

**CREATING AN ADAPTIVE LEARNING ENVIRONMENT BASED ON
ARTIFICIAL INTELLIGENCE AND ITS IMPACT ON THE QUALITY OF
PRIMARY EDUCATION**

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Abstract. This article analyzes the theoretical and practical impact of adaptive learning environments based on artificial intelligence technologies on the quality of primary education. The article highlights the main components of adaptive systems: dynamic assessment, personalized learning trajectories, real-time feedback, and teacher support mechanisms. It argues that the cognitive, emotional, and social development of children of primary school age should be taken into account when designing AI-based systems. It also evaluates the impact of adaptive learning on the quality of education in terms of: mastery level, motivation, reducing inequality, and changing the role of the teacher. The article also analyzes the pedagogical, ethical, and technological problems of implementing AI adaptive learning.

Keywords: artificial intelligence, adaptive learning, primary education, personalized learning, quality of education, learning trajectory, dynamic assessment, digital transformation in education.

Introduction. One of the most important tasks facing the modern education system is to provide personalized education on a mass scale, tailored to the individual needs of each student. The traditional education model, i.e. the “one size fits all” principle, cannot fully compensate for the differences in the level of knowledge, speed of perception, interests and cognitive styles of students in the classroom. This problem is especially acute at the primary education stage, since it is during this period that children develop an attitude towards learning, self-confidence and basic academic skills. The rapid development of artificial intelligence (AI) technologies in the last decade has created fundamentally new opportunities for solving this problem. Adaptive learning environments based on artificial intelligence allow not only to adapt educational material to each student, but also to assess his knowledge in real time, predict and build an individual development trajectory. This article theoretically analyzes the impact of adaptive educational systems on the quality of primary

education, highlights their structural elements, advantages, as well as problems associated with their implementation.

Relevance of the topic. The modern education system is moving to a new level under the influence of the rapid development of digital technologies and artificial intelligence. In particular, organizing the educational process taking into account the individual characteristics of students in primary education is one of the urgent problems. In this regard, creating an adaptive educational environment based on artificial intelligence and implementing it in practice is recognized as an important factor in improving the quality of primary education. An adaptive educational environment allows for the individualization of educational materials in accordance with the level of knowledge, abilities and learning speed of students. Artificial intelligence technologies create the opportunity to automate this process, analyze the level of students' mastery, and offer appropriate learning strategies. As a result, the effectiveness of the educational process increases, and each student's personal development trajectory is formed. At the same time, the analysis of existing practice shows that the use of adaptive learning environments based on artificial intelligence in the primary education system has not been sufficiently established. In many cases, the educational process, based on traditional methods, cannot fully meet the individual needs of students. This negatively affects the quality of education, the level of motivation and mastery of students.

In this regard, the development of pedagogical and technological foundations for creating adaptive learning environments based on artificial intelligence, scientifically substantiating its impact on the quality of primary education and implementing it in practice determines the relevance of this study. Scientific research conducted in this area serves to individualize the educational process, increase the effectiveness of students' learning, and develop modern pedagogical approaches.

Topic analysis. An adaptive learning environment is a digital system that automatically changes its content, speed, complexity, and presentation method based on data collected from the student's interactions. Artificial intelligence is the "mental" center of this system, combining three main components: a student model (a set of data about his knowledge, cognitive characteristics, motivation, and even emotional state), a pedagogical model (a knowledge base about what strategies, tips, and explanations should be given to achieve the goal), and a content model (the structural structure of educational materials, their interrelationships, and levels of difficulty). Designing adaptive systems in the context of primary education requires special responsibility.

This is because abstract thinking in children aged 6 to 10 is not yet fully developed, attention spans are short, and play remains one of the main types of activity. Therefore, adaptive systems designed for primary grades should not only personalize knowledge, but also include game elements (gamification), visual and audio stimuli, as well as mechanisms that take into account the emotional state of the child. For example, an SI system that detects that a child has made a mistake several times, instead of giving him a more difficult problem, can re-explain the topic in a different way, through an interactive simulation or story, identify the gap in understanding that caused the mistake, and offer exercises aimed at eliminating it. Such an approach allows you to identify and eliminate the problem of "knowledge gaps" at an early stage, which prevents the student from lagging behind in mastering at later stages.

