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The use of artificial intelligence in teaching programming to students

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Abstract. In the context of rapid integration of artificial intelligence (AI) into all spheres, including education, understanding its impact on the learning process, especially in the field of programming, is of paramount importance. The aim of this paper was to identify and evaluate the impact of AI on the formation of students' programming competences and to develop recommendations for optimising its application in the academic environment. The study was conducted using empirical methods, including anonymous questionnaire survey of second-year students of two leading universities. The study found that 100% of surveyed students actively used AI in the learning process, with a significant majority (78.5%) regularly interacting with AI applications, indicating a high degree of dependence, exacerbated by insufficient fundamental training and limited access to paid resources. It was found that students often perceive AI outputs uncritically and tend to focus on getting ready-made code without delving into understanding the algorithms, potentially leading to a loss of autonomy and errors. Despite these challenges, AI is showing significant benefits such as personalising learning, increasing efficiency and engagement, positioning itself as a powerful support tool for educators. The data obtained also indicate insufficient differentiation of the concepts of "AI" and "neural networks" among the respondents, which emphasises the need for deeper theoretical training and development of analytical skills. The results of the study provided valuable information for teachers and educational programme developers, allowing them to adjust approaches to teaching programming, to strengthen the emphasis on critical thinking and independence, and to develop methods for effective integration of AI into the educational process, taking into account its advantages and limitations

Keywords: educational process; automation; platforms; ChatGPT; Gemini; DeepSeek; GitHub Copilot

INTRODUCTION

The educational process cannot be imagined without the active introduction of artificial intelligence (AI), especially in the field of programming. The rapid development of technologies and the growing demand for qualified specialists in the field of information technology, the use of AI in teaching programming opens new horizons for students and teachers. For faculty, the impact of AI on student learning is of great interest (Shevchuk & Hunaza, 2025). Research on the application of AI to facilitate programming instruction is actively developing. A. Tseplyaev (2023) noted that there are more and more ways to simplify the process of learning programming through the emergence of AI-based code generation models that can be used in the implementation of low-level tasks. This can allow students to focus on higher level algorithms.

A. Sazonov (2024) noted that the use of AI in software development opens unique opportunities for programmers to improve creation processes, optimise code, automate tasks, and even create innovative solutions. K. Kurbanova (2025) in her article noted that the use of

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artificial intelligence in the organisation of self-study of "Fundamentals of Programming" opens new opportunities for effective, flexible and personalised learning. In turn, S. Bevzenko (2024) emphasised that the study of automatic programming methods with the use of artificial intelligence is a promising direction that has the potential to change the ways in which program code is created. Automatic programming in natural language makes the process of creating software code more accessible for people without specialised IT education, which expands the potential audience of developers. M. Kaleem *et al.* (2024) noted that solving a typical programming problem involves algorithmic thinking, pattern recognition, decomposition and abstraction skills. These skills are the foundation of computational thinking (CT) and are essential for a programmer. Therefore, the programming instructor needs to consider these skills when assessing students. Universities are gradually adjusting the curriculum of undergraduate students to include more computer-oriented courses such as data mining, Python programming, and database applications, argued S. Zhang *et al.* (2023).

The new phase is related to the introduction of generative AI based on Large Language Models (LLM) such as GPT (OpenAI), Gemini (Google), Llama (Meta) and Claude3 (Anthropic). O. Herden (2024) wrote that generative artificial intelligence (GIA) has caused a big stir recently. These systems have the ability to generate text, images, or other data using generative models. They will have an impact on all kinds of knowledge work, especially writing computer programmes. For software developers, the way of working will change using these systems. Therefore, it is necessary to show students the use, possibilities and limitations of these techniques.

