

PEDAGOGICAL FOUNDATIONS OF AI-TUTOR SYSTEMS IN E-LEARNING PLATFORMS AND THEIR SIGNIFICANCE IN TEACHING PROGRAMMING

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Abstract. This article examines the pedagogical foundations of AI-Tutor systems as electronic learning platforms and their significance in programming education. The study explores the potential of artificial intelligence-based educational technologies to personalize the learning process, monitor students' knowledge levels, provide adaptive learning materials, and support independent learning activities. Furthermore, the advantages of AI-Tutor systems in strengthening theoretical knowledge, developing practical programming skills, and providing immediate feedback are discussed. The findings indicate that the integration of artificial intelligence technologies into education contributes to improving the quality and effectiveness of learning, enhancing student motivation, and developing professional competencies in programming education.

Keywords: AI-Tutor, artificial intelligence, e-learning, digital education, programming education, pedagogical technologies, adaptive learning, interactive learning, educational platforms, learning effectiveness.

Introduction. The rapid development of digital technologies worldwide is bringing about fundamental changes in the education system as well. In particular, the widespread implementation of Artificial Intelligence (AI) technologies in the educational process is contributing to the creation of new forms and methods of teaching. In the modern education system, providing quality education based on learners' individual needs, improving the assessment of knowledge, and increasing the effectiveness of the learning process are considered among the most urgent issues. From this point of view, AI-Tutor systems operating on the basis of artificial intelligence are of particular importance as an innovative solution in organizing the educational process.

In recent years, the development of electronic learning platforms has led to the widespread use of distance and blended learning formats. However, traditional e-learning systems are often characterized by presenting the same content and materials to all learners [1]. As a result, differences in learners' levels of knowledge, interests, and pace of learning are not sufficiently taken into account. AI-Tutor systems, by using artificial intelligence algorithms, analyze each learner's level of knowledge, form an individual learning trajectory, and offer adapted recommendations and assignments.

The process of teaching programming disciplines has its own specific complexities. Students must not only master theoretical knowledge but also acquire the skills to solve practical problems independently. During practical lessons, identifying each student's mistakes in a timely manner and providing individual support requires a great deal of time and effort from the teacher. AI-Tutor systems help organize this process effectively by analyzing program codes, identifying errors, providing explanations, and offering appropriate recommendations. This contributes to the development of students' independent learning skills, the formation of algorithmic thinking, and the improvement of programming competencies.

Today, numerous scientific studies are being conducted on the study of artificial intelligence-based educational technologies and their integration into the educational process.

The purpose of this article is to analyze the pedagogical foundations of AI-Tutor systems as electronic learning platforms and to highlight their importance in teaching programming. In the course of the research, the functional capabilities, pedagogical advantages, and role of AI-Tutor systems in improving educational effectiveness are analyzed from a scientific and theoretical perspective.

Methods. In this study, theoretical and empirical research methods were used to determine the pedagogical foundations of AI-Tutor systems as electronic learning platforms and their importance in teaching programming. The research process was carried out in several stages and was aimed at comprehensively

analyzing the impact of artificial intelligence-based educational technologies on the learning process [2].

In the first stage of the study, scientific literature related to the topic, articles published in international scientific journals, conference materials, and scientific sources devoted to e-learning and artificial intelligence technologies were studied. At this stage, the methods of analysis, synthesis, comparison, and generalization were used. Through the analysis of the literature, the development trends of AI-Tutor systems, their pedagogical opportunities, and the experience of their application in programming education were identified.

In the second stage of the study, the functional capabilities of AI-Tutor systems were analyzed from a pedagogical point of view. In particular, such functions as automatic assessment of knowledge, provision of adaptive learning materials, formation of individual learning paths, real-time consultation, and monitoring of learners' activities were studied. In this process, the methods of systematic analysis and pedagogical modeling were applied.