The impact of adaptive learning on the quality of primary education can be considered in several main directions. First, it is an improvement in learning outcomes. Meta-analyses conducted in different countries show that in classes using adaptive systems, the learning rate of students is significantly higher than in classes taught in the traditional way. This is because each student works in his own zone - that is, in the "zone of proximal development" that Vygotsky noted. The SI system offers the student not very easy or very difficult materials, but tasks that are one step above his current level of knowledge, but are quite manageable. This is especially important in primary education, because constant failure can form a complex in a child "I am not able to study". On the contrary, constant slight success slows down development. The adaptive system automates the maintenance of this delicate balance. Secondly, adaptive learning serves to increase students' intrinsic motivation. For primary school students, quick and positive feedback is important. In a traditional classroom, a teacher cannot provide immediate feedback to 30-40 students at a time. The SI system, on the other hand, instantly responds to each student's every move, visually shows his success, analyzes his mistakes, and suggests the next step. This strengthens the child's sense of ownership of his learning process, forming the belief that "I can do it." Thirdly, adaptive systems can help reduce inequality in education. Children from different socio-economic backgrounds come to school with different levels of readiness. The SI system allows each child to start exactly at their own level, without marking any child as "left behind" or "advanced." This is especially crucial for children starting primary school, as it sets the stage for a positive first experience at school. Fourth, adaptive learning fundamentally changes the role of the teacher. Many fear that AI will make teachers unemployed. However, experience shows that adaptive systems free the teacher from

routine, mechanical tasks - checking numerous notebooks, explaining the same topic over and over again, assessing students' knowledge. In return, the teacher will be able to devote more time to individual work with each student, developing their creative abilities, organizing group projects and, most importantly, to the child's emotional and social development. AI systems provide the teacher with detailed reports through analytical tools on the general state of the class, in which subjects each student is struggling, and which students need additional attention. This allows the teacher to make informed, accurate, and effective decisions.

Despite the effectiveness of adaptive learning environments based on artificial intelligence, their introduction into primary education is associated with a number of serious problems. First of all, this is a question of ethics and the protection of personal data. Adaptive systems collect and analyze a huge amount of data about the student - from his cognitive characteristics to emotional reactions. Without resolving issues such as how to protect the personal data of primary school children, who can use this data and for what purposes, as well as the level of parental control, it can be dangerous to introduce the systems on a large scale. The second important problem is digital inequality. The use of adaptive systems in primary education requires stable internet, modern devices and technical support. Schools in socio-economically disadvantaged areas may not have these opportunities, which is likely to further deepen the gap in education. The third problem is the digital competence of teachers and their trust in the system. No matter how perfect an adaptive learning environment is, it is only as effective as the teacher can use it and interpret its results in the direction of pedagogical goals. Many primary school teachers, especially older teachers, have psychological barriers to using new technologies. Therefore, the introduction of adaptive systems must be accompanied by teacher training programs and ongoing methodological support for them. Fourth, the pedagogical foundations of adaptive systems in primary education have not yet been fully developed. Many existing systems are designed mainly for specific subjects such as mathematics and the mother tongue, and the possibilities for using adaptive approaches in areas such as creative thinking, music, physical education or the development of social skills are limited. In addition, for a primary school child, live communication with a teacher, cooperative play and discussions with peers are important factors that SI can never fully replace. Therefore, adaptive learning environments should not be seen as a complete replacement for traditional classroom activities, but as a means of enriching them and empowering the teacher.

In conclusion, adaptive learning environments based on artificial intelligence have great potential for improving the quality of primary education. They allow creating a personalized learning trajectory taking into account the individual characteristics of each child, providing real-time feedback, freeing the teacher from routine workloads, and reducing inequality in education. However, to realize this potential, it is necessary not only to create technological solutions, but also to set ethical standards, develop digital infrastructure, improve the skills of teachers, and, most importantly, to thoroughly develop the pedagogical foundations of adaptive education. Primary education is the stage that is the foundation of personality formation. At this stage, artificial intelligence technologies should be used as a tool that expands the capabilities of the human factor, rather than displacing it. Only then can adaptive learning environments serve to improve the quality of education, realize the abilities of each child, and prepare them for lifelong learning. In the future, the integration of adaptive systems with elements of neuroscience, emotional AI, and augmented reality technologies will make primary education more effective, interesting, and in line with the nature of the child. In this regard, the cooperation of representatives of the fields of pedagogy, psychology, computer science, and neurobiology will be of great importance.

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