Artificial Intelligence and the Methodological Preparation of Students for Education in Technology and Entrepreneurship

Nikolay Tsankov [1], Ivo Damyanov [2]

[1] *Faculty of Education, Trakia University, Stara Zagora, Bulgaria*
[2] *Faculty of Mathematics and Natural Sciences, South-West University, Blagoevgrad, Bulgaria*

Abstract **– The implementation of artificial intelligence in education poses new challenges for future teachers, requiring not only adaptation to these technologies, but also their effective integration into the learning process. The present study aims to analyse the perceptions and experiences of student-future teachers in the use of artificial intelligence in the development of methodological units on technology and entrepreneurship for primary school. Two popular AI tools were used in the study – ChatGPT and MagicSchool.AI. The study was conducted among 75 students, and an adapted version of the Use-Modify-Create approach was used for the development of their methodological units. A system of criteria and indicators was developed, on which the methodology for conducting the analysis was built. The results show serious difficulties in various aspects of working with artificial intelligence, which emphasizes the need for additional training and support for mastering these technologies. The correlation analysis reveals significant connections between different skills of student-future primary school teachers related to working with artificial intelligence. These dependencies provide valuable guidance for improving the training of pedagogical specialists and the development of their digital competencies.**

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Corresponding author: Nikolay Tsankov,
Faculty of Education, Trakia University, Stara Zagora, Bulgaria
Email: nikolay.tsankov@trakia-uni.bg

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1. Introduction

Training students - future teachers - requires effective methods for developing analytical thinking, critical reflection and creative application of knowledge. Many lecturers want students to think deeply and critically about key concepts, to remember and understand information presented in class, and to develop analytical skills that they can apply to new situations. However, what most academic courses actually require is simply reproduction of information, which does not foster the development of analytical skills [1]. Although artificial intelligence (AI) has been a topic of discussion since the middle of the last century and has gone through various stages of upsurge and stagnation, in recent years generative artificial intelligence has entered society with extraordinary speed. This brings into focus questions about its benefits and potential drawbacks, especially in the educational sphere, as well as the readiness and ability of students - future teachers - to fully master it [2].

A systematic review of research on the use of artificial intelligence in education conducted in [3] shows that despite growing interest in the topic, there is still a lack of sufficient empirical studies, especially in the training of future teachers. It has been found that AI can assist teachers in planning, implementing, and evaluating the learning process, reducing their workload and allowing for more accurate tracking of students' needs and progress. At the same time, challenges related to the limited use of multimodal data, the low level of teacher involvement in the development of AI systems, and technical and pedagogical limitations stand out. The conclusion is that in order to realize the potential of AI in education, more empirical research, skills development and awareness among future teachers, and multidisciplinary collaboration between developers, educators, and practitioners are needed.

Increasingly, the possibilities for integrating artificial intelligence into the learning process are being discussed, which could significantly transform traditional methods of learning and teaching. Among the main areas in which there are proposals for AI use are: personalized learning, intelligent tutoring systems, automated assessment, virtual classrooms and distance learning. In addition, AI can contribute to data analysis and provide valuable insights, natural language processing, development of adaptive learning platforms, and analytics for tracking student success [4].

Despite these opportunities, research [5] shows that less than half of future teachers use AI tools in their teaching, and their attitudes toward them are mixed – some see the benefits, but others are skeptical or even think these technologies should be banned. The lack of knowledge and experience leads to low awareness and underutilization of AI's capabilities, which slows down its transformative role in education. On the one hand, future teachers recognize the potential of AI to reduce language barriers, facilitate access to global knowledge, support work with students with special educational needs, and improve the effectiveness of the learning process. On the other hand, they identify a number of challenges related to ethical use, the reliability of information, and the risk of reducing students' activity and critical thinking. The study also shows that students' experience with AI in university education does not always lead to its practical implementation, including one aimed at creating a more inclusive learning environment. In conclusion, there is a need for universities to build digital and AI literacy in future teachers, encourage the responsible and ethical use of technology, and prepare students for a professional environment in which AI will play an increasingly important role.

