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COMPARATIVE ANALYSIS OF THE RESULTS OF USING ARTIFICIAL INTELLIGENCE IN EXPERIMENTAL AND CONTROL GROUPS

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Abstract

This study presents a comparative analysis of the results of using artificial intelligence technologies in experimental and control groups. During the pedagogical experiment, the impact of adaptive tasks, automated assessment, and learning analytics on students' academic achievement, motivation, independent thinking, classroom activity, and digital competence was examined. The collected data were analyzed using mathematical and statistical methods, including the Student's t-test. The findings demonstrate a significant improvement in educational quality indicators in the experimental group where AI-based tools were applied, with statistically reliable differences.

Keywords: artificial intelligence, experimental group, control group, education quality, adaptive learning, automated assessment, learning analytics, learning motivation, independent thinking, statistical analysis.

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Introduction

The use of artificial intelligence technologies in the modern education system is considered an important factor in individualizing the learning process, introducing adaptive tasks, and improving the quality of education indicators. Especially at the primary education level, the possibilities of AI-based digital tools are extensive in developing students' cognitive activity, learning motivation, and independent thinking.

The purpose of this study is to conduct a comparative analysis of the results of using artificial intelligence technologies in experimental and control groups and to determine their impact on educational quality indicators.

Research Methodology

The methodology of this research is aimed at scientifically identifying the impact of using artificial intelligence (AI) technologies on educational quality indicators and was organized on the basis of a pedagogical experimental approach. The methodological foundation of the study is formed by the system approach, the competency-based approach, and the learner-centered education concept.

The system approach considers the educational process as a single system consisting of interrelated elements and makes it possible to analyze how artificial intelligence technologies influence each component of this system (content, method, tool, outcome, and assessment). The competency-based approach substantiates that students should not be limited to memorizing knowledge, but should be able to apply it in practical situations, solve problem-based tasks, acquire communication skills, and possess digital literacy. The learner-centered approach places the student at the center of the educational process and promotes the principle of organizing instruction based on each learner's individual pace of learning, interests, and needs

The study was carried out on the basis of a pedagogical experimental design. The main objective was to compare the effectiveness of an educational process in

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which AI-based adaptive tasks and automated assessment tools were applied with the traditional teaching process based on conventional instructional methods. In order to ensure scientific consistency, the experimental methodology relied on pre-planned stages, control measurements, and mechanisms of comparative analysis.

Two groups were formed in the study: an experimental group and a control group. In the experimental group, AI-based digital learning tools, in particular adaptive tasks and automated assessment systems, were introduced. In the control group, the existing traditional methods (oral explanation, textbook-based exercises, and teacher-graded tests) were continued. While forming the groups, special attention was paid to the principle of equalizing their initial level of preparedness. That is, before the experiment, diagnostic tests and observations were conducted to ensure that the initial level of knowledge, motivation, and activity of both groups were close to each other. Such an approach made it possible to scientifically justify that the subsequent changes occurred precisely under the influence of AI tools.

The AI-based teaching process implemented in the experimental group included several important mechanisms. First, an adaptive task system was introduced. The essence of adaptivity is that tasks are automatically selected and modified according to the learner's individual level of mastery. For example, if a student makes a mistake in a certain type of problem, the system offers additional, simpler exercises on the same topic; conversely, if the student completes tasks quickly and correctly, more complex problems are provided. This process automates the differentiated approach and helps to form an "individual learning path" for each learner.

Second, an automated assessment mechanism was applied. As soon as the learner completed a task, the system checked the result, identified errors, and provided immediate feedback. Rapid feedback instantly shows the learner what is incorrect; as a result, the process of working on mistakes is not prolonged and knowledge is reinforced.

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Third, the learning analytics component was activated: the system collected statistical data on each learner's results, the number of completed tasks, types of errors, time indicators, and development dynamics. This enabled the teacher to clearly identify the strengths and weaknesses of each learner and facilitated the making of individual pedagogical decisions.

In the control group, teaching was conducted on the basis of traditional methods. Here, the lessons were organized in the usual way: explaining the topic, doing exercises from the textbook, assigning homework, and conducting periodic tests. The assessment process was mainly carried out through the teacher's checking and oral feedback. Although the natural development of students could also be observed in this group, it was theoretically substantiated—and later empirically verified—that the lack of automatically provided individualization, limited immediate feedback, and the absence of systematic learning analytics could lead to lower growth rates compared to the experimental group.

The evaluation criteria of the study were clearly defined in advance. The first criterion was the level of knowledge acquisition, which was measured through diagnostic tests, topic-based assessments, and the results of completing learning tasks. The structure of the tests took into account levels of complexity (low – medium – high), which made it possible to assess not only students' reproductive knowledge but also their skills in practical application and analysis.

