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TRAINING FUTURE COMPUTER SCIENCE TEACHERS TO USE ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE EDUCATIONAL PROCESS

Summary. The article discusses the training of future computer science teachers to use artificial intelligence (AI) technologies in education. The authors highlight the relevance of this issue in light of the rapid spread of AI technologies in various spheres of life and the need to develop students' digital competencies related to the use of artificial intelligence.

The study aims to identify the essential competencies that future computer science teachers need to effectively use AI in education. It also analyzes the existing problems and challenges in this area, studies the prospects for the use of AI in education, develops recommendations for improving relevant training programs, and overcoming barriers to the implementation of AI technologies.

The study identified three main groups of competencies for future computer science teachers in the field of AI: technical, pedagogical, ethical and legal. Technical competencies include knowledge of AI technology principles, algorithms, and software. Pedagogical competencies relate to the ability to adapt teaching materials and methods to the capabilities of AI and to develop appropriate tasks and projects. Ethical and legal competencies involve comprehending the risks and challenges associated with AI usage, as well as being aware of the ethical principles and legal norms in this field.

The article analyzes technical, pedagogical, ethical, and legal problems related to introducing AI technologies into computer science teacher training and education. It also explores the potential benefits of AI in education, such as personalized and adaptive learning, improved teaching and assessment effectiveness, and the development of critical thinking and creativity in students. The authors suggest methods to enhance computer science teacher training programs, such as incorporating specialized AI courses, providing practical training, and involving industry experts. They also stress the significance of considering the most effective international practices in this field.

To summarize, the article highlights the pressing need to modernize the computer science teacher training system in Ukraine. This is necessary to develop the competencies required for the effective use of AI technologies in the educational process. Such modernization will contribute to the development of students' digital literacy and ensure the competitiveness of the Ukrainian educational system in the context of digital transformation.

Keywords: artificial intelligence, training of computer science teachers, digital competencies, educational process, technologies in education, innovative teaching methods, ethics of artificial intelligence, modernization of education, digital transformation.

1. INTRODUCTION

Formulation of the problem. The development of artificial intelligence (AI) technologies has intensified in recent years, and their use in various spheres of life and business has increased. As a result, training specialists capable of working effectively with AI technologies has become a strategic priority. This is particularly relevant for computer science teachers, who are responsible for developing students' competencies and skills in working with artificial intelligence. However, the current Ukrainian teacher training system pays insufficient attention to the study and application of AI technologies in education. As a result, most future computer science teachers are not adequately trained to work with artificial intelligence technologies and lack the necessary practical skills.

This presents significant challenges in developing students' digital competence in relation to artificial intelligence, which is a key competency in the twenty-first century. Therefore, it is important to investigate the training of future computer science teachers in the use of artificial intelligence technologies in education. The study's relevance is due to several factors. The rapid spread of artificial intelligence technologies in various spheres of life has been observed in recent years. AI is already being actively implemented in the economy and business, and is also beginning to influence education. To build a competitive educational system in Ukraine in the context of digital transformation, it is necessary to train teachers capable of ensuring that students master digital competencies related to the use of AI technologies. AI development is a priority for both the European Union and Ukraine in terms of shaping the education of the future. Digital competence is one of the key competencies for the 21st century.

There is evidence that the level of training for computer science teachers in AI is insufficient, hindering the introduction of innovative technologies. Therefore, it is relevant to study the training of specialists in the use of artificial intelligence technologies in education from both theoretical and practical perspectives.

Analysis of recent research and publications. The introduction of artificial intelligence (AI) technologies into the educational process is a relevant and widely discussed topic in academic circles. Domestic and foreign researchers have extensively covered this issue.

The paper titled 'The Great Transformation Program: Education 4.0: Ukrainian Dawn' [1] proposes the implementation of innovative technologies, such as AI, in the educational process. At the same time, the paper 'Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators' [2] from the Directorate-General for Education contains EU

ethical guidelines on the use of AI and data in teaching and learning for educators. The guidelines focus on potential risks and the importance of maintaining academic integrity.