Embedding generative AI into specialised platforms is considered to be a more effective approach. K. Kuramitsu *et al.* (2023) observed that coding assistance with deep learning is an emerging problem that has attracted a lot of attention in the software development community. To compactly integrate coding assistance with deep learning, the authors focused on neural machine translation (NMT), which allows users to translate natural language descriptions into expressions in a programming language such as Python. In turn, M. Abolnejadian *et al.* (2024) believe that it is possible to teach students an introduction to Python programming through a dedicated learning platform that uses ChatGPT to create personalised learning materials based on each student's educational experience. P. Menon (2023) suggested using GitHub Copilot, which can provide coding suggestions and generate correct and readable code in common programming languages. The use of Copilot in programming courses encourages teachers to learn about Copilot's capabilities and how they could adapt their teaching by incorporating an AI assistant capable of generating code. S. George & P. Dewan (2024) noted that the success of GPT in coding tasks made it important to consider the impact of GPT and similar models on the teaching of programming.

Students' use of GPT to solve programming problems can hinder their learning. However, they can also gain significant benefits such as quality feedback on programming style, explanations of how a given piece of code works, help in debugging the code, and the ability to see valuable alternatives to their code solutions. The aim of this paper was to comprehensively analyse the impact of AI on students' programming skills and to identify optimal strategies for its use in the learning process.

MATERIALS AND METHODS

An empirical study in the form of an anonymous questionnaire was conducted to investigate students' general awareness of, and attitudes towards, the use of artificial intelligence in education, as well as the extent to which they depend on AI when studying programming. This method was chosen as it was considered the most suitable for collecting data on the opinions, knowledge, and behavioural patterns of a large group of respondents while ensuring confidentiality and minimising response bias. The study took place in the 2024/25 academic year and involved 65 second-year students from two higher education institutions: J. Balasagyn Kyrgyz National University (25 students from the IVT-23 group) and Al-Farabi Kazakh National University (branch in Bishkek) (40 students from the KI-23 group). All respondents were enrolled on the "Programming" course, ensuring the relevance of the sample for the purposes of this study.

Traditional paper questionnaires were used for data collection. The questionnaires were self-administered, allowing students to answer at their own pace and without direct influence from the researchers. The form of the survey was mixed, including both closed-ended questions with suggested answers and open-ended questions requiring extended comments. The questionnaire consisted of eight key questions aimed at gathering information about different aspects of students' interactions with AI:

1. What do you know about AI? (Answer options: (a) nothing; (b) a little; (c) know enough; (d) have full knowledge).

2. Is there a difference between the concepts of AI and neural networks? (Answer options: (a) yes; (b) no; (c) these concepts are interrelated).

3. What AI-related resources are you aware of? (Answer options: (a) list if you know; (b) don't know).

4. Are you aware of any neural network resources and if so, which ones? (With an open field for listing).

5. Have you had to work with AI-related applications, and if so, which ones? (With an open field for enumeration).

6. Does AI help you in your studies or, on the contrary, does it prevent you from thinking independently and solving problems? (Answer options: (a) helps; (b) hinders; (c) both; (d) do not use AI).

7. How often have you had to use AI in your studies and which application would you favour? (With an open field to indicate frequency and preference).

8. Would you like to associate your activity with AI in the future? (Answer options: (a) yes; (b) no; (c) maybe).

The questionnaire procedure was conducted in classrooms in the presence of researchers, who ensured the distribution and collection of questionnaires, as well as answered students' clarifying questions on the wording. Anonymity of participation was strictly observed to ensure the validity of the responses. The survey was conducted in accordance with the ethical principles specified in the Guidance Note of the European Commission on Ethics and Data Protection (2021). The data obtained were subjected to quantitative and qualitative analyses. Quantitative analysis involved calculating the percentage of responses to closed questions. Qualitative content analysis was applied to the open-ended questions to identify recurring themes, usage patterns, and students' overall perceptions of AI. The results were presented in the form of tables and infographics for clarity. Particular attention was paid to identifying correlations between the level of knowledge about AI, frequency of its use and perceived usefulness/harm to the learning process.

RESULTS AND DISCUSSION

Analysing the results of the student questionnaire

In order to analyse and systematise the data obtained from the students' questionnaire results regarding their knowledge and use of artificial intelligence in the learning process, the responses were collected and summarised in Table 1.

Table 1 refers to the use of AI in the learning process not in relation to a specific discipline, but in general. The infographic on the results of this survey is presented in Figure 1. The responses to questions 2 and 7 were 100%, so they are not shown in the diagrams.

