

A new paradigm of education and potentials of artificial intelligence



Danimir P. Mandić 

University of Belgrade, Faculty of Education, Belgrade

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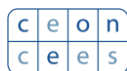
Corresponding author:

Danimir P. Mandić

Correspondence email:

Danimir.Mandic@uf.bg.ac.rs

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Abstract:

This paper addresses the possibility of using artificial intelligence (AI) in education and establishing rules, restrictions and procedures for the safe use of AI in different fields. In the past two decades, we have been trying to improve educational technology by using multimedia, hypermedia, virtual and extended reality, as well as educational software. It has led to the raised quality of learning, increased dynamics and obviousness of the teaching process, as well as encouraged motivation of students. In the past few years, the possibilities of using AI in education have been researched, particularly in the sphere of personalized learning, more dynamic teaching, as well as complex evaluation of students' work. The paper analyzes the benefits, challenges and risks in relation to the use of AI in education and emphasizes the importance of maintaining balance between AI and human interaction. It also analyzes the use of robots in education with the aim of encouraging creativity and critical thinking, as well as developing problem-solving skills through the development of algorithm thinking. In the past year, the application of ChatGPT has been intensified in education and that is why it is necessary to define rules and procedures in which this technology would contribute to teaching and learning.

Keywords: artificial intelligence; educational technology; digital competences

INTRODUCTION

Modern technologies bring intense changes in the field of engineering, traffic, economy and medicine, while changes occur somewhat more slowly in education. Today's development of educational technology is harmonized with the development of information technology, in line with the needs of students in the 21st century. Modern educational technology based on AI leads to the introduction of significant changes in the work methods, organization of teaching, as well as the evaluation of students' work. Integration of artificial intelligence technologies in education ensures individualization and differentiation of teaching contents in line with the possibilities, prior knowledge and learning styles of every student. Robots and 3D simulations in education offer possibilities of practical learning and experimenting which are difficult to provide in traditional teaching, while they give special importance to encouraging research and activities of students in the process of acquiring new knowledge. Serbia ranks among the most avant-garde countries which have introduced subjects and content necessary for acquiring digital competences from pre-school age to the university level of education¹. In pre-school age, through a project approach, the use of the simplest digital devices is ensured, while in the first four grades

of primary school the content is studied in relation to the possibility of using digital devices, children's safety and the development of algorithm thinking. In higher grades of primary school and in secondary school, digital competences are further improved through the subject of computing, where students study content related to computer hardware, computer networks, data bases, as well as elementary programming. The curriculum stipulates content related to the manner of functioning and the application of AI in different fields, thus informing students about the way of learning about artificial intelligence, as well as about the possibilities of its application in different fields. Serbia is one of the leading countries in Europe in defining the Strategy of the Application of Artificial Intelligence until 2030, in which the application of AI in education will have a special place, including the effect of AI on teaching and learning technology. At the Faculty of Education in Belgrade, future educators and teachers acquire digital competences in line with the recommendations of UNESCO and OECD. The Republic of Serbia has defined the New Framework of digital competences for teachers, in which 25 digital competences grouped in six fields. Following the legal regulations and recommendations of the Ministry of Education, the Faculty of Education regularly innovates curricula so that future educators and teachers are adequately

trained for most modern teaching and learning methods. In the Centre for Robotics and Artificial Intelligence in Education (CRAIE), which was founded in cooperation with the Beijing Normal University (BNU) and the software development company NetDragon Websoft from China, the most modern equipment and applications have been installed in relation to 3D simulations, virtual reality, holograms, robotics and artificial intelligence. CRAIE is a research-development centre within the Faculty of Education, intended for the incapacitation of students and permanent specialization of teachers in the field of digital technologies. In education, from the pre-school age onwards, programmable robots are used, such as Bee-Bots, which encourage the development of algorithm thinking. Apart from educational robots, advanced humanoid robots are also used, which can help teachers and students in knowledge personalization, programming and performing different tasks and simulating real-life situations with permanent interaction and feedback, which enables monitoring, measuring and evaluation of each

student's progress. They can help in teaching coding, mathematics, physics as well as other subjects, and make learning more interactive and pleasant. In their interaction with robots, students develop computing thinking, logical thinking and the ability of solving complex problems. The selection of adequate methods of work and modern didactic systems promotes cooperation among students and teamwork in the robot programming process, task solving and engaging in practical projects. These cooperation experiences cultivate communication skills, empathy, critical thinking and the ability to work efficiently in a team. They can be adjusted to students' individual needs and their prior knowledge, as well as abilities, offering adjusted content, activities and feedback.