In Ahmad Faisal Choiril Anam Fathoni's article 'Leveraging Generative AI Solutions in Art and Design Education,' the author discusses the use of generative AI solutions in art and design education. The article 'Bridging Sustainable Creativity and Fostering Academic Integrity for Innovative Society' [3] discusses the potential of AI-based generative solutions in art and design education. It highlights their ability to promote sustainable creativity and academic integrity.

In their work titled 'The System of Training Future Teachers to Use Artificial Intelligence Technologies' [4], domestic researchers I.I. Hromova, N.V. Martyniuk, and O.V. Shevchenko also address this topic. Additionally, A.I. Shevchenko's article 'Strategy for the Development of Artificial Intelligence in Ukraine' in 'Science and Education' [5] presents a strategy for the development of AI in Ukraine in the context of science and education.

The topic's relevance is supported by various publications, including 'Smart Education in the Transforming Digital Society' [6], which discusses the role of smart education in the digital society transformation, 'Artificial Intelligence and Open Science in Education' by M. Maryenko and V. Kovalenko [8], which explores AI and open science in education, and 'The Impact of Educational Trends on the Digital Competence of Students in Ukraine and Poland' [9], which examines the effect of educational trends on students' digital competence.

Sources [10] and [3] deal with the technical aspects of generative AI models based on pixel pretraining and their potential use in art education.

Recent research and publications indicate a growing focus on training future computer science teachers to use AI technologies in education. However, this topic requires further study to develop appropriate methods and training programs, as well as to address ethical and legal issues related to AI use in education.

The purpose of this article is to conduct a comprehensive study of training future computer science teachers to use AI in the educational process. Specifically, the article aims to identify the key competencies required by future computer science teachers for the effective use of artificial intelligence (AI) technologies in education. Additionally, the plan is to analyze current issues and challenges regarding the integration of AI technologies into computer science teacher training and education as a whole. The study will also focus on exploring the potential and opportunities presented by the implementation of AI in education, particularly in the training of future computer science teachers. Recommendations will be developed based on the study, proposing approaches to improve relevant training programs. Competencies in the field of AI will be taken into account. Additionally, identifying ways to overcome ethical, legal, and technical barriers to the effective implementation of AI technologies in education is an important component of the study. Finally, the analysis of best practices and experiences from other countries in training teachers to use AI is planned, along with identifying opportunities to adapt this experience to Ukrainian realities.

2. RESULTS OF THE RESEARCH

The development of education can no longer rely solely on the influence of human capital. It is necessary to change the educational environment itself, not only to increase the number of labor resources, but also to qualitatively change the very content of education, its methods, tools, and environment, that is, the transition to smart learning is necessary [6, p. 53]. The educational process has undergone significant changes over the centuries and has evolved under the influence of various factors, including technological development, changes in social values, and the need to adapt to new challenges [7, p. 190]. Identifying the key competencies of future computer science teachers in the field of artificial intelligence (AI) is crucial to ensure their readiness to effectively use AI technologies in the educational process. After analyzing scientific research, industry reports, and best practices, three main groups of competencies that future computer science teachers should possess have been identified:

1. Technical Competencies: This category of competencies encompasses the knowledge and skills required to comprehend the principles of AI technologies, algorithms, and software. It is essential for future computer science teachers to possess a fundamental understanding of areas such

as machine learning, natural language processing, computer vision, and other AI domains. Additionally, they should be well-versed in various AI tools and platforms to effectively utilize them in the learning process.

2. Pedagogical Competencies: The successful integration of AI technologies into the educational process requires specific pedagogical competencies. Computer science teachers of the future should be able to adapt teaching materials and methods to account for the capabilities of AI. They should also be able to develop learning tasks and projects that incorporate the use of AI technologies to enhance learning efficiency. In addition, it is important for teachers to have an understanding of how AI can support personalized and adaptive learning, while also promoting critical thinking and creativity in students.

3. Ethical and Legal Competencies: The use of AI technologies in education raises ethical and legal issues that must be considered. Future computer science teachers must understand the potential risks and challenges associated with the use of AI, such as data privacy issues, algorithmic bias, and intellectual property issues. They should be aware of ethical principles and codes of conduct related to the use of AI in education, as well as relevant legal rules and regulations.