Table 1. *Results of students' questionnaires about knowledge and use of artificial intelligence in teaching*

No.	Question	Answer 1	Answer 2	Answer 3
1	What do you know about AI?	Know a little – 67.7% (44 students)	Know enough – 32.3% (21 students)	
2	Is there a distinction between AI and neural networks?	Concepts are interrelated – 100% (65 students)		
3	What AI-related resources are you aware of?	ChatGPT – 100% (65 students)	Gemini – 44.6% (29 students)	Copilot, DeepSeek – 10.8% each (7 students each)
4	Are you aware of any neural network resources and if so, which ones?	Positive – 32.3% (21 students)	Negative – 67.7% (44 students)	
5	Have you worked with AI applications?	Affirmative – 78.5% (51 students)	Negative – 21.5% (14 students)	
6	Does AI help you in your studies?	Yes – 66.15% (43 students)	No – 33.85% (22 students)	
7	How often have you had to use AI in your studies and which application would you favour?	Used – 100% (65 students)	ChatGPT – 100% (65 students)	
8	Would you like to get involved with AI?	Yes – 80% (52 students)	No – 20% (13 students)	

Source: *compiled by the authors*

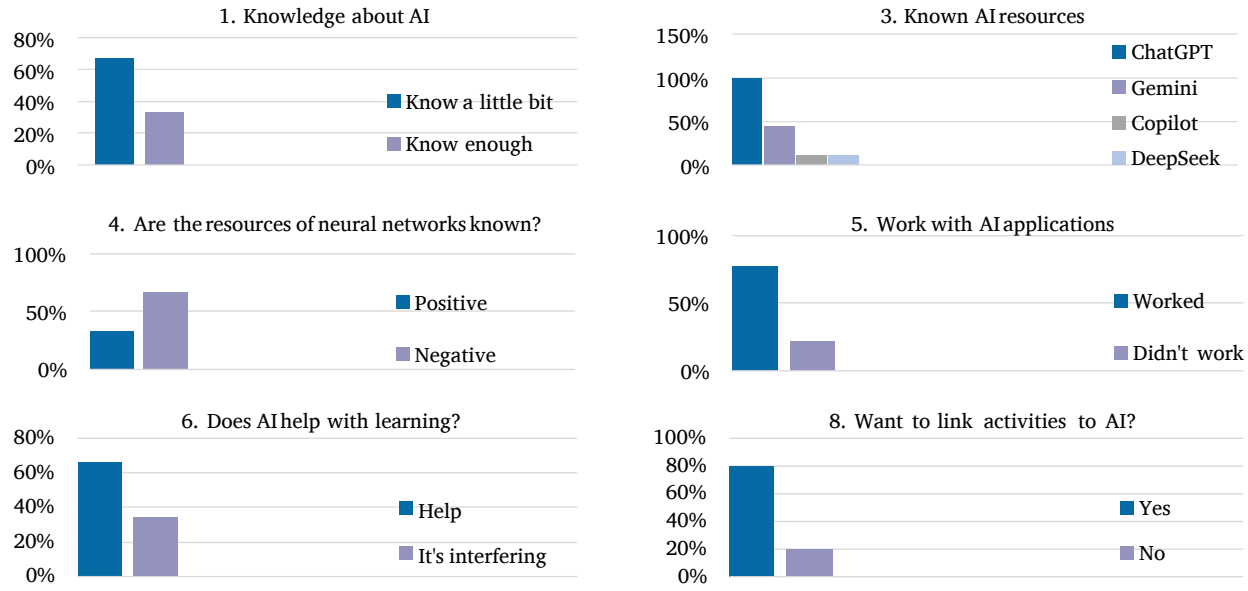

Figure 1. *Results of students' questionnaires on the application of AI*

Source: *compiled by the authors*

The analysis of answers to the first question of the questionnaire confirmed the expected results corresponding to the level of training of second-year students who demonstrated a basic understanding of AI concepts. At the same time, the answers to the second question revealed a significant need for clarification of terminology: 100% of respondents indicated the relationship between AI and neural networks, but in an academic context it is necessary to clearly distinguish these concepts, as neural networks are only a subset or one of the approaches within the broad field of AI. Responses to the third question regarding known AI resources were generally acceptable given the students' active use of neural networks. However, it was noted that respondents use only a limited range of available educational resources designed to optimise the learning process.

