on experience. In other words, they are not pre-programmed to accomplish a specific goal and possess the ability to self-learn" [6]. In education, machine learning is used for analyzing

results, predicting learning difficulties, and creating personalized learning pathways.

- **Natural Language Processing (NLP)** - this technology enables systems to understand and analyze informal human language. It is used for automated assessment of texts (e.g., essays) as well as for creating educational chatbots that communicate with learners in a natural and accessible manner.
- **Recommender Systems** - these are algorithms that analyze learners' behavior, interests, and academic performance to suggest the most suitable lessons, courses, or resources. Such systems are widely employed on platforms like Coursera, Duolingo, and Khan Academy.
- **Virtual Assistants and AI Chatbots** - these AI agents provide real-time support by answering questions, offering explanations, guidance, and interactive activities. They contribute to greater learner autonomy and support self-directed learning. An example of such a system is Khanmigo.

3. Assessment using artificial intelligence

Artificial intelligence opens up new horizons in the educational process by implementing intelligent technologies that allow for dynamic adaptation of content, tracking progress and providing objective assessment. These tools create conditions for active, effective and motivating learning, tailored to the individual needs and capabilities of each learner.

In the context of assessment, AI offers a number of advantages, including automation, personalization and the ability to identify difficulties early. Through data and language processing (NLP), intelligent systems can analyze both quantitative and qualitative results and provide timely, objective and adapted feedback. This not only facilitates the work of teachers, but also supports learners in building a better understanding and confidence in their own knowledge.

AI algorithms effectively process and assess multiple-choice questions, short-answer responses, mathematical problems, and formulas. This significantly reduces grading time and minimizes subjectivity in assessment.

Main applications of AI in assessment:

- **Automated Test Grading** - a predefined key and scoring rules are applied, which ensures speed, consistency and minimizes the risk of human error.
- **Assessment of Written and Creative Assignments** – Through natural language processing (NLP) technologies, systems such as Grammarly, Turnitin, or Write & Improve can analyze grammar, style, argumentation, and text structure. This enables rapid and consistent evaluation of essays, projects, and presentations.
- **Formative assessment** - Intelligent platforms provide instant feedback and direct the learner to additional resources or exercises based on errors made. This type of assessment supports real-time learning.
- **Progress analysis and early detection of difficulties** - AI can analyze behavioral and performance data of the learner, detect signs of difficulty, and inform the teacher or the student himself of necessary intervention. This facilitates individual support and prevention of failures.

Table 2 presents leading AI assessment tools, their application and pedagogical effectiveness.

Table 2: Leading assessment tools

Tool / Platform	Application	Pedagogical Effectiveness
Gradescope	Automated checking of tests and open-ended tasks	Saves time, maintains objectivity and traceability
Grammarly	Analysis of grammar, style, and text structure	Enhances writing skills through continuous feedback
Write & Improve	Feedback on essays and written assignments	Supports the development of academic writing skills
Turnitin	Plagiarism detection and originality analysis	Reduces the risk of plagiarism and enhances engagement with the learning process
Khan Academy	Instant feedback during learning	Facilitates learning through targeted feedback
DreamBox Learning	Adaptive assessment based on progress in mathematics	Supports individual advancement through adaptability

As illustrated by the examples presented, artificial intelligence significantly expands the possibilities for effective and timely assessment. Comparison with traditional methods highlights the key advantages of AI, such as instant feedback, objectivity, and adaptability.

Within the course "*Object-Oriented Programming in C++*", students were given a test containing both open-ended and closed-ended questions. The closed-ended questions were graded automatically according to a predefined answer key, while the open-ended questions were assessed using AI-assisted rubric-based evaluation. The rubric included four criteria: **accuracy** (correctness of concepts), **completeness** (coverage of cases and constraints), **clarity** (structure and argumentation), and illustration (a brief verbal example or scenario). The final grade was calculated as the sum of the scores across the four criteria.