The application of artificial intelligence in education increases student engagement, but the long-term effects on student knowledge and skills are yet to be analyzed. AI can provide personalized learning and adaptive support, but its use as a modern tool alone does not guarantee positive outcomes [6].

In this context, [7] proposes a collaborative model based on Bloom's taxonomy, which distributes educational tasks between teachers and Generative AI according to their optimal capabilities, thereby promoting the development of cognitive, psychomotor, and emotional skills. Real-life cases from Australia, the US, and China show that the model is applicable and adaptable in different educational contexts. Its successful implementation requires the participation of school administrations, policymakers, and institutions, as well as the adaptation of curricula with an emphasis on personalized learning and addressing challenges such as ethics, equal access, confidentiality, and support for teachers through training and resources.

Despite the challenges, the integrated human-Generative AI approach reveals the transformative potential of new technologies in education. Future research is needed to clarify the long-term effect on students' critical thinking, creativity, and social-emotional development, to identify effective methods for teacher training and professional development, and to propose strategies for the active use of Generative AI in the classroom, ethical assessment models, and culturally sensitive solutions that ensure accessibility and inclusivity.

Similar conclusions are drawn in [8], which emphasizes the need for basic training in AI through seminars, workshops and guest lectures to enrich students' knowledge of the possibilities, limitations and ethical aspects of the technology. It is recommended that specialized modules be integrated into the curricula of teacher training programs, including both theoretical foundations and practical experience with AI tools through simulations and projects. The creation of professional learning communities and incentive programs can encourage a positive attitude towards AI and active involvement in innovation and collaboration. It is also important to ensure continuous professional development through training, online resources, and mentoring programs that prepare future teachers for the dynamic development of technology. In conclusion, it is emphasized that although AI is transforming education, teachers remain indispensable in their role in supporting critical thinking and the moral and emotional development of students, and their training should be geared toward the effective and responsible use of new technologies.

In [9], six roles that generative AI can play in collaborative, learner-centered activities are outlined, namely:

(1) Opportunity engine: Helps generate different ways of expressing ideas.
(2) Socratic opponent: Acts as a simulated argumentative supporter/opponent.
(3) Collaboration Coach: Assists in exploring information for people to refine/compile.
(4) Co-Designer: Assists in designing prototypes/drawings.
(5) Exploratorium: Provides tools to help visualize/interpret data.
(6) Storyteller: Creates stories involving specific events/viewpoints.

However, the current generative AI as a learning model lacks long-term memory (as each chat starts from zero) and secondly, the ability to reflect on its results and consolidate its knowledge from each conversation. More fundamentally, it does not cover the emotional and experiential aspects of what it takes to be a learner and a teacher.

People do not simply act as behavioral and cognitive agents; they care about each other and about being effective learners [9].

The implementation of artificial intelligence in education poses new challenges for future teachers, who must not only adapt to these technologies, but also integrate them effectively into the learning process [10]. To better understand how students - future teachers perceive AI, how they use it, and what difficulties they encounter, a focused study is needed. Lack of sufficient training and guidance often leads to uncertainty in using these technologies, as well as risks associated with their misapplication. At the same time, if trained properly, future teachers can turn AI into a valuable tool that facilitates teaching and learning.

This study aims to analyze the perceptions and experiences of students - future teachers in the use of artificial intelligence in the development of technology and entrepreneurship units for elementary school (grades 1-4). For this purpose, two popular AI tools, ChatGPT [11] and MagicSchool.AI [12], will be used, which offer different options for integrating AI into education. ChatGPT provides quick access to information, generation of learning materials and assistance in creating interactive lessons, while MagicSchool.AI specializes in educational applications and personalized support for teachers.

