



EFFORTS RELATED TO TEACHING AI IN PRE-UNIVERSITY EDUCATION IN THE REPUBLIC OF SERBIA

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Abstract:

Until 2021 Digitalization in Education was mainly related to the increased use of computers and the Internet in the classroom. Future developments will be based on Artificial Intelligence (AI), or on the combinations of AI and other technologies. Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the period 2020-2025 pointed out that the education system needs to respond to broader changes in society and business because of the global progress of artificial intelligence. As a response to challenging future, Pre-university education curriculum is updated with the AI related learning content. In primary education, three mandatory school subjects have defined learning outcomes associated with AI. In secondary education, AI is mainly introduced or planned to be introduced as a part of the curriculum of the elective school subjects. Revision of the Digital Competence Framework for Teachers - Teacher for the Digital Age is planned and will include competences related to AI and large amount data management.

Keywords: artificial intelligence, curriculum, pre-university education

1. Introduction

According to the European Commission High Level Expert Group on Artificial Intelligence, Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge or processing the information derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can adapt their behavior by analyzing how the environment is affected by their previous actions.

AI is a collection of technologies that combine data, algorithms, and computing power. Advances in computing and the increasing availability of data are therefore key drivers of the current upsurge of AI. Europe can combine its technological and industrial strengths with a high-quality digital infrastructure and a regulatory framework based on its fundamental values to **become a global leader in innovation in the data economy and its applications** as set out in the European data strategy¹.

While most innovation in the past decade related to an increased use of computers and the internet in the classroom, the next wave will be based on AI, or on combinations of AI and other technologies.²

¹ COM (2020) 66 final.

² Vincent-Lancrin, S. and R. van der Vlies (2020), *Trustworthy artificial intelligence (AI) in education: Promises and challenges*, OECD Education Working Papers, No. 218, OECD Publishing, Paris, <https://doi.org/10.1787/a6c90fa9-en>.

An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy. AI system lifecycle phases consist of 1) planning and design, data collection and processing, and model building and interpretation; 2) verification and validation; 3) deployment; and 4) operation and monitoring. Machine learning (ML), as one of AI techniques, is described as a set of techniques to allow machines to learn in an automated manner through patterns and inferences rather than through explicit instructions from a human. One of the most promising techniques behind ML is referred to as 'neural networks', which is accompanied by growing computational power and the availability of massive datasets, also known as big data.³

In education, artificial intelligence is embedded in many technological innovations that provide learning analytics, recommendations, and diagnosis tools in various ways and for various purposes. In many cases, AI applications are still nascent and used in experimental and local contexts rather than at scale at the system level. There are, however, many examples of promising uses that foreshadow how AI might transform education in the next decades, both in the classroom and at the system levels, and address different stakeholders: students, teachers, administrators, parents, as well as policy makers.⁴

2. Strategic Development of AI in the Republic of Serbia

Since education (formal and informal) is the basic mean of human resources development, first specific objective of the *Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the period 2020-2025* is defined as "Development of education geared to the needs of modern society and economy conditioned by the advancement of artificial intelligence".⁵

As it is difficult to anticipate the future development of the job market at the level of individual jobs, obvious trends such as multidisciplinary nature of new professions, growing role of data openness, data sharing, value exploitation from data, are indicating the need to enhance teaching content at primary and high schools in accordance with the requirements conditioned by the progress of artificial intelligence. Regarding that, two indicators are defined:

Indicator 1. The number of primary school subjects where the teaching and learning program properly includes artificial intelligence compared to the target values defined in the first phase.

Initial value: 0

Target value for the end of 2022: 1

Target value for the end of 2025: 2

Indicator 2. The number of subjects in high schools where the teaching and learning program properly includes artificial intelligence.

The initial and target values of the indicators will be determined in the framework of the implementation of the measure.

3. Digitalization in Pre-university Education and AI in the Curriculum

Since 2017 digitalization in education has been one of the strategic goals of the Republic of Serbia. It is implemented through three broad areas:

- Human capacity development
- Development of ICT infrastructure

³ OECD (2019), Artificial Intelligence in Society, OECD Publishing, Paris, <https://dx.doi.org/10.1787/eedfee77-en>.

⁴ Vincent-Lancrin, S. and R. van der Vlies (2020), *Trustworthy artificial intelligence (AI) in education: Promises and challenges*, OECD Education Working Papers, No. 218, OECD Publishing, Paris, <https://doi.org/10.1787/a6c90fa9-en>.

⁵ <https://www.srbija.gov.rs/tekst/437277/strategija-razvoja-vestacke-inteligencije.php>

- Design and establishment of Electronic Services (Unified Education Information System, electronic gradebooks, digital textbooks, eEnrollment in Pre School, Primary and Secondary Education...).

Since 2017, there have been many government initiatives in this area with the aim of creating better conditions, which will enable students to develop key competences for lifelong learning, and cross-curricular competencies as defined by the law. Also, the curriculum in pre-university education has been innovated and is based on learning outcomes. The emphasis is on obtaining generic and transversal knowledge and skills, with more opportunities for cross-curricular learning and the development of 21st-century skills (such as creativity, critical thinking, teamwork, problem solving).

There are promising policy developments elaborated in *The Education Development Strategy in the Republic of Serbia until 2030* that has one segment dedicated to the development of digital education, which was followed by an Action Plan and dedicated budget.