Of particular interest were the answers to the fourth question, which confirmed the previously identified tendency for the majority of students not to distinguish between AI and neural networks. According to the results of the fifth question, 78.5% of students actively interact with AI applications; while 21.5% do not use them for objective reasons, for example, due to the lack of regular access to the Internet. In response to question six, 66.15% of respondents gave a positive answer regarding the usefulness of AI in learning, although they recognised a limitation in critically thinking about the results obtained from AI. The remaining 33.85% expressed a preference for independent problem solving, motivated by a desire to understand the logic behind decisions. Finally, 80% of students expressed their willingness to link their future professional activity with AI, which is an expected result, given the dynamic development of the IT sphere, but does not exclude the presence of students with other career orientations.

There is a discussion regarding the potential impact of AI on the programming profession. D. Amodei, CEO and Cofounder of Anthropic, predicts that AI will generate up to 90% of code in the next 3-6 months, and then almost all code within a year (Pangambam, 2025). However, not all experts share this pessimistic scenario. Current automatic code generation capabilities demonstrated by tools such as Copilot and ChatGPT show that the generated code often contains errors, which precludes full trust in it. The statistics of GitHub (2023) showed that users accept only about 30% of the code offered by Copilot, although the acceptance rate increases with increasing experience with the tool. However, a Stanford University study showed that the use of AI can lead to an increase in the number of errors in code written by programmers, suggesting that the impact of AI is ambiguous (Prather *et al.*, 2024).

The results of the survey, which showed 100% use of AI by students in the learning process, indicated the formation of a high degree of dependence on artificial intelligence. It is important to note that students tend to uncritically perceive the answers generated by AI, believing them to be optimal and not allowing for the possibility of errors. When asked to explain the algorithmic basis of the generated code, students often find it difficult to give explanations, which indicates the priority of obtaining a ready result over understanding the essence of the solution. Consequently, in the process of teaching programming it is necessary to emphasise students' attention to their responsibility for the final result and to develop the skills of critical evaluation of solutions offered by AI.

Advantages and disadvantages of using AI in education

The use of AI in the educational process has a number of positive aspects. Generative AI systems capable of generating code (GenAI code generators) can automate routine tasks of writing low-level code, allowing students to focus on developing high-level algorithms, as M. Dolinsky (2024) noted. A study by M. Liffiton *et al.* (2023) showed that the CodeHelp system effectively answers students' questions without generating ready-made code, facilitating independent search for solutions. The work of D. Cambaz & X. Zhang (2024) demonstrated the potential of LLM-based code generators in the role of teaching assistants and virtual tutors to enhance teaching and learning. An approach based on data and principles from educational psychology as well as computational pedagogy indicates a significant increase in student engagement and mastery in learning to code in AI-based virtual environments, according to F. Sarshartehrani *et al.* (2024).

AI TA developers note that models such as ChatGPT, LLaMA, and Gemini demonstrate outstanding abilities to understand, generate, and explain code in a programming context, making them promising tools for teaching assistants (Lee *et al.*, 2023). Moreover, research suggests that some LLMs may rival or even surpass the abilities of some students. N. Humble (2024) argued that ChatGPT is capable of providing correct or partially correct explanations and solutions in software testing and programming that can be improved through operational development. Similar results were obtained for Copilot, where up to half of the programming tasks could be solved using the original description and the remainder using operational engineering techniques.

However, along with the benefits, there is a downside to using AI. Generative models can produce erroneous code and produce different answers to the same query. In this regard, AI TA supports the concept of "Subgoal learning", an effective learning strategy that helps students decompose complex tasks into subtasks (Lee *et al.*, 2023). Despite the ability of large language models to answer questions, write essays, and solve programming tasks, the generated prompts may contain misleading information or be insufficiently detailed, especially in the final stages of the tasks (Roest *et al.*, 2024).