The use of AI leaves more for teacher's interaction with students, the development of value attitudes and personal character traits, thus giving special significance to education, which has been neglected in our schools (Figure 1).



Figure 1.

Working with educational robots in the Centre for Robotics and Artificial Intelligence at the Faculty of Education

By analyzing students' progress, robots can identify deficiencies in their knowledge and provide targeted interventions, ensuring that every student receives support necessary for success. In this exciting era of robotics in education, we will write about the possibilities of changing teaching and learning, accept innovation and witness the transformative effect of these intelligent machines. Students who learn with the aid of new technologies perceive the teaching process as

a journey on which education encounters technology, thus empowering them to become life-long learners, think critically and solve problems in the constantly changing world.

AI AND TEACHERS' COMPETENCES

Since artificial intelligence is becoming more and more important in education, it is of essential relevance for

teachers to develop new competences and skills in order to efficiently use and integrate AI technologies in their teaching theory and practice. Teachers should be informed about the possibilities offered by AI and trained for the skilful use of artificial intelligence tools and technologies. This includes understanding the way in which AI algorithms function, being familiar with the platforms and applications created by artificial intelligence and knowing how to use educational resources based on artificial intelligence. Moreover, teachers should be trained how to interpret and analyze AI-generated data in order to monitor, measure and evaluate students' progress and identify problems in learning. Continued feedback ensures students' greater motivation and creates good conditions for self-evaluation, thus making the learning process more efficient and effective (Figure 2).



Figure 2.

Virtual reality in in the Centre for Robotics and Artificial Intelligence at the Faculty of Education

Teachers should understand how to integrate AI technologies efficiently in their content and how to adjust teaching methods and the system of evaluating students' work to modern educational technology. This includes harmonizing artificial intelligence tools with learning goals, modelling learning activities based on artificial intelligence and using artificial intelligence as support to different teaching strategies in the use of modern educational technology. With the development of new technologies, teachers should be flexible and ready to learn permanently and update their competences. This involves being informed about the latest technology in education, participating in the possibilities of professional development and cooperation with other teachers for the purpose of exchanging best experiences. In addition, teachers must be aware of the ethical implications of using artificial intelligence in education and some problems with the applications which are not in line with ethical principles. They

should understand the matters related to data privacy, security and algorithm partiality. Teachers need to ensure that AI tools are used with responsibility, ethically and in a manner which respects students' privacy and promotes fairness (Milutinović, Mandić, 2022) (Figure 3).



Figure 3.

Artificial Intelligence in in the Centre for Robotics and Artificial Intelligence at the Faculty of Education

It is very important that students should develop critical thinking and comparative analysis of information received from AI with the information found in reviewed textbooks. Teachers should be able to facilitate cooperation among students by using platforms and tools based on artificial intelligence. They should also be trained for cooperation with artificial intelligence systems, such as virtual assistants and chat-bots, in order to support individual learning and provide personalized feedback. While artificial intelligence may automatize certain tasks, teachers' role is to develop students' critical thinking skills and encourage their creativity. Teachers need to devise modern learning methods which encourage students to think critically about the AI-generated content, to ask questions about assumptions and to develop creative problem-solving skills. Although there is concern that AI might replace teachers, it is difficult to imagine because human interaction, empathy, socialization and educational work with students are irreplaceable. Teachers should focus on building permanent interaction with students, giving emotional support, cooperation and creating a stimulating and inclusive environment in the classroom. By developing these competences, teach-

ers can efficiently use AI technologies for improving their teaching practices, personalizing learning experience and supporting their students' success. It is important for teachers to accept AI as a tool which supplements their professionalism and improves their ability to fulfil students' different requirements in the modern era (Mandić, 2023).