In the third stage, observation and comparative analysis methods were used to evaluate the effectiveness of AI-Tutor systems in teaching programming. In this regard, the results of learning processes organized with the use of artificial intelligence-based educational tools and those organized through traditional methods were compared. The students' level of mastering theoretical knowledge, the quality of completing practical assignments, independent learning skills, and learning motivation were defined as the main assessment criteria.

Results and Analysis. During the study, the impact of AI-Tutor systems on the process of teaching programming was analyzed from pedagogical and methodological perspectives. The results of the study showed that the use of artificial intelligence-based electronic learning platforms contributes to increasing the effectiveness of students' learning activities.

The analysis revealed that one of the most important advantages of AI-Tutor systems is the ability to individualize the educational process. While in traditional teaching the same assignments and learning materials are used for all students, AI-

Tutor systems recommend tasks according to each student's level of knowledge, learning pace, and difficulties. As a result, students receive more support in mastering complex topics and have the opportunity to eliminate gaps in their knowledge more quickly [3].

In the process of teaching programming disciplines, AI-Tutor systems appeared as an effective auxiliary tool for writing code, creating algorithms, and identifying programming errors. The immediate feedback provided by the system helped students independently identify and correct their mistakes. This had a positive impact on the development of students' critical thinking and problem-solving competencies.

The research results also showed that students' activity and motivation increased in learning sessions organized with the help of AI-Tutor systems. Interactive assignments, automatic assessment mechanisms, and individual recommendations strengthened students' interest in the learning process. As a result, they devoted more time to independent learning activities and achieved higher results in completing practical assignments.

The analysis also revealed that AI-Tutor systems have a positive impact on teachers' activities. In particular, automatic assessment and monitoring capabilities reduce teachers' time expenditure and allow them to focus more on methodological and creative activities. At the same time, based on the data collected through the system, it becomes possible to regularly monitor students' level of mastery and implement an individual approach [4].

However, some problems were also observed during the study. In particular, the effective use of AI-Tutor systems requires a stable internet connection, modern technical devices, and a sufficient level of digital competencies. In addition, the recommendations provided by artificial intelligence cannot always fully replace the professional decisions of a teacher. Therefore, AI-Tutor systems should be regarded not as a tool that replaces the teacher, but as a technology that supports the teacher's professional activity.

Discussion. The results of the study showed that AI-Tutor systems can be effectively used as an important pedagogical tool in the process of teaching programming.

In teaching programming disciplines, students' levels of knowledge and pace of learning differ significantly from one another [5]. Therefore, it is difficult to ensure an individual approach to each student in traditional classroom lessons. AI-Tutor systems partially solve this problem by making it possible to organize an adaptive learning process that takes into account students' individual characteristics. This contributes to the effective implementation of the principles of learner-centered education in practice.

Another important aspect identified during the study is the role of AI-Tutor systems in developing students' independence. Practical exercises and independent work play a key role in learning programming. Artificial intelligence-based support systems encourage students to work on their mistakes, solve problems independently, and regularly assess their own knowledge [6]. As a result, learners develop not only technical skills but also self-management and reflection competencies.

At the same time, certain limitations in the implementation of AI-Tutor systems in the educational process should not be overlooked. First, the insufficient development of technological infrastructure may limit the effective use of these systems in some educational institutions. Second, there is a possibility that the recommendations of artificial intelligence algorithms may not fully take into account all aspects of pedagogical situations. This is because the educational process is closely connected not only with the transmission of knowledge but also with educational, motivational, and social factors.

Furthermore, the use of AI-Tutor systems does not reduce the role of the teacher; on the contrary, it raises it to a new level. A modern teacher acts as a specialist who analyzes the data provided by artificial intelligence, manages the learning process, and supports students' personal development [7]. Therefore,

developing teachers' competencies in working with digital technologies and artificial intelligence will remain one of the important tasks in the future.

Conclusion. This study analyzed the pedagogical foundations of AI-Tutor systems as electronic learning platforms and their importance in teaching programming. The results of the study showed that artificial intelligence technologies are an effective tool for individualizing the educational process, identifying students' levels of knowledge, providing adaptive learning materials, and organizing mechanisms for immediate feedback.

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