The research will analyze not only the students' experiences with these tools, but also the challenges they face when integrating AI into the teaching-learning process. Particular attention will be paid to the extent to which AI tools assist prospective teachers in developing instructional materials, and how they perceive their role in the educational process. A comparative analysis of the results will assess the effectiveness of the AI tools used and the extent to which they can support prospective primary teachers in their professional preparation.

2. Materials and Methods

In [13], an effective teaching method is suggested, proposing a three-step progression—*Use, Modify, Create* (Figure 1). This method is a skilful blend of hands-on action and experimentation, encouraging creative thinking while developing problem-solving skills. In this three-step process, the gradual deepening of interactions enables learners to experiment using a ready-made model. Through a smooth transition, they begin modifying this model by increasing the complexity until they finally create an entirely new model. The process of using, modifying, and creating gradually activates various key aspects of computational thinking [14] such as abstraction, automation, and analysis.

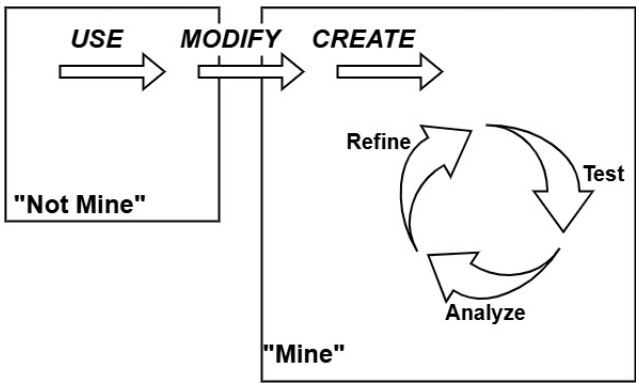

Figure 1. UMC Model [5]

While the application of UMC in programming education [15], [16] is quite natural and expected, in [17], the authors propose the application of the approach to teaching economics using computer models in spreadsheets.

UMC is emerging as an effective method in teaching computational thinking to students in school STEM classes [18].

A number of improvements and additions have also been proposed for the method, such as U2MC, TIPP-SEE [19], etc. Within undergraduate education, UMC has been successfully applied at MIT [20] within an introductory machine learning course for students with a minimal knowledge of programming. The same method has been successfully applied in the context of continuing education and skills development as described in [21].

However, artificial intelligence creates new opportunities for the adaptive application of established educational strategies that can be adapted to take advantage of its potential to support student learning. In particular, approaches stemming from the concept of Computational Thinking have a natural synergy with the capabilities of AI as they promote logical thinking, algorithmic approach and problem-based learning. The integration of these strategies with AI not only facilitates a personalized learning process, but also provides new methods for interactive and dynamic mastery of knowledge and skills.

The methodology for the implementation of the research, which has a contingent of 75 students of the Bachelor of Science, part-time study in the specialty of "Preschool and Primary School Pedagogy", follows the Use-Modify-Create approach, which includes three axial stages, each of which aims to evaluate the possibilities for integration of artificial intelligence in the development of projects of methodological units for teaching technologies and entrepreneurship in primary school.

Initially, in the *Use* stage, students work with an existing methodological unit related to entrepreneurship in primary school, using textbooks, teacher guides and other methodological handbooks.

They analyse the main methodological emphases, which include learning tasks (e.g. economic concepts such as work, income, expenditure, etc.), practical tasks and activities, resources (materials and tools to complete the tasks) and expected outcomes (e.g. broadening understanding of economic concepts and developing initiative and entrepreneurship). This stage is the foundation on which students will build the subsequent stages.

The next stage is the modification (*Modify*) of the selected methodological unit, with students using AI, specifically the ChatGPT and MagicSchool platforms, to refine the existing content. They redesign tasks and activities while introducing new technologies and learning approaches. Students can generate new ideas for economic tasks and integrate virtual simulations or interactive projects to help students solve economic problems and develop entrepreneurial skills. Changes in resources also include offering new sources of information and interactive platforms. At this stage, the students should ensure that the modified methodological unit continues to follow the logic of the tasks and expected outcomes.