TEACHERS AND AI

As we have already mentioned, a number of experts in education claim that AI-supported teaching will suppress teachers by giving students an opportunity for self-education and self-evaluation. It might make teachers unnecessary in a certain way, which would cause a revolution in teaching by putting students in the position of independent creators of learning. Based on research, it can be concluded that teaching, supported by smart devices based on AI with new methods, changes the teachers' role, but cannot replace them. In line with these changes, AI-supported teaching makes it possible for the teacher to change his/her role of a lecturer, evaluator and primary source of knowledge into a new role which implies competences of organizers, planners, researchers, motivators and verifiers of students' work. Although both learning and teaching are key components of the educational process, the ultimate goals are to ensure students' better learning outcomes and their motivation for learning. AI can analyze individual information about students and provide personalized recommendations, content and activities adjusted to their specific needs and learning styles. This personalized approach helps students to be involved more deeply in the content and to optimize their learning outcomes. Evaluations based on artificial intelligence may be adjusted to students' responses, offering questions and tasks which are adjusted to their interests, abilities and prior knowledge. The software based on artificial intelligence can provide momentary feedback to students about their performance, thus enabling them to identify and correct mistakes in real time (Baker & Inventado, 2014) (Figure 4).

This timely feedback helps students to understand their advantages and weaknesses, enabling them to make changes and improve their learning. AI can help students to access a wide range of educational resources and information. Platforms based on artificial intelligence can recommend relevant content, suggest further reading and provide access to online libraries, thus improving students' ability to research and deepen their understanding of topics. New technologies, such as virtual reality (VR), extended reality (ER) and

play-based learning, may create impressive and interactive learning experiences. Teachers are becoming convinced that teaching and learning based on artificial intelligence, used in combination with other types of teaching, are a purposeful innovation. On the other hand, the curriculum preparation, verification and implementation require teachers' huge efforts, as well as material investments and pedagogically trained staff, which makes it more difficult than traditional education. For this reason, many curricula which are currently criticized have not been prepared professionally enough and have not been tested in practice by authorized experts. That might lead to a situation in which teachers would show resistance to the introduction of innovation if they believe it has not been sufficiently formed and devised in pedagogical terms. Teaching and learning based on artificial intelligence are still a relatively new and insufficiently elaborated concept and that is why many critical objections and some results should be taken conditionally. All the weaknesses of the teaching process we have spoken about will not be manifested in practice if it is professionally programmed and organized (Ristić, Mandić, 2018).



Figure 4.
Extended reality in the Centre for Robotics and Artificial Intelligence at the Faculty of Education

Teaching and learning results based on artificial intelligence fulfil the learning logic, open new learning possibilities, encourage students' activity, ensure progress at students' own pace, make the teaching process more attractive, provide economy and efficiency of the teaching process and thus belong to the category of teaching which is most attractive and suits young people's needs and interests. Most importantly, this new organization of teaching and learning should increase students' internal and external motivation and help them to acquire functional knowledge and to understand facts and procedures. Furthermore, it helps students to have more permanent knowledge. These

technologies engage students, promote active learning and make the learning process more pleasant and attractive. AI can be adapted to various learning styles and preferences by being adapted to different students. For example, some students may prefer visual learning while others may prefer auditive or kinesthetic approaches. AI can ensure content and activities which fulfil individual learning preferences. Modern technologies can improve accessibility for students with special needs. Speech recognition based on artificial intelligence and text-to-speech conversion tools can help students with impaired vision or with learning disabilities by providing them with more efficient access to educational materials. AI can analyze large data quantities about students' performance and learning patterns by offering valuable insights to teachers. These insights can help teachers to understand the efficiency of their teaching strategies, to identify improvement areas and adjust their approaches to teaching in order to fulfil students' individual needs in a better way.

STUDENTS AND AI

As education develops with the integration of artificial intelligence, students' roles also change. The essential change is that students will not be passive actors in formal education, but they should become active participants and researchers. They have access to personalized learning experiences, interactive and adaptable evaluations. Students are encouraged to take initiative for learning, to establish goals and make decisions in line with their interests and prior knowledge, as well as abilities. AI technologies provide students with tools and resources to be included in independent learning. Students can research topics of interest, access educational materials at their own pace and assume responsibility for progress in learning. Platforms based on artificial intelligence can offer recommendations and guidelines, empowering students to manage their own learning experiences. They ensure consistency in the learning pace and details of the presented content, maximum adaptability to students' individual abilities, their psychological traits, speed and learning style. Materials are logically selected in series in which acquiring further knowledge is logically related to prior knowledge, including constant connection of students with their teachers (D'Mello & Graesser, 2012).