The aim of AI-assisted assessment was to compare its evaluation with expert (teacher) judgment using the same rubric, while maintaining transparency and reproducibility. Therefore, a portion of the responses was graded in parallel by both AI and the instructor, with an escalation threshold established: if the difference exceeded approximately one point on the final scale or if key rubric "signals" were missing (e.g., clear distinctions, specified cases, brief verbal example), the response was reviewed manually. The AI was instructed to provide not only scores for each criterion but also a brief explanation of why and 3–5 recommendations, ensuring traceability and easy verification.

Convergence with instructor evaluation was high for factual and definitional questions (e.g., access specifiers and multiple inheritance). Discrepancies occurred primarily in the illustration criterion, when the response was formally correct but too general or lacked a specific example. After adding "anchor" exemplars (strong/medium/weak responses) and providing the AI with clarifying instructions to require a brief illustration, the number of escalations decreased.

AI Prompt (abridged):

"*You are an experienced OOP assistant. Evaluate a student's response according to the given rubric. Respond in Bulgarian. Return only a table with the following fields: Accuracy (0–4), Completeness (0–2), Clarity (0–2), Illustration (0–2), Final Score (0–10; calculated according to the formula), Justification (1–2 sentences explaining why), Recommendations (a list of 3–5 specific brief recommendations). Evaluate solely based on the provided text and do not invent facts. If a verbal illustration is missing, assign 0 for 'Illustration' and note this in the 'Justification' field.*"

Escalation Rule: If the difference between AI and instructor scores exceeds approximately 1 point, or if key "signals" are missing (definition/distinction; case/constraint; brief illustration), manual review is mandatory.

Validation of the correctness of the assessment. The consistency of the AI and teacher assessments was demonstrated by double-scoring anonymized responses on the same rubric. The most frequent discrepancies were observed in the "Illustration" criterion, which led to the inclusion of anchor samples and clarification of the instructions to the AI regarding the specificity of the example.

Table 3 presents the results of AI-assisted assessment for the four open-ended questions. For each question, scores for the previously mentioned criteria are shown, along with the normalized final score on a 0–10 scale. This approach makes both the overall results and areas for further development visible.

The open-ended questions were:

1. What is the difference between the access modifiers public, private and protected?
2. Can multiple inheritance be replaced with single inheritance and if so, how?
3. What is the difference between a class and an object?
4. What is a constructor and what is it used for?

Table 3: Average score of open-ended questions (AI-assisted by rubric, n=7)

Question №	Average accuracy (0-4)	Average completeness (0-2)	Average clarity (0-2)	Average illustration (0–2)	Average final score (0-10)
1	3	1.71	1.71	0.86	7.29
2	3.43	1.57	1.57	1.14	7.71
3	2.86	1.29	1.71	0.43	6.29
4	3.71	2	1.71	1	8.43

The scores were obtained by anonymizing the responses and feeding them to a model instructed to assign scores based on the rubric criteria and return brief comments/recommendations. The final score was calculated using a given formula with weights of 0.40 for "accuracy" and 0.20 each for "completeness", "clarity" and "illustration", which emphasizes the correctness of the content without neglecting the scope, structure and applicability of the response.

The interpretation of the results indicates very strong performance on **Question 4** (average final score **8.43/10**, maximum completeness **2.00/2**), followed by **Question 2** (**7.71/10**) with high accuracy (**3.43/4**) but moderate clarity and completeness (**1.57/2**). **Question 1** is stable (**7.29/10**), with illustration (**0.86/2**) being a weaker aspect. The most challenging is **Question 3** (**6.29/10**) — lower accuracy (**2.86/4**), low completeness (**1.29/2**), and particularly low illustration (0.43/2), suggesting that definitions of "class/object" are often provided without a brief example.