The development of competencies is crucial in preparing future computer science teachers for the effective and responsible use of artificial intelligence technologies in education. Teachers must possess technical, pedagogical, ethical, and legal competencies to maximize the potential of AI in improving the quality of learning and student development.

The integration of artificial intelligence (AI) technologies in the training of future computer science teachers presents various technical, pedagogical, ethical, and legal challenges. From a technical perspective, the primary obstacles include inadequate infrastructure in educational institutions, limited access to AI tools and platforms, and a lack of proper technical support and expertise. Pedagogical challenges in AI education include a lack of appropriate teaching materials and methods, insufficient teacher experience, and difficulty integrating AI components into curricula. Additionally, ethical and legal issues related to the use of AI in education must be considered. In the educational context, challenges related to AI include ensuring confidentiality and data protection, combating bias and inaccuracy of AI models, resolving ethical dilemmas, and determining responsibility for decisions made by AI systems. Additionally, it is important to preserve the principles of academic integrity and prevent the improper use of AI to generate texts or solve problems.

Overcoming these technical, pedagogical, ethical, and legal barriers requires comprehensive efforts by educational institutions, government agencies, IT companies, and industry experts. Only if these problems are effectively addressed can we achieve successful integration of AI technologies into the process of training future computer science teachers.

To modernize the IT infrastructure of educational institutions, it is necessary to provide them with powerful computing resources, high-speed networks, and modern software. Additionally, expanding access to AI tools and platforms can be achieved through cooperation with IT companies and developers to obtain preferential or free access for educational purposes [8].

In addition to technical aspects, it is important to enhance the qualifications of teachers by organizing trainings, seminars, and courses. This will enable them to acquire the necessary knowledge and skills in the field of AI. Additionally, high-quality teaching materials, cases, and simulators should be developed to prepare computer science teachers to use AI. This statement should be accompanied by a review and update of curricula that integrate AI components and practical work with AI technologies.

Addressing ethical and legal issues in AI education involves implementing ethical codes and regulations that consider data privacy, anti-bias, academic integrity, and ethical responsibility. To achieve this, educational institutions should collaborate with industry experts, IT companies, research institutes, and leading AI specialists to effectively overcome challenges. It is important to exchange experience and best practices between educational institutions that are already implementing AI technologies in teacher training.

Only a comprehensive combination of technological, pedagogical, ethical, and organizational measures will allow to qualitatively prepare future computer science teachers to use artificial intelligence technologies in the educational process.

The use of artificial intelligence technologies in the training of future computer science teachers opens up wide prospects and opportunities. One of them is personalized learning, when AI systems, such as adaptive learning platforms, can adapt content and teaching methods to individual student needs. The creation of intelligent learning environments, such as virtual classrooms with AI elements, allows simulations of different situations and provides personalized recommendations.

AI technologies can provide automated assessment and feedback by using systems to evaluate student responses and identify knowledge gaps. This helps teachers evaluate and adjust the learning process effectively. Future computer science educators will have the chance to enhance their programming and design skills by practicing the development and testing of AI applications, algorithms, and models using specialized platforms such as TensorFlow, PyTorch, or Azure AI.

AI-based modeling and simulation learning will enable students to experiment with various scenarios and situations related to teaching computer science, such as virtual classroom simulators. AI solutions can automate certain administrative tasks, such as scheduling, by using AI systems to optimize timetables.

AI tools can support the professional development of teachers by providing recommendations and improving teaching methods, updating knowledge and skills. For example, recommendation systems can be used for teacher professional development. The introduction of AI into the educational process offers opportunities for students and teachers to conduct research in the field of artificial intelligence, develop new algorithms and applications using services such as Google AI, IBM Watson, or Microsoft Cognitive Services.

For instance, a computer science teacher can use ChatGPT, a powerful language model that can generate text based on human input, in the classroom.

When studying the topic of ‘Algorithms and Data Structures’, a teacher can utilize ChatGPT to generate various examples of algorithms and their implementation in different programming languages. For instance, the teacher can request ChatGPT to generate pseudocode and program code to sort an array using the merge algorithm (fig. 1).