Generative AI (GAI) often exhibits weaknesses in more complex tasks such as identifying vulnerabilities in software, working with object-oriented approaches in programming, and tasks that require both conceptual understanding and directly writing code (Denny *et al.*, 2023). It is important to note that these challenging tasks for GAI are often similar to those that cause difficulties for the

students themselves. Modern software development, especially in large-scale projects, requires from future specialists not only the ability to write code (which GAI tools can perform), but also teamwork skills, effective communication and constant human interaction with colleagues and users, which GAIs at the current stage of development are not able to reproduce at the human level. The problems of GAI accuracy are compounded by the fact that systems are not aware of their own inaccuracies, which can mislead students. Moreover, effective use of GAI presupposes strong foundational knowledge, which is a challenge in the context of modern education, where there is a tendency to reduce the hours of study of basic disciplines. Therefore, it is recommended that instructor supervision is exercised when integrating GAI into the educational process to ensure that students' use and conclusions of the system are consistent with the course content. Effective implementation of AI in education also requires revision of curricula and assessment methods to take into account the development of students' skills required to work in a pervasive automation environment.

CONCLUSIONS

The results of this study strongly suggest that there is a significant problem with the nature of students' use of AI, which is particularly critical given their future specialisation in information technology. There is a clear and growing dependence of students on AI, which appears to be due to several factors. First of all, it is insufficient fundamental training in core disciplines, exacerbated by the reduction of teaching hours. In addition, limited technical background or access to advanced AI tools plays a role, forcing students to rely on commonly available but not always optimal solutions. Despite the undeniable benefits of AI in teaching programming, there are significant challenges to its integration. A key issue is the financial inaccessibility of many professional AI platforms, which limits students' ability to learn advanced tools. Moreover, excessive and uncritical use of AI leads to a loss of autonomy in problem solving. Students often fully trust the results generated by AI without critically evaluating them, which can lead to the implementation of incorrect or inefficient solutions. This, in turn, hinders the development of a deep understanding of algorithms and programming logic. Another problem is the need for high-quality, relevant data for training AI systems, which is a prerequisite for their correct and effective operation in an educational context.

Nevertheless, the use of AI in programming education opens new and promising opportunities for both students and teachers. AI can significantly increase the personalisation of learning by adapting materials and tasks to the individual needs of each student, making the process more effective and engaging. However, it is fundamentally important to recognise that AI should be seen as a supportive tool designed to complement, not replace, traditional teaching methods. The role of the instructor remains central to the learning process, encompassing student motivation, support and critical thinking. AI can effectively facilitate this by automating routine tasks, providing immediate feedback and generating valuable data for continuous improvement of the learning process and adaptation of educational programmes.

In the light of the results obtained, further research on this topic seems to be extremely relevant and necessary. It is planned to continue studying this topic in more detail, taking into account the specifics of each discipline within IT education and specific generative AI models used by students. Special attention will be paid to quantitative and qualitative assessment of the phenomenon of using AI in the learning process based on an extended sample of respondents. This will allow for a deeper identification of both advantages and disadvantages inherent in the application of AI in the educational environment and the development of sound recommendations to optimise its integration.

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CONFLICT OF INTEREST

No conflict of interest exists at this time.