Summarized by criteria: **clarity** is relatively consistent (~1.7/2), **accuracy** is high except for Question 3, **completeness** lags mainly in Questions 2 and 3, and **illustration** is the weakest component across all questions (<1.2/2). This supports the addition of an explicit requirement to "include a brief verbal example" in the instructions/rubric, the use of anchor exemplars (strong/medium/weak), as well as short micro-explanations and exercises

Closed-ended questions were also automatically scored by key in Gradescope, and an analysis of the most frequently selected wrong options was performed in parallel. The most frequently selected wrong option was "private" in the question "Which specifier provides

access in descendants, but not outside the class?", which indicates a misunderstanding of the distinction between private and protected in inheritance. Next in line was the choice of "delete" in the question "Which operator is used to free a dynamic array?", which indicates confusion between delete and delete[]. The option "indexing starts at 1" in the question about arrays was also frequently confused. These examples are indicative of the main difficulties of the students, and the combined procedure provided both speed and objectivity in the check and high diagnostic value for planning additional exercises

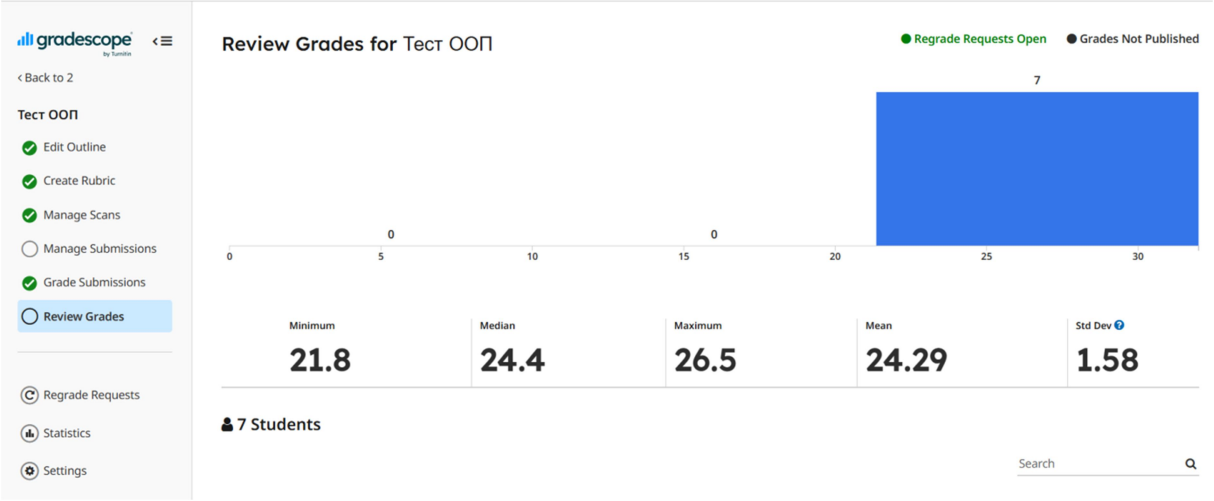

Fig. 2. Distribution of total test scores (n = 7) reported by Gradescope

The compact distribution of the total score (Fig. 2) and the closeness between the median and the mean support the observed consistency in the scoring. This corresponds to the high convergence of the AI-teacher on factual questions and the localized discrepancies on the "Illustration" criterion.

With a clear rubric, anonymized responses, and an escalation rule, the AI scores consistently and in most cases its score matches the teacher's assessment on factual and definitional questions. Human verification is still needed in borderline cases, especially when a short verbal example is missing. This combines the speed of automation with quality control and fairness.

In addition to all the advantages that AI-based scoring systems offer us, they also hide many challenges. Not all algorithms are completely transparent in their methodology, and when assessing written texts there is a risk of cultural and linguistic biases [7]. This requires careful selection of tools and combining automatic scoring with human expertise.

4. Etical and social aspects of using AI in education

Despite the significant advantages that artificial intelligence (AI) offers in education, its implementation raises a number of ethical and social issues that should not be overlooked. Technologies that process personal data, make decisions, or provide automated feedback require critical analysis from the perspectives of transparency, fairness, and the protection of human rights.

