

THE SIGNIFICANCE OF AI TECHNOLOGIES FOR TEACHING PROGRAMMING LANGUAGES

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Abstract: *This article analyzes research conducted by local and foreign scholars on teaching programming languages. It highlights the applications of artificial intelligence technologies in programming education, including the advantages of automatic assessment, personalized feedback, and intelligent tutoring systems. Furthermore, the article explores opportunities for developing students' algorithmic thinking, detecting errors in program code, and creating individualized learning paths.*

Keywords: *Programming languages, programming education, intelligent learning systems, automatic assessment, program code analysis.*

The use of modern technologies in the education system is becoming increasingly important for today's digital technology specialists. In particular, the application of artificial intelligence technologies in teaching programming languages is proving to be a vital tool for increasing the efficiency of the educational process, developing students' independent thinking, and forming individual learning paths. The field of programming requires not only theoretical knowledge but also practical skills. For this reason, traditional teaching methods cannot always fully accommodate the needs of all students. Given that students' knowledge levels, logical reasoning, algorithmic approaches, and coding abilities differ, it becomes necessary to create a learning environment tailored to them.

For instance, when learning programming languages, a student might make syntactic or logical errors during the coding process. AI-based learning tools can quickly identify these errors, explain their causes, and guide the student toward the correct solution. This process helps the student not just to receive a ready-made answer, but also to develop the skills to understand, analyze, and independently correct the error.

Today, the labor market is increasingly demanding skills in programming, algorithmic thinking, problem-solving, and the effective use of digital technologies. Therefore, the use of modern, interactive, and intellectual educational tools in teaching programming languages is an important pedagogical task. Artificial intelligence technologies allow for the linking of theoretical knowledge with practical exercises in the educational process, increasing student motivation, expanding opportunities for independent learning, and accurately analyzing learning outcomes. The application of artificial intelligence

technologies in teaching programming languages manifests in various forms. In particular, the educational process will be more effectively organized through intelligent learning platforms, automatic code verification systems, chatbots, virtual assistants, adaptive testing systems, electronic simulators, and recommendatory training modules. Such tools allow students to study the topic independently, complete practical tasks, work on mistakes, and gradually develop their knowledge.


In this regard, scientific research, specifically on the use of artificial intelligence technologies for teaching programming languages, has been carried out by our country's scholars, namely N.N. Zaripov [2], U.U. Jumankuziev [3], U.M. Mirsanov [4], F.M. Zakirova [5] and F.J. Tokhirov [6]. The research works of these scholars are dedicated to the methodology of teaching programming languages to students and information and communication technologies, distance learning, and programming languages. However, their work does not pay attention to the use of AI technologies for programming languages. In particular, the research of U.M. Mirsanov and F.J. Tokhirov focuses on improving the scientific and methodological foundations of teaching programming technologies, and this work:

- a model for developing logical and algorithmic thinking in programming has been developed, which is based on systemic-activity, semantic, problem-based, and cognitive approaches;
- the educational-organizational model for teaching the Scratch (visual), Python (structured), and Delphi (object-oriented) programming languages has been improved;
- a methodology has been developed for using web-quest technology, project-based learning, and web-adapted tools in programming instruction;
- an organizational-structural model for developing students' team-based project creation, creative abilities, and cognitive thinking has been proposed;
- an open informational-educational environment, software tools with methodological support, and algorithmic mental schemas have been developed to enhance students' programming competencies.

Additionally, scientific research in teaching programming languages has been conducted by scholars from the Commonwealth of Independent States, such as D.A. Sharov [7], N.O. Kuznetsov [8], and Y.A. Petrova [9].