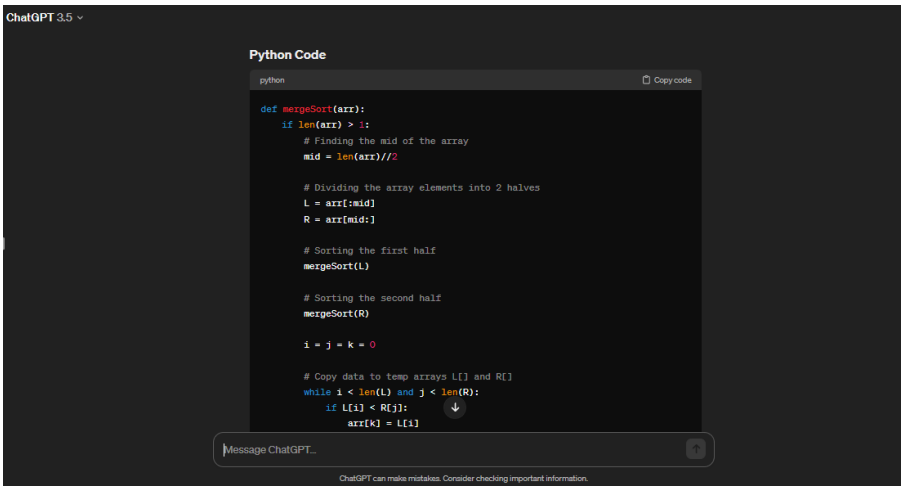

Fig. 1. Python code generated in ChatGPT

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It is crucial to bear in mind that the utilization of ChatGPT or other AI systems in computer science classes should only function as a supplementary tool, complementing, rather than replacing, teaching activities. Teachers should still meticulously verify and rectify the output of AI systems to ensure its precision and pertinence to the learning process.

To guarantee the high-quality training of future computer science teachers and the development of necessary competencies in the field of artificial intelligence, it is crucial to enhance existing training programs. Primarily, updating the curricula's content and introducing new courses on AI that cover basic concepts, models, machine learning methods, neural networks, natural language processing, and computer vision are essential. Furthermore, it is essential to enhance the practical component and project activities by incorporating laboratory work, practical tasks, and the execution of projects related to the development and utilization of AI solutions in the educational setting. This will aid in the advancement of AI education.

The integration of AI tools and platforms, such as TensorFlow, PyTorch, Microsoft Cognitive Services, IBM Watson, and others, into the educational process is crucial for students to gain practical experience and develop relevant skills. Attention should also be paid to developing critical thinking skills and ethical competencies, as well as the ability to critically assess the capabilities and limitations of AI systems and the ethical aspects of their use in education.

Partnerships should be established with reputable IT companies, and AI experts should be engaged to conduct master classes, training, and consultations for students and teachers. This will ensure the exchange of experience and the development of relevant practical skills. Continuous professional development of teachers is also crucial. Regular training, refresher courses, and internships should be provided to update their knowledge and skills in AI, improve teaching methods, and use new AI tools.

Finally, to encourage AI research activities, students and teachers should conduct research related to the application of AI in education, the development of new algorithms, and teaching methods using AI technologies.

The introduction of artificial intelligence technologies into the educational process opens up new opportunities, but also poses ethical, legal, and technical challenges that must be addressed. To overcome these barriers, the following aspects should be considered:

– *Ensuring Data Privacy and Security:* The use of AI systems often involves the collection and processing of large amounts of personal data of students, teachers, and other participants in the educational process. Therefore, it is necessary to develop clear rules and standards for protecting this data, adhere to the principles of confidentiality, obtain consent for the processing of personal data, and ensure appropriate cybersecurity measures.

– *Eliminating Bias and Discrimination in AI Algorithms:* AI systems can produce biased results due to imperfect algorithms or training data. To ensure fairness, it is crucial to thoroughly test AI solutions for bias, ensure diversity and representativeness of training data, and continuously monitor and adjust the systems' performance.

– *Developing critical thinking and digital literacy skills:* it's essential for students and teachers to interact effectively with AI systems, understand their capabilities and limitations, and consider the ethical implications of using AI. It is recommended that relevant courses and training be integrated into educational programs.

– *Ensure transparency and accountability of AI systems.* AI decision-making processes should be transparent and understandable for all participants in the educational process. Accountability and audit mechanisms for AI solutions should be developed to ensure fairness and lack of bias.