The final stage is the creation (*Create*) of a new methodological unit. In this stage, students create new, innovative teaching methods that enrich the learning process and support the development of entrepreneurship and initiative. They design new learning-cognitive and practical tasks that lead to the same results, but through new technologies and approaches that stimulate students to be active and creative in the learning process. Students also create new resources such as online platforms or videos that enrich learning and provide additional opportunities for interaction. At this stage, the focus is on innovation and the active use of AI as a means to enhance the learning process.

This methodology combines theoretical knowledge with practical application and active incorporation of new technologies, while developing problem-solving skills by integrating the capabilities of AI. It offers students the opportunity to develop critical thinking skills through various stages of participation and to prepare for their future professional development as teachers capable of integrating modern technological solutions into the educational process.

The assignment focuses on the design of methodological options for the formation and development of the key competency "initiative and entrepreneurship" in primary school students, focusing on the methodology of technology and entrepreneurship education. Students must demonstrate how the methodological units they select and modify will help achieve specific learning outcomes related to economic and entrepreneurial skills.

The expected outcomes of the assignment, as a draft methodological unit for the teaching of technology and entrepreneurship in primary school, include the expansion of students' knowledge of basic economic concepts such as labour, income, expenditure, occupation, salary, family budget, goods and services. This can help them become aware of how economic processes work and what the basics of entrepreneurship are by linking theoretical knowledge to practical tasks. As part of the assignment, students will be encouraged to come up with ideas for solving economic problems in practice using real examples and situations, which will develop their critical and entrepreneurial skills. An understanding of the production of goods and services and how they meet personal and social needs will be a key component in the development of entrepreneurial thinking, as students will learn to link economic theories to concrete actions and solutions. They will become aware of how products are manufactured, exchanged and sold, and will be able to apply these principles in the context of different learning activities and projects.

The programme also aims to shape students' understanding of personal responsibility and initiative as important factors for personal and societal advancement. At the same time, the projects and assignments included in the methodological units' projects should stimulate activity, inventiveness and imagination, and students will have the opportunity to work on innovative and practical tasks that develop their creativity and entrepreneurial spirit.

Finally, the assignment should be methodologically designed to contribute to the formation of basic economic knowledge and entrepreneurial skills, while developing and supporting students' competences for initiative and enterprise. Through appropriate integration of AI and modern teaching methods, it should provide opportunities for students to actively participate and express themselves in the practical aspects of learning, encouraging them to be enterprising and responsible in the modern world.

Based on the research intentions, a system of criteria and indicators was developed (Table 1) on the basis of which the methodology for conducting the study was designed, covering key aspects of technical competence, critical thinking, creativity and ethical use of AI. Specific indicators have been identified to assess skills related to navigating AI platforms, formulating effective queries (prompts), integrating AI-generated resources, and the ability to critically analyse results. Each criterion is addressed at multiple levels, allowing for a detailed profile of the degree of AI uptake and application in the activities studied. The system ensures objectivity in assessment and creates conditions for further improvement of competences in AI work.

Table 1. System for assessing AI skills

Criteria	Indicators
Technical competence in using AI	Skills for working with AI platforms
	Skills for formulating effective queries (prompts)
	Skills for integrating AI-generated resources
Critical thinking and evaluation of AI results	Quality of analysis of AI-generated materials
	Evaluation and comparison of AI-generated materials with traditional sources
	Argumentation of the selection and evaluation of AI-generated results
Creativity and innovation through the use of AI	Level of originality and innovation of generated ideas
	Creative adaptation of AI proposals to the specific needs of the task
Autonomy and ability to solve problems using AI	Degree of independence in using AI to solve problems
	Degree of adaptability and self-correction in working with AI
Effective communication and presentation of results	Structuredness and clarity in presenting AI results
	Transparency of argumentation for the use of AI in development
Ethical and responsible use of AI	Awareness of ethical limitations and principles when using AI
	Degree of compliance with ethical norms when integrating AI content

3. Results

The results of the data analysis indicate significant difficulties in various aspects of working with AI, highlighting the need for additional training and support to master these technologies.