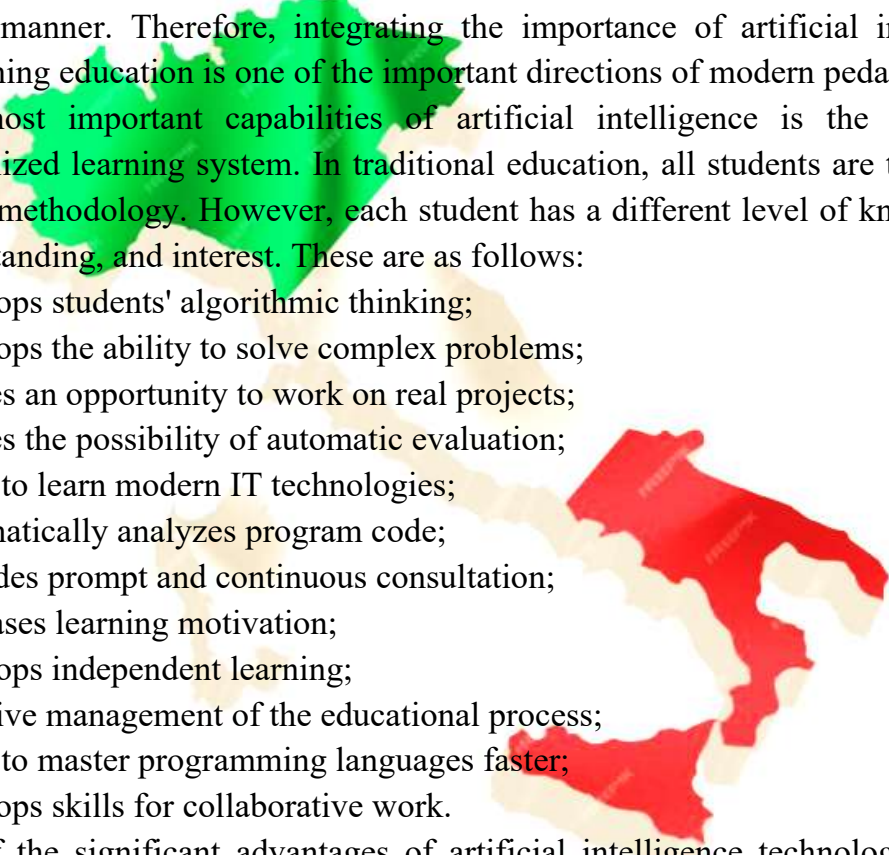
In the international community, the use of artificial intelligence technologies in education has been explored by scholars such as Yoshinari Hachisu [10], Atsushi Yoshida [11], Angelo Kyrilov [12], David C. Noelle [13], and M. Di Salvo [14].

The works of the scientists listed below indicate three main directions for using artificial intelligence technologies in teaching programming languages: automatic task creation, automatic assessment, and individual feedback. These approaches help students develop skills in independent work, error detection, algorithmic thinking, and debugging.



In particular, the possibilities and limitations of artificial intelligence, written by M. Di Salvo, are analyzed in comparison with human intelligence. The scholar highlights theoretical and practical issues related to the implementation of artificial intelligence technologies in society, law, and education. The main goal of the study is to identify ontological and functional differences between human intelligence and artificial intelligence, and to evaluate the role of artificial intelligence systems in decision-making processes. However, in this scientist's research on programming languages, attention was not paid to students' algorithmic thinking and individual training in solving complex problems.

The application of artificial intelligence technologies in teaching programming serves to organize the educational process in a person-centered, interactive, adaptive, and effective manner. Therefore, integrating the importance of artificial intelligence into programming education is one of the important directions of modern pedagogy. Also, one of the most important capabilities of artificial intelligence is the creation of an individualized learning system. In traditional education, all students are taught based on the same methodology. However, each student has a different level of knowledge, speed of understanding, and interest. These are as follows:

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- develops students' algorithmic thinking;
 - develops the ability to solve complex problems;
 - creates an opportunity to work on real projects;
 - creates the possibility of automatic evaluation;
 - helps to learn modern IT technologies;
 - automatically analyzes program code;
 - provides prompt and continuous consultation;
 - increases learning motivation;
 - develops independent learning;
 - adaptive management of the educational process;
 - helps to master programming languages faster;
 - develops skills for collaborative work.

One of the significant advantages of artificial intelligence technologies in teaching programming languages is the individualization of the educational process. Each student differs in their speed of mastery, level of knowledge, and practical training. Artificial intelligence systems can analyze a student's completed tasks, answers, coding errors, and activities, and recommend exercises of appropriate complexity. As a result, strong students work on more complex problems, while students with gaps in knowledge reinforce their knowledge through additional explanations and simple tasks.

Also, the importance of artificial intelligence technologies effectively supports the activities of teachers. In programming subjects, many practical tasks, laboratory work, and

code verification require a lot of time and effort from the teacher. Automatic AI-based assessment systems can check students' program code, identify errors, analyze results, and provide preliminary conclusions according to assessment criteria. This allows the teacher to save time, work individually with each student, and improve the quality of education.

In implementing the aforementioned tasks, the importance of using artificial intelligence technologies to effectively spend students' leisure time in organizing an educational system designed for teaching programming languages is achieved through algorithmic thinking and individual training.

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