AI encourages students to develop critical thinking and problem-solving skills. Instead of passively consuming information, students face the challenge of analysing,

evaluating and synthesizing knowledge. AI technologies can offer possibilities to students to be involved in complex problem-solving tasks and to develop their analytical and creative thinking abilities. AI facilitates the cooperative learning experience, enabling students to work together on projects, share ideas and participate in debates. Students learn to cooperate efficiently, present their ideas and respect different perspectives. Tools based on artificial intelligence can support virtual cooperation, enabling students to be connected and cooperate beyond the boundaries of the physical classroom. With AI integration, students should develop digital literacy skills. They should be trained to use AI tools, to navigate digital platforms and to critically assess online resources. Students learn how to find their way in the digital environment with responsibility, how to understand ethical implications of artificial intelligence and become informed modern citizens. New technologies promote the culture of life-long learning. Students understand that learning is not limited to the classroom and that they should constantly improve their skills and adjust to the rapidly changing world. AI technologies can provide personalized recommendations for further learning, thus helping students to develop a way of thinking about progress and a desire for permanent improvement. Educational technologies may help students in expressing their creativity. Students can use tools based on artificial intelligence for digital art, composing music, narration and other creative enterprises. AI can provide students with new paths in researching and expressing their unique talents and perspectives. Thanks to artificial intelligence, students have the opportunity to express their opinions and to advocate goals in which they believe. They can use AI technologies for researching, data collection and efficient advocating of their ideas. Students become empowered advocates of social and ecological matters, using artificial intelligence to initiate positive changes in their communities. Since education includes artificial intelligence, students' roles shift from passive knowledge recipients to active participants in their own learning. They develop basic skills, learn permanently and contribute to cooperation and a more innovative educational environment. By using artificial intelligence for the improvement of the learning process, teachers can create more interesting, personalized and efficient learning experiences for students. While teaching remains an essential component, the focus is shifted towards ensuring and supporting better learning outcomes for students and developing empathy and social competences (Mandić, Mišćević, Bujišić, 2024) (Figure 5).



Figure 5.

Humanoid robot Ema was developed by Chinese company NetDragon Websoft Holdings Limited which is used in the education of future teachers in the Centre for Robotics and Artificial Intelligence in Education, within the Faculty of Education, the University of Belgrade.

Photo: Faculty of Education

CHALLENGES AND RISKS OF AI APPLICATION IN EDUCATION

In the use of AI to date, it is possible to observe three different approaches formed in certain countries. They differ by the teachers' attitude towards the use of AI, the benefits students have, as well as the risk of plagiarism. In the first group, teachers and experts on education are completely against the use of AI in education and do everything to forbid students' access to AI. They believe that the results gained by students from ChatGPT, Gemini, and Copilot applications help them to reduce their own efforts and engagement and not to achieve desired competences intended by educational goals. Some essays have happened to be graded with the highest grades while teachers were

unaware that it was the result of the work of AI, the consequence of which was severe punishment, including expulsion from higher-education institutions. Teachers think that students had no permission to use modern sources of information, and students believed that they would have all technology at their disposal after completing university studies, so they could not understand why higher-education institutions did not prepare them for using available technologies to optimally solve defined tasks. In our opinion, teachers in this particular case do not want to give up traditional teaching methods, in particular ways of evaluating students' knowledge. Teachers in the second group try to ignore the presence of AI, thinking that changes and results given by AI software will not have more significant effects in the near future. In their opinion, AI is

under control, students will not use it excessively, so that at the moment there is no need for defining rules regarding its use. Education experts in the third group think proactively and are aware of rapid changes. They know that graduates will complete their projects and solve problems by using artificial intelligence whenever possible and no one will be against it in the companies employing them. Of course, it is necessary to have a critical relationship towards results given by AI in this stage of its development. It is also important to ensure that students' privacy is protected, and that data are stored safely and used in line with relevant regulations. Schools and educators must have clear policies for solving data privacy problems (Mandić, 2023). Artificial intelligence systems and robots must be programmed and ethically used in education. It is important to take into account the partialities and limitations of AI algorithms, as well as potential impact on students' welfare and mental health. Teachers should be aware of ethical implications of artificial intelligence and ensure that its use is in line with educational values and goals.