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Аннотация. Жасалма интеллекттин бардык тармактарга, анын ичинде билим берүүгө жана окуу процессине интеграция болушу, өзгөчө программалоо тармагына тийгизген таасирин түшүнүү өзгөчө мааниге ээ. Бул иштин максаты студенттердин программалоо компетенциясынын калыптанышына жасалма интеллектин таасирин баалоо жана аны академиялык чөйрөдө оптималдуу колдонуу боюнча сунуштарды иштеп чыгуу болуп эсептелет. Изилдөө эмпирикалык методдорду жана анын ичинде эки алдыңкы университеттин экинчи курсунун студенттеринин анонимдүү сурамжылоосун колдонуу менен жүргүзүлгөн. Изилдөө көрсөткөндөй, сурамжылоого алынган студенттердин 100 % окуу процессинде жасалма интеллекти жигердүү колдонушат, ал эми олуттуу көпчүлүгү (78,5 %) жасалма интеллект тиркемелери менен үзгүлтүксүз иштешет. Бул көз карандылыктын жогорку деңгээлин көрсөтүп турат. Ошондой эле, фундаменталдык даярдыктын жетишсиздиги жана акы төлөнүүчү ресурстарга жетүүнүн чектелгендиги да бул маселени курчутат. Студенттер көбүнчө жасалма интеллектин ишинин натыйжаларына терең маани бербестен эле кабыл алып, алгоритмдерди түшүнбөй туруп, даяр кодду алууга басым жасашат. Бул өз алдынча аракеттенүүнү жоготууга жана каталардын пайда болушуна алып келет. Бул көйгөйлөргө карабастан, жасалма интеллект окутууну жекелештирүү, эффективдүүлүктү жогорулатуу жана мугалимдер үчүн күчтүү жардамчы курал катары олуттуу артыкчылыктарды көрсөтөт. Сурамжылоонун жыйынтыгында алынган маалыматтарга караганда респонденттердин арасында “Жасалма интеллект” менен “Нейрондук тармактар” түшүнүктөрүнүн ортосундагы айырмачылыктарды так түшүнүүнүн жоктугу көрүнүп, тереңирээк теориялык окутуунун жана аналитикалык ой жүгүртүүнү өнүктүрүүнүн зарылдыгы көрүнүп турат. Изилдөөнүн натыйжалары, мугалимдер жана окуу пландарын иштеп чыгуучулар үчүн баалуу маалыматтарды берип, аларга программалоону окутууга болгон мамилени оңдоого, критикалык ой жүгүртүүгө жана өз алдынча өркүндөөгө басым жасоого, анын артыкчылыктарын жана кемчиликтерин эске алуу менен жасалма интеллектти билим берүү процессине эффективдүү интеграциялоо ыкмаларын иштеп чыгууга мүмкүндүк берет

Негизги сөздөр: билим берүү процесси; автоматташтыруу; платформалар; ChatGPT; Gemini; DeepSeek; GitHub Copilot

Использование искусственного интеллекта в обучении студентов программированию

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Аннотация. В условиях стремительной интеграции искусственного интеллекта (ИИ) во все сферы, включая образование, понимание его влияния на процесс обучения, особенно в области программирования, приобретает первостепенное значение. Целью данной работы были выявление и оценка влияния ИИ на формирование компетенций студентов в области программирования и разработка рекомендаций по оптимизации его применения в академической среде. Исследование проводилось с использованием эмпирических методов, включая анонимное анкетирование студентов вторых курсов двух ведущих университетов. В ходе исследования было установлено, что 100 % опрошенных студентов активно используют ИИ в учебном процессе, при этом значительное большинство (78,5 %) регулярно взаимодействует с ИИ-приложениями, что свидетельствует о высокой степени зависимости, усугубляемой недостаточной фундаментальной подготовкой и ограниченным доступом к платным ресурсам. Выявлено, что студенты часто некритически воспринимают результаты работы ИИ и склонны фокусироваться на получении готового кода, не углубляясь в понимание алгоритмов, что потенциально приводит к утрате самостоятельности и появлению ошибок. Несмотря на эти вызовы, ИИ демонстрирует значительные преимущества, такие как персонализация обучения, повышение эффективности и вовлеченности, позиционируясь как мощный вспомогательный инструмент для преподавателей. Полученные данные также указывают на недостаточную дифференциацию понятий «ИИ» и «нейронные сети» среди респондентов, что подчеркивает необходимость более глубокой теоретической подготовки и развития аналитических способностей. Результаты исследования предоставляют ценную информацию для преподавателей и разработчиков образовательных программ, позволяя им скорректировать подходы к обучению программированию, усилить акцент на критическом мышлении и самостоятельности, а также разработать методики эффективной интеграции ИИ в учебный процесс с учетом его преимуществ и ограничений

Ключевые слова: образовательный процесс; автоматизация; платформы; ChatGPT; Gemini; DeepSeek; GitHub Copilot