

## **ADAPTIVE LEARNING WITH AI: ANALYSIS OF EXISTING SOLUTIONS AND DEVELOPMENT PROSPECTS**

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**Abstract.** In the context of rapid technological development, adaptive learning systems are becoming important innovations that can transform the educational process through personalization and interactivity. This article analyzes existing solutions in the field of adaptive learning using artificial intelligence (AI) and discusses the prospects for their further development. Key technologies such as natural language processing, machine learning and recommendation systems that allow content to be adapted to the individual needs of students are being explored. The advantages of such systems in increasing student engagement, academic performance and motivation, as well as their limitations related to ethical aspects and technical barriers, are shown. Based on the analysis of modern research, directions for improving adaptive systems are proposed, including improving scalability, developing inclusive solutions and ensuring data security. The article focuses on the importance of an interdisciplinary approach in the development of educational technologies to create an inclusive and effective learning experience.

**Keywords:** Adaptive learning, artificial intelligence, personalized education, machine learning, educational technologies.

**Introduction.** Adaptive learning using artificial intelligence (AI) is one of the key areas in the modern educational process. These technologies offer a personalized approach, taking into account the individual characteristics of students, their learning style, level of training and current needs. The development of adaptive learning systems has led to significant changes in the educational environment, making it more flexible and interactive.

This article is aimed at analyzing existing solutions in the field of adaptive learning, identifying their strengths and weaknesses, as well as identifying promising areas for further development. The work includes the following structural elements:

1. The level of knowledge of the problem. This section provides an overview of current research, analyzes key technologies and their role in improving the educational process.

2. Critical assessment of solutions. The existing adaptive learning systems, their advantages and limitations are considered. Special attention is paid to the ethical aspects and challenges of implementation.

3. Conclusions and prospects. Recommendations are formulated to improve adaptive learning systems, including new approaches to personalization, inclusivity and data security.

The article is aimed at specialists in the field of educational technologies, researchers and practitioners interested in using AI to improve the quality of education.

**Modern achievements in adaptive learning.** Adaptive learning using artificial intelligence (AI) is one of the fastest growing areas of educational technology. Modern systems strive to personalize the learning process by providing students with resources that match their individual abilities, preferences and learning styles. Such technologies are used in both school and higher education, increasing student engagement and academic achievement.

AI in adaptive learning systems is represented by a wide range of technologies:

- Machine learning: It is used to analyze large amounts of data on student interaction with learning platforms. For example, clustering algorithms group students based on similar behavioral and cognitive characteristics [3].

- Natural Language Processing (NLP): Allows virtual assistants to interact with students through chatbots and voice interfaces, providing timely feedback and support [2].

- Recommendation systems: These algorithms offer learning materials based on student preferences, current progress, and learning needs [1].

The AIIA (Artificial Intelligence-Enabled Intelligent Assistant) system is an example of integrating AI into higher education, where virtual assistants analyze real-time data, create personalized learning routes and provide support through LMS (Learning Management Systems) [2].

Another example is the use of the EdNet Dataset, which provides researchers with data on learning interactions. These data make it possible to evaluate the effectiveness of adaptive systems based on metrics such as student engagement and academic performance [3].

Most empirical studies show that adaptive systems increase students' motivation, engagement, and academic performance. For example: personalized recommendations help to keep students interested in the learning process, adaptive technologies help to eliminate knowledge gaps by adapting the complexity of tasks to the student's level of training [1].

The strength of such systems is their ability to adapt in real time. For example, systems can modify content based on feedback provided by students, or analyze progress using performance metrics.

**Limitations and challenges.** Despite significant progress, existing research faces a number of challenges:

- Problems of ethics and data privacy: The use of large amounts of student data requires strict compliance with confidentiality standards. In most works, this problem is only indicated, but not considered in depth [2].

- Technical limitations: Processing of big data, especially multimodal (texts, audio, video), is still limited by the performance of modern systems [3].

- Lack of empirical data: Although many studies emphasize the benefits of adaptive systems, their long-term effects on educational outcomes and cognitive development of students remain poorly understood [1].

There are several gaps in the research database. Most research focuses on the application of adaptive systems in controlled settings or on a limited sample of students. The problems of integrating these systems into global educational platforms remain unresolved. Little attention has been paid to the development of systems adapted for students with disabilities or for educational institutions with limited resources. The impact of adaptive systems on the work of teachers has not been sufficiently studied, although such systems can significantly change pedagogical strategies.

**Prospects for further research.** To eliminate the existing limitations and achieve the full potential of adaptive learning, the following steps are necessary: develop ethical standards for working with student data, in-depth studies of the long-term impact of adaptive systems on educational outcomes, scaling up research to reach global educational systems, including developing countries.

Adaptive learning with AI is already demonstrating high efficiency in solving the problems of education personalization. However, issues related to ethics, accessibility and integration of these systems into the global educational context remain open. In-depth research and collaboration between technology developers, educational institutions and scientists will help overcome these limitations and create truly effective and inclusive educational solutions.

Modern research confirms the high effectiveness of adaptive learning using AI, especially in the context of the personalization of the educational process. Adaptive systems analyze student data in real time and offer individualized learning paths, which helps to increase student engagement and motivation. For example, systems integrated with machine learning algorithms can predict students' learning behavior and intervene in a timely manner to prevent them from falling behind. These approaches demonstrate a marked improvement in academic results, especially for students with low levels of training, as such systems help fill knowledge gaps and improve understanding of complex concepts.

However, the introduction of such technologies faces a number of challenges. Firstly, it is the complexity of integrating such systems into existing educational platforms, which requires significant resources. In addition, AI systems depend on the quality of the data they analyze, which creates the risk of system errors if the data is incorrect or incomplete. Data privacy issues also remain unresolved. Although many studies focus on the importance of confidentiality, there are no generally accepted standards for the ethical use of student data.

Despite these limitations, adaptive learning is actively being implemented in practice. For example, the DreamBox Learning and Smart Sparrow platforms demonstrate a high level of student engagement through the use of real-time

recommendations and flexible content customization. However, further research is needed to understand the long-term impact of adaptive systems on educational outcomes, as well as their effectiveness in various cultural and resource contexts. Only through deeper analysis will it be possible to ensure the scaling of these technologies and their successful application in the global educational environment.

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