While artificial intelligence and robots can improve learning experience, possible inequalities may also arise in the approach to these technologies. Schools and districts must consider the questions of fairness and ensure that all students, regardless of their socio-economic background, have equal possibilities in benefiting from artificial intelligence and robotics in education. Integration of artificial intelligence and robots in the classroom requires training and supporting teachers adequately. They need to develop necessary skills and knowledge in order to efficiently use these technologies and to integrate them in their teaching practice. It is necessary to provide possibilities for permanent professional development so that teachers may use the full potential of artificial intelligence and robots in education. Teachers should ensure that technology is used as a means of improvement, and not a replacement of the teacher/student relationship. The application of artificial intelligence and robotics in education can lead to substantial costs, including the purchase of hardware, software and current maintenance. Schools and districts must carefully consider financial implications and sustainability of including these technologies in their school curricula. Schools need to consider the adaptability of their technological infrastructure and the ability to be in line with updates and progress in the field of artificial intelligence and robotics. This ensures that technology remains relevant and efficient in its support to learning outcomes, teachers' education-

al work, the development of students' critical thinking and creative potential. Integration of AI and robots in education can cause concern about the potential displacement of certain jobs in the educational sector. It is important to consider the social impact and implications of automation for workforce, as well as the need for teachers' retraining and specialization for the purpose of their adjustment to changeable roles and responsibilities. By addressing these risks and considerations, teachers can maximally use the advantages of artificial intelligence and robots in education, while simultaneously ensuring responsible and ethical use of these technologies. It is necessary to carefully plan and implement strategies which prioritize students' welfare, fairness and effective pedagogy in the context of integration of AI and robotics (Mandić, Mišćević, Bujišić, 2024).

At the Faculty of Education, research entitled *Possibilities and limitations of modern educational technology from the point of view of teachers in Serbia* was conducted in cooperation with UNESCO. Teachers' self-evaluation is a process in which they form opinions about the adequacy and effectiveness of their own knowledge, performance, beliefs and effects with the aim of self-improvement. This was particularly important in the domain of being informed about the possibilities offered by AI-supported educational technology. It is important to ensure that students receive high-quality education which will prepare them for success in the contemporary world. We used the tool for online surveying called Survey Monkey. In the questionnaire, our respondents/ teachers were asked questions about their evaluation of the achieved level of ICT competences, particularly of AI. Our respondents were teachers at different levels of education, from pre-school, via primary and secondary school, to university. The Figure 6 below gives us answers to one of the key questions.

The research results show that teachers are not sufficiently informed about the possibilities offered by AI nor are they trained for its use. To improve teachers' ICT competence, it is necessary to have a clear action plan and progress indications for the use of technologies in education. The Faculty of Education of the University of Belgrade is ready, in cooperation with the Ministry of Education and the *Institute for the Improvement of Education* to implement teacher training and to monitor their progress on a permanent basis.

How would you rate your satisfaction with the use of modern technologies based on artificial intelligence, e.g., ChatGPT, Bing or Gemini in the teaching process? Evaluate it on the scale from 1 to 4 (this and all future scales will always be oriented from negative towards positive as follows: 1 - I am not satisfied at all, 2 - I am partly not satisfied, 3 - I am neither satisfied nor dissatisfied, 4 - I am partly satisfied, 5 - I am completely satisfied).

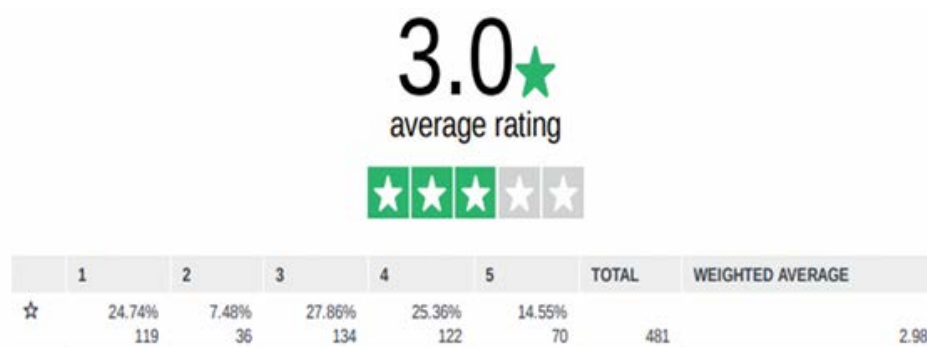


Figure 6.