One of the main challenges is **the protection of personal data**. Many AI systems collect and process sensitive information related to students' progress, behavior, and even their emotional and behavioral states. In the absence of clarity regarding how these data are stored, shared, and used, there is a risk of violating the right to privacy. Compliance with national and international regulations (such as GDPR) is crucial to ensure learners' safety.

Another important issue concerns **algorithmic bias**. AI systems are "trained" on datasets that often reflect social, cultural, or linguistic prejudices. This can result in unequal treatment of certain groups of learners, particularly those whose thinking styles or linguistic environments differ from the "norm" embedded in the system [4].

The lack of transparency regarding how AI makes decisions is also a significant concern. For both instructors and learners, it is often difficult to understand why a particular result was recommended or graded in a specific way. This complicates the verification and correction of potential errors and reduces trust in the systems [8].

Moreover, there is a risk of **diminishing the teacher's role**. Excessive reliance on AI may undervalue the importance of human interaction in education - particularly in terms of emotional support, individualized guidance, and ethical judgment.

Last but not least, **social inequality** is a factor that is exacerbated by unequal access to digital technologies [7]. Students from poorer or remote areas often lack the necessary technology, internet connectivity or digital skills, which puts them at a disadvantage compared to their peers.

All these challenges highlight the need for **ethical standards, regulations and pedagogical responsibility** when implementing AI in education. The participation of teachers, IT specialists, psychologists and politicians is essential for the development of balanced and fair educational policies that ensure a safe and equitable environment for all learners.

CONCLUSION

Artificial intelligence is already having a significant impact on the modern education system, creating new opportunities for personalized learning, effective assessment and overall transformation of the learning process. Through intelligent platforms, adaptive algorithms and data analysis, AI helps educators create more flexible, engaging and effective educational environments that meet the individual needs of each learner.

The experimental validation presented in this article confirms the practical utility of AI-assisted assessment: a high level of agreement between AI and instructor evaluations was observed for factual and conceptual tasks, grading time was significantly reduced, and students received more diagnostic feedback.

Despite its numerous advantages, the use of AI in education is not without challenges. Issues related to data privacy, algorithmic fairness, transparency, and equitable access to technology require careful consideration. It is essential to establish an ethical framework to ensure that AI implementation is conducted responsibly and benefits all participants in the educational process.

In conclusion, the future of education lies in skillfully combining the technological capabilities of artificial intelligence with human pedagogical experience, empathy and ethics. Only through a balanced and informed approach can we build a sustainable, innovative and equitable education system that prepares learners for the challenges of the 21st century.

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REFERENCES

1. Du-Harpur, X., Watt, F. M., Luscombe, N. M., & Lynch, M. D. (2020). What is AI? Applications of artificial intelligence to dermatology. British Journal of Dermatology, 183(3), 423–430. DOI: https://doi.org/10.1111/bjd.18880
2. Floridi, L., & Cowls, J. (2019). A unified framework of five principles for AI in society. Harvard Data Science Review, 1(1). DOI: https://doi.org/10.1162/99608f92.8cd550d1
3. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.
4. 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. DOI: https://doi.org/10.1186/s41239-019-0171-0
5. Khan, S. (2024). The future of AI in education: Personalization and empowerment. Khan Academy Insights. Available at: https://www.khanacademy.org/ai-education (last view: 26-06-2025)
6. SoftUni. (n.d.). The essence and application of machine learning. SoftUni Blog. Available at: https://softuni.bg/blog/machine-learning-essence-and-application (last view: 26-06-2025)
7. OECD. (2021). Artificial intelligence and the future of skills: Evidence from OECD surveys. Organisation for Economic Co-operation and Development. DOI: https://doi.org/10.1787/75fbb8e3-en
8. Luckin, R. (2018). Machine learning and human intelligence: The future of education for the 21st century. UCL IOE Press.

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