Complementary to this policy is the Strategy for the *Development of Artificial Intelligence in the Republic of Serbia* for the period 2020-2025 where education policy in this domain has been introduced and elaborated within the Specific objective 1 - development of education geared to the needs of modern society and economy conditioned by the advancement of artificial intelligence.⁶

The formal expectations for students regarding the development of digital literacy are formulated in the *Law on Foundations of the Education System*.⁷ The law intends to ensure a comprehensive approach to the development of complex and multi-layered concepts such as media, information, and digital competences. It presents the regulatory framework aiming at continuous development of key or transversal and general cross-curricular competencies within the Serbian pre-university education system. Digital literacy and digital competency are listed among the key and general interdisciplinary competences. The focus seems to involve an inevitable reduction in declarative knowledge and the need to develop new knowledge, practical skills, and attitudes. The law highlights the need to assure higher transferability of knowledge in different fields, including better conversion of acquired competences into capacities for action, personal achievements, and lifelong learning.

In a broader sense, the outcome of the learning process should be turned into practical skills and a new attitude, which allow students to act accordingly in complex social situations. (Basic) ICT skills, computational thinking and information literacy in pre-university education are developed through two school subjects: Digital World and Computer Science. Also, project-based learning involving (basic) ICT skills, computational thinking and information literacy is promoted through methodological instructions for teachers, which are an integral part of each school subject curriculum.

Digital World is a mandatory school subject within the first cycle of Primary Education, involving pupils aged 7-10. Implementation started from the school year 2020/21. As stated in the curriculum, the overall goal of teaching and learning in Digital World is to develop students' digital competences to enable them to use digital devices safely and wisely for learning, communication, cooperation, and the development of algorithmic thinking. AI has been introduced through the real-world examples of using digital technology during which one gets the impression that the digital device is behaving intelligently. For example, the teacher and students will talk about the use of computers in agriculture for automatic sorting of vegetables, pest detection or the use of computers to control cars without drivers (thanks to sensors the car will not hit a pedestrian, go through a red light, or exceed the speed limit).

At this point, nearly 120,000 first grade and second grade primary pupils are involved in learning topics within the Digital World subject. In parallel, Digital World curricula for third and fourth grade are being developed. At the national level a working group consisting of various experts in computer science, education psychology, curricula development and pedagogy has been established to discuss, design, and propose the new curricula. The subject

⁶ https://www.srbija.gov.rs/extfile/sr/437304/strategija_razvoja_vestacke_inteligencije261219_2_cyr.pdf

⁷ https://www.paragraf.rs/propisi/zakon_o_osnovama_sistema_obrazovanja_i_vaspitanja.html

has 36 school-hours per year and is structured around three teaching areas: Digital Society, Safe use of Digital Devices and Computational Thinking.

Computer Science is a mandatory school subject within the second cycle of primary education, involving students aged 11-14. Implementation started from the school year 2017/18. At this point, nearly 250,000 students are involved in learning topics within the Computer Science subject.

As stated in the curriculum, the overall aim of the subject is to enable students to manage information, be secure while communicating in the digital environment, and create digital content and computer programs to solve various problems in a society that is changing rapidly with the development of digital technologies.

In all four grades, the subject is structured around three teaching areas: (basic) ICT Skills, Information Literacy and Computational Thinking. Within the field of Computer Science, the most important novelty is learning programming – in the fifth-grade students learn visual programming languages (most often Scratch, which is localized in the Serbian language and Cyrillic alphabet), while from the sixth-grade students learn textual programming languages (e.g., Python). The number of teaching hours is 36 per year. AI has been introduced in the eighth-grade through explanation of the concept of artificial intelligence and examples of application. Special attention is dedicated to the Ethical Principles for Artificial Intelligence.

Technique and Technology is the second mandatory school subject within the second cycle of primary education in which AI is presented. As stated in the curriculum, the overall aim of learning Technique and Technology is to develop students' technical-technological literacy, to build responsible attitude towards work and production, living and working environment, use of technical and technological resources, gain a better insight into their own professional interests and to act in entrepreneurial and proactive manner. AI has been introduced in the seventh and eighth grade with special focus in the application of AI in robotics. The subject has 72 school-hours per year.

In the secondary education, AI is part of the curriculum of several school subjects, mainly elective ones. For example, in the fourth grade of Grammar School, among other elective subject students can choose Contemporary Technology and learn about AI. At this point, new elective subjects are created for all VET schools. Some of them will offer content related to AI.

Regarding teaching, meaningful, responsible, and ethical application of AI in education is a priority. Revision of the *Digital Competence Framework for Teachers - Teacher for the Digital Age*⁸ is planned for 2023. Revised document will include competences related to AI and large amount data management. The development of teachers' competencies in technology-oriented subjects will present a main challenge.

4. Conclusion

Ethical dimension of AI should be the central area of focus in education. AI systems should empower human beings, allowing them to make informed decisions and fostering their fundamental rights. The data, system and AI business models should be transparent. Humans need to be aware that they are interacting with an AI system and must be informed of the system's capabilities and limitations. AI systems should provide benefit to all human beings, including future generations. It must, hence, be ensured that they are sustainable and environmentally friendly. Moreover, they should consider the environment, including other living beings, and their social and societal impact should be carefully considered.⁹

As stated in the *Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the period 2020-2025*¹⁰, the implementation of changes in the education system is complex and time-consuming, future development in education should be implemented in two phases:

⁸ https://zuov.gov.rs/wp-content/uploads/2019/08/2019_ODK_Nastavnik-za-digitalno-doba.pdf

⁹ <https://digital-strategy.ec.europa.eu/en/node/1950>

¹⁰ <https://www.srbija.gov.rs/tekst/437277/strategija-razvoja-vestacke-inteligencije.php>

- in the short term, the activities that will kickstart and shape the process should be envisioned.
- in the long term, this will lead to actual changes in the programs of teaching and learning, and educational standards with an appropriate development of competency among the teachers and other factors that influence the capacity building within the educational system.