The research conducted at the Faculty of Education

CONCLUSION

In the past few years we have faced numerous changes in different social fields, including education. After the pandemic period during which teachers and students were forced to use new technologies and platforms for online learning, changes were initiated in education which intensified the development of digital technologies. From the relevant world research, it can be concluded that educational technology based on artificial intelligence frees teachers to a certain extent from routine jobs of teaching and grading while giving them more time for interaction with students, the development of critical thinking, value attitudes and creative potential. Teachers could have more possibilities to progress in professional terms, engage in creative work, research in the teaching process, solve educational problems, implement educational/upbringing programs, and be more socially involved in their communities. In this way, teachers have more time for planning their work, introducing necessary innovation and enrich work with their creativity. Integration of artificial intelligence and robots in education opens the world of possibilities and advantages both for students and teachers. These technologies have the potential for making revolutionary changes in the learning experience, making it more personalized, attractive and efficient. Platforms and robots based on artificial intelligence offer personalized learning paths, adjusting to students' individual needs and promoting independent learning. They offer practical experiences which encourage critical thinking, problem solving and cooperation skills. Artificial intelligence and robots promote inclusivity in education by ensuring accessible learning experiences to students with different needs. These

technologies may be adjusted to support different learning styles, individualized teaching, as well as content adapted to students with special needs. Naturally, it is important to take into account risks and dangers related to the use of artificial intelligence and robots in education. Privacy, ethical use of artificial intelligence, fairness, teacher training and consideration of costs must be carefully taken into account in order to ensure its responsible and efficient application. By accepting artificial intelligence and robots in education we can create dynamic and innovative learning environments which prepare students for future challenges. These technologies have the power to encourage curiosity, motivate for learning and equip students with skills and knowledge needed for their progress in the rapidly-changing world. Modern teaching methods imply reduced time for teachers' lessons who, unlike traditional teachers, do not pass ready-made knowledge to students, but encourage them to research independently and find new information, and to progress in line with their own prior knowledge and abilities. Artificial intelligence might help us to make individualization and differentiation personalized for every student. In the developing teaching process, students learn on their own, using branched person-oriented textbooks which should replace outdated linear textbooks used in the same way for years. We believe that AI will contribute to better-quality teaching, and that teachers will have more time for educational work with students, for teaching them how to learn, how to develop logical thinking, for knowledge functionality, and in particular for addressing the development of children's character traits with the aim of creating best possible persons, which is the primary goal of society on the whole.

Endnotes

Serbia is the first country in Southeast Europe which has adopted the Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the period 2020–2025 ("Official Gazette of the RS", No. 96/19), and the preparation of a new strategy for the upcoming period is underway. Moreover, Serbia has joined the Global Partnership on Artificial Intelligence (GPAI) and will chair this organization in the next three years.

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Нова парадигма образовања и потенцијали вештачке интелигенције

Сажетак:

Овај рад бави се могућношћу коришћења вештачке интелигенције (ВИ) у образовању и успостављањем правила, ограничења и процедура за безбедну примену ВИ у различитим областима. У последње две деценије покушавамо да унапредимо образовну технологију коришћењем мултимедије, хипермедије, виртуелне и проширене реалности, као и образовних софтвера. То је довело до подизања квалитета учења, повећања динамичности и очигледности наставе, као и подстицања мотивације ученика. У последњих неколико година истражују се могућности коришћења ВИ у образовању, посебно у сфери персонализованог учења, динамичнијег подучавања, као и комплексног вредновања рада ученика. У раду се анализирају користи, изазови и ризици у вези са коришћењем ВИ у образовању и наглашава важност одржавања равнотеже између ВИ и људске интеракције. Анализира се и коришћење робота у образовању с циљем да се подстакну креативност и критичко мишљење, те да се развијају вештине решавања проблема кроз развој алгоритамског мишљења. У последњих годину дана интензивира се примена ChatGPT-а у образовању, те је неопходно дефинисати правила и процедуре којима би ова технологија дала допринос настави и учењу.

Кључне речи: вештачка интелигенција, образовна технологија, дигиталне компетенције