When analyzing the results of the indicator "Skills in working with AI platforms", it is evident that 50% of the participants had serious difficulties navigating the ChatGPT and MagicSchool platforms. This indicates that many of them fail to navigate the interfaces of these tools effectively, which significantly limits their ability to use the full potential of AI technologies. The lack of understanding of the platforms' functions limits their effectiveness in the educational process.

The results of the indicator "Ability to formulate effective queries (prompts)", show that 70% of participants fail to compose clear and relevant questions, resulting in irrelevant or inaccurate results. This highlights the difficulty students have in communicating effectively with AI, which is key to obtaining quality answers.

The results of the evaluation of the indicator "Ability to integrate AI-generated resources" warranted the conclusion that 43% of the participants failed to incorporate the results of AI into their methodological work.

The lack of ability to integrate these materials indicates that students do not realize the full potential of AI to enrich pedagogical work.

Concerning the indicator "Quality of analysis of AI-generated materials", 57% of the participants did not demonstrate critical analysis or comparative evaluation of the results, while only 12% were able to carry out a complete analysis.

Concerning the indicator "Evaluation and comparison of AI-generated materials with traditional sources", 54% of participants performed a comparative analysis but without depth and critical evaluation, while 34% managed to perform a detailed and justified comparative analysis.

Within the indicator "Reasoning for the selection and evaluation of AI-generated outputs", 17% of participants provided insufficient reasoning to support their evaluations, while only 28% demonstrated the ability to present clearly articulated and logically sound arguments.

The results concerning the criterion "Creativity and innovation through the use of AI" show different levels of originality and innovation. Only 3% of the participants managed to generate fully innovative ideas, while 29% included AI suggestions that complemented the development in an interesting way. 38% used AI to generate ideas but with limited creativity.

Regarding the criterion of "Independence and problem-solving ability using AI," only 16% of students - future elementary school teachers were able to independently identify challenges and find effective solutions using AI. 27% demonstrated the ability to problem-solve using AI, but often needed some guidance.

Results for the criterion "Effective communication and presentation of results" revealed that 26% of participants demonstrated the ability to present their findings in a clear, logical, and structured manner, which facilitated understanding and interpretation of information. However, 18% of participants had difficulty structuring and justifying their results, resulting in unclear and unsystematic presentations.

With respect to the criterion "Ethical and responsible use of AI", 23% of participants showed high awareness of the limitations and potential risks of AI, striving to apply ethical principles in their work. At the same time, 49% did not demonstrate sufficient understanding of the ethical issues involved in using AI, which can lead to inappropriate use of generated content and a lack of critical approach to the credibility and transparency of information.

Correlational analysis identified important relationships between various skills of students – future elementary school teachers related to working with AI that offer valuable guidance for improving the quality of teacher education and the development of these skills.

The first relationship found was between the skill of working with AI platforms and the skill of formulating effective queries (prompts) by students - future primary school teachers as the correlation was positive and reached a value of r = 0.72. This suggests that students' technical competency in working with the platforms is strongly related to success in formulating accurate and effective prompts. Users who are well-prepared to navigate AI platforms are able to elicit relevant and accurate results through optimally formulated questions.

The correlation between critical thinking and the evaluation of AI outcomes and creativity in the use of AI (r=0.47) indicates that students - future elementary school teachers with more developed critical thinking tend to exhibit greater innovation and creativity in their work with AI.

The correlation between ethical awareness and the degree of ethical compliance in integrating AI content (r=0.76) highlights the importance of ethical issues in the context of AI. The participants who had a higher awareness of ethical issues were significantly more likely to comply with ethical norms when using AI, such as properly citing sources and clearly distinguishing AI-generated results from their own ideas.