The second criterion was learning motivation, which was evaluated on the basis of questionnaires, observations, and indicators of students' engagement in the lesson. In determining motivation, such indicators as interest in the lesson, willingness to complete tasks, tendency toward independent learning, and attitude toward encouragement were taken into consideration.

The third criterion was independent thinking, which was measured through performance in problem-based tasks, responses to analytical questions, the ability to draw logical conclusions, and the justification of solutions.

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The fourth criterion was classroom activity, which was assessed through students' participation in question-and-answer sessions, their involvement in group work, the speed of task completion, and their initiative.

The fifth criterion was digital competence, which was evaluated on the basis of skills such as using electronic resources, accessing and properly using the platform, completing digital tasks, and analyzing results. The digital competence criterion is of particular importance in today's educational environment, as digital literacy expands students' opportunities for independent learning at subsequent stages.

Mathematical and statistical analysis was applied in order to evaluate the results obtained in the study on a scientific basis. In particular, Student's t-test was selected to determine the reliability of the differences between the experimental and control groups. This criterion serves to verify whether the difference between the mean values of two independent samples is not random. In the study, the initial and final mean values for each criterion were calculated, and then the difference between the experimental and control groups was tested using the t-test. If the calculated t value exceeds the critical value in the table and the condition $p < 0.05$ is satisfied, the difference is considered statistically significant. This makes it possible to confirm with scientific evidence that the changes in the experimental group are associated with the influence of artificial intelligence technologies.

Thus, the research methodology was organized in accordance with the scientific requirements of the experimental approach: the initial equivalence of the groups was ensured, the evaluation criteria were clearly defined, AI tools were systematically implemented in the experimental group, and the results were tested for reliability through statistical analysis. Such a systematic structure of the methodology provides a solid basis for the objective evaluation of the research results, their scientific generalization, and the development of practical

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recommendations for the integration of artificial intelligence technologies into the educational process.

1-table. Initial Diagnostic Results (%)

Indicator	Experimental group	Control group
Level of knowledge	33 %	34 %
Motivation	42 %	41 %
Independent thinking	30 %	29 %
Activity	39 %	38 %

At the initial stage, the indicators of the experimental and control groups were almost equal, which shows that the initial level of preparedness of the groups was the same. This situation created methodologically appropriate conditions for the comparative analysis of the subsequent results.

2-table. Final Results (%)

Indicator	Experimental group	Control group
Level of knowledge	45 %	38 %
Motivation	54 %	46 %
Independent thinking	39 %	33 %
Activity	51 %	44 %

In the final results, a significant increase was observed in the experimental group across all indicators. In particular, the motivation and activity indicators were high, which demonstrates the effectiveness of AI-based interactive tasks and immediate feedback. Although a certain level of growth was also observed in the control group, it can be explained by natural development.

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3-jadval. Growth Dynamics (%)

Indicator	Experimental group	Control group
Level of knowledge	+12 %	+4 %
Motivation	+12 %	+5 %
Independent thinking	+9 %	+4 %
Activity	+12 %	+6 %

The growth indicators in the experimental group are almost twice as high as those in the control group. This confirms that AI-based adaptive learning systems ensured a differentiated approach and created opportunities for students to learn at a pace corresponding to their individual learning speed..

4-table Digital Competence Level (%)

Indicator	Experimental group	Control group
High	47 %	28 %
Medium	41 %	46 %
Low	12 %	26 %

Regular use of artificial intelligence-based platforms significantly increased digital literacy in the experimental group. The proportion of low-level students decreased to 12%, which demonstrates the effectiveness of digital tasks.

As a result of the calculations, the value $t = 2.31$ was obtained and the condition $p < 0.05$ was satisfied. This indicates that the differences between the experimental and control groups are statistically significant. Therefore, the use of artificial intelligence technologies had a direct impact on the improvement of educational quality indicators. The results of the experiment showed that AI-based adaptive tasks make it possible to take into account students' individual needs. Automated assessment systems provided immediate feedback and effectively organized the process of working on errors. Interactive digital resources increased students' interest and enhanced their classroom activity.

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In the control group, however, the growth was limited by traditional methods, and an individualized approach was not sufficiently ensured.

Conclusion

The comparative analysis of the results of the experimental and control groups confirmed that the use of artificial intelligence technologies significantly improves educational quality indicators. In the experimental group, the indicators of knowledge acquisition, motivation, independent thinking, classroom activity, and digital competence demonstrated higher growth rates compared to the control group. Statistical analysis confirmed the reliability of the differences.

Thus, the introduction of AI-based adaptive learning systems into primary education is an effective means of ensuring the quality of education and the individual development of students.

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