– *Develop a regulatory framework and codes of ethics.* To ensure the appropriate use of AI in education, it is crucial to establish a regulatory framework and codes of ethics. This framework should define clear rules and standards for the use of these technologies and involve all stakeholders, including educators, parents, technology companies, and regulators.

– *Ensuring Accessibility and Equal Opportunities.* The introduction of AI technologies should not create new barriers or exacerbate existing inequalities in access to education. It is necessary to ensure that AI solutions are accessible and inclusive to all students, regardless of their socioeconomic status, place of residence, or physical abilities.

– *Development of technical infrastructure and support*. The successful implementation of AI in education necessitates the presence of suitable technical infrastructure, equipment, and support for all participants involved in the educational process. This may involve investments in hardware and software, staff training, and the establishment of technical support centers.

This requires coordinated efforts from all stakeholders, including educators, technology companies, legislators, parents, and students themselves. To overcome these barriers, a comprehensive approach and adherence to ethical norms and principles are necessary. The goal is to ensure that artificial intelligence technologies bring maximum benefit to improving the educational process.

3. CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

To summarize, training teachers to effectively use artificial intelligence in education is a multifaceted task that requires a comprehensive approach at various levels.

Updating the curricula for future teachers by integrating courses on the basics of AI, machine learning, natural language processing, computer vision, and other relevant topics is necessary. It is crucial to offer both theoretical and practical components, such as laboratory work, projects, and the use of AI tools and platforms.

Additionally, it is essential to focus on developing future teachers' critical thinking skills, ethical competencies, and understanding of the potential impacts and consequences of implementing AI technologies in education. This will enable them to apply AI solutions effectively and responsibly.

To enhance the quality of training, it is crucial to establish a partnership among educational institutions, IT companies, and AI experts. This will facilitate the exchange of experience, conduct workshops, trainings, and ensure that the training material is up-to-date. Another key aspect is the continuous professional development of existing teachers. Regular refresher courses, internships, and training programs should be organized to enhance employees' knowledge and skills in the field of AI and to master new methods and technologies.

At the level of educational policy and regulation, it is crucial to establish ethical codes, rules, and standards for the use of AI in education. These measures would ensure compliance with principles such as privacy protection, data security, elimination of bias and discrimination, and transparency and accountability of AI systems.

Finally, investing in the development of suitable technical infrastructure and support in educational institutions is necessary to ensure equal access to AI technologies for all participants in the educational process. Effective training of teachers in the use of artificial intelligence to improve and modernize the educational system requires a comprehensive and coordinated approach that takes into account the best international practices, including the experiences of leading universities and companies.

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ПІДГОТОВКА МАЙБУТНІХ УЧИТЕЛІВ ІНФОРМАТИКИ ДО ВИКОРИСТАННЯ ТЕХНОЛОГІЙ ШТУЧНОГО ІНТЕЛЕКТУ В ОСВІТНЬОМУ ПРОЦЕСІ

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Анотація. Стаття присвячена темі підготовки майбутніх учителів інформатики до використання технологій штучного інтелекту (ШІ) в освітньому процесі. Автори розглядають актуальність цього питання в контексті стрімкого поширення ШІ-технологій у різних сферах життя, а також необхідності формування в учнів цифрових компетентностей, пов'язаних із застосуванням штучного інтелекту.

Метою дослідження є визначення ключових компетентностей, необхідних майбутнім учителям інформатики для ефективного застосування ШІ в освіті, аналіз існуючих проблем і викликів у цій сфері, вивчення перспектив використання ШІ в освіті, розробка рекомендацій щодо вдосконалення відповідних програм підготовки та подолання бар'єрів для впровадження ШІ-технологій.

У ході дослідження було виділено три основні групи компетентностей для майбутніх учителів інформатики у сфері ШІ: технічні, педагогічні, а також етичні та правові. Технічні компетентності охоплюють знання принципів роботи ШІ-технологій, алгоритмів та програмного забезпечення. Педагогічні компетентності стосуються здатності адаптувати навчальні матеріали та методики з урахуванням можливостей ШІ, розробляти відповідні завдання та проєкти. Етичні та правові