The analysis also shows a positive correlation between the degree of self-efficacy and the degree of adaptability in working with AI (r=0.67). The participants who worked independently also demonstrated a higher degree of adaptability when dealing with new situations arising from the use of AI.

4. Discussion

The participants encounter difficulties at all stages of working with AI – from navigating the platforms and formulating prompts to integrating the generated materials into their own work. This determines the need for additional training and guidance on these aspects. Without appropriate preparation and support, students cannot fully use these technologies, which limits their potential for improving their methodological units through AI.

Students have serious difficulties in being critical and in carrying out a detailed evaluation and argumentation of AI-generated materials. This indicates the need for additional training in the analysis, comparison and argumentation of AI results, which would improve their ability to use these technologies more fully and effectively.

Students are starting to use AI technologies, but they still have difficulties in generating innovative and original ideas, as well as in adapting these ideas to the specific needs of the task. This emphasizes the need to encourage greater creativity and innovation in the educational process.

While some students can work with AI, they face significant difficulties in working with the systems independently. This suggests the need for more in depth training and greater support for developing skills for independent problem-solving and adaptation to new situations.

Some of the students demonstrate good structure and transparency in presenting the results. However, for many of them additional efforts are needed to improve clarity and detail in explaining the use of AI in methodological developments.

Although some of the participants show good awareness and comply with ethical norms, a large number of them lack the ability to clearly distinguish sources and fully understand the ethical issues related to the use of AI. This highlights the need for more in depth training and guidance on the ethical use of AI in the educational process.

The results show that the successful work of students – future primary teachers with AI does not depend only on technical competence, but also on skills such as critical thinking, ethical awareness, independence and adaptability. The correlation between critical thinking and student creativity highlights the importance of teaching approaches that not only develop technology-related skills, but also analytical and creative skills. This could be beneficial for creating more innovative and effective AI solutions by students – future primary school teachers. Moreover, the high correlation between students - future primary school teachers' ethical awareness and compliance with ethical norms suggests that the formation of ethical attitudes is not only a responsibility but also a real necessity for the effective and responsible use of AI by future pedagogical specialists. This highlights the need to include ethical topics in the training of all future teachers who work with AI in order to prevent potential ethical conflicts and misuse of the technology. Moreover, the positive relationship between the autonomy and adaptability of students - future primary school teachers when working with AI reveals the importance of developing these skills in training, which could promote not only individual effectiveness in working with AI, but also the ability to quickly adapt to new and constantly changing technologies and challenges. This is key for the future training of pedagogical specialists in the field of AI, who will need to be able to adapt to new technological requirements and work independently.

Further research in these areas could provide additional guidelines for optimizing the training of students - future primary school teachers and practice in the use of AI, considering all these skills and characteristics, which are not only important, but also interconnected.

5. Conclusion

The results of the analysis clearly show that students encounter significant difficulties in working with artificial intelligence, especially in the aspects of navigating the platforms, formulating effective prompts and integrating AI-generated resources into their methodological developments. These challenges limit their ability to use the full potential of AI technologies in the educational process. Moreover, the lack of critical thinking and in-depth analysis of AI-generated resources further complicates the process of understanding and applying these technologies in a way that enriches pedagogical practice. To overcome these difficulties, the curriculum for educating future primary teachers should include targeted topics related to working with AI, such as the effective use of AI platforms, critical evaluation of AI-generated resources and ethical aspects of working with AI. It is particularly important that students be trained on how to formulate clear and relevant prompts in order to obtain more precise results, as well as develop skills for analyzing and comparing AI-generated materials with traditional sources. In addition, topics such as integrating AI into methodological developments and innovative approaches to its use in the classroom can help students adapt these technologies to the needs of primary education.

Adapting the CMU model and applying it in combination with artificial intelligence can provide an effective approach to training future teachers in the full use of AI to enrich methodological units. By integrating critical thinking principles, students can develop structured and analytical skills that allow them to use AI tools not only as a source of information, but also as a means of creatively planning and adapting learning content.

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