

International Cooperation for Digital Innovations in Primary Schools

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The contemporary world is technology-oriented and technology users are younger and younger. Digital literacy has become one of the basic skills that educational institutions focus on delivering for. Together with the technological advancement, the skill of programming has emerged as no longer the need of the hour, but as a lifelong skill. The search for innovative ways of introducing digital content to the youngest users constitutes the main objective for educational institutions, together with an urge to come up with effective educational solutions to provide primary schools with tools and methods to teach programming. Cooperation of varied institutions, ranging from primary schools, universities, cybernetics and robotics societies, to renowned publishing companies, proves to be an effective initiative making exchange of best practices possible and joint efforts realistic. The paper presents the outcomes of the cooperation of European institutions from Poland, Croatia, Portugal, Italy, Finland, Denmark, The Netherlands and Turkey under three international Erasmus+ projects. Jointly created databases, tools and methods to teach about programming and AI include innovative ideas for teaching computational skills with and without technology. International cooperation guarantees wide access to the materials for elementary school educators worldwide and fosters digital innovation in schools.

Key words – *primary school education; programming; AI; Erasmus+ projects; innovation*

I. INTRODUCTION

Why has technology become so important in our lives? ‘It is an essential tool that we cannot avoid, it plays an important part in the majority of our lives. Technology essentially harnesses the tools, technologies and strategies used to help us solve problems and simply make our lives better and easier (...).Technology is inevitable in our everyday lives.’ [1] With that said, digital literacy can be defined as an indispensable skill for every individual who needs it to interact with the surrounding world. Digital competencies, being undoubtedly the crucial ones, are no longer to be gained at secondary or high school levels only, the age of the technology user has dropped significantly. When it comes to children the advantages of digital education is far-reaching. Not only is it a powerful tool to expand the students’ learning opportunities but it also constitutes an important part of their development and future prospects, both social and professional.

‘For many children digital devices and the possibilities they enable are threaded through everyday life from the earliest days, and their early experiences and

understandings are patterned by technology use.’ [2]. Therefore, educational institutions are in need for innovative solutions towards digital education and progress from the possibly earliest stages of education.

‘Fostering digital literacy means going beyond functional skills and the ability to complete basic internet searches and PowerPoint presentations. It means giving students the opportunity to use a wide range of technologies collaboratively, creatively and critically.’ [3] Unfortunately, in many cases, primary school teachers do not feel adequately prepared for the challenge of introducing concepts such as coding or Artificial Intelligence to the youngest learners in an attractive and efficient way. What is more, with the digital development progressing so rapidly, working out highly effective educational solutions is not an easy task for a single institution. Therefore, international cooperation of varied institutions serves as an innovative approach towards educational digital innovation so necessary to meet the demands of the contemporary school. It provides an opportunity to equip schools with the innovative tools and solutions to guide the youngest learners to become not only the users, but also the creators of the digital content. This triggered European educational institutions’ efforts under Erasmus+ projects to create cutting-edge educational databases for teaching programming and elements of Artificial Education to primary school students. Not only do the databases consist of technology-based curricula, lesson plans and textbooks for teaching programming and technology-related topics, but these are also suggestions for introducing the concept of programming without technology as such, with the innovative MEMA method being the most representative and effective example of this. Without international collaboration of educational institutions the exchange of best practices would not have been possible on such a scale.

As Henry Ford (1863-1947) once said: ‘Coming together is a beginning, staying together is progress, and working together is success.’

II. DIGITAL INNOVATIONS IN PRIMARY SCHOOLS

Digital innovations in schools seem inevitable. Why is it so important that schools teach coding? ‘In a world where there’s a lot of content and games to consume, it’s important to have creators of good, engaging, and quality content. By learning how to code students have an

opportunity to be the creator, not just the consumer.’ [4] With the digital literacy becoming one of the major skills to be mastered by primary school students, it is vital for the educational institutions to come up with ideas on how to engage young users into becoming active participants in the digital transformation. The ability to passively use the digital contents may not be enough within a decade. Competences related to programming are undoubtedly worth investing the educational efforts into. ‘Today, the importance of learning to code rivals even that of reading and writing. It’s a core skill that can help a child develop a deeper understanding of how technology works. Given the extent to which technology shapes our lives, learning to code helps develop a better understanding of the world around us.’ [5]

A direct answer to the above mentioned expectations is the Erasmus+ CodeInnova project. The initiative created by five European educational institutions: Zamojskie Towarzystwo Oświatowe, Zamość, Poland; I. Osnovna škola, Čakovec, Croatia; Školska knjiga d.d., Zagreb, Croatia; JYU, University of Jyväskylä, Finland; Agrupamento de Escolas de Fornos de Algodres, Portugal aimed at the creation of uniform school curriculum for teaching programming in primary schools together with the teaching database. The following project results have been created under the project:

- Joint and coherent core curriculum for teaching programming at primary school;
- 50 model lesson plans, coherent with the core curriculum;
- 2 textbooks for teaching programming at primary school: for grades 1-4 and 5-9;
- Internet platform to support teaching programming at primary school, including didactic materials in 5 languages: English, Croatian, Polish, Portuguese and Finnish. (<https://www.skolskiportal.hr/projekt/erasmus-2/>)

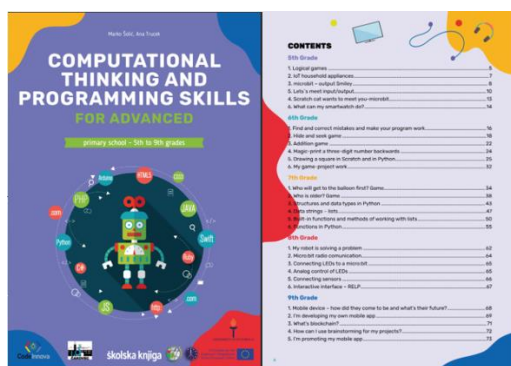


Figure 1: Erasmus+ CodeInnova Textbook Grades 5-9

The idea of introducing the concept of AI into primary schools has been challenged by Erasmus+ project ARTIE: ‘Artificial Intelligence in Education - challenges and opportunities of the new era: development of a new curriculum, guide for educators and online course for students’. The strategic partnership of: I. osnovna škola Čakovec, Croatia; Agrupamento de

Escolas do Barreiro, Portugal; I Społeczna Szkoła Podstawowa im. Unii Europejskiej, Zamość, Poland; Croatian Robotics Association, Croatia; and Nefinia, The Netherlands, aim at the creation of tools and methodologies to guide educators on how to introduce elements of Artificial Intelligence to young technology-oriented learners. The educational final project result ‘AI-Edu Kit’ to be composed under the project comprises of:

- AI in Education: A new curriculum; (<https://www.erasmus-artie.eu/>);
- Challenges and opportunities of the new era: A Handbook for Teachers;
- TwinSpace - an open window to other educational realities: Online course for students.



Figure 2.: Erasmus+ ARTIE New Curriculum

The project outcomes constitute ready to use educational materials, leading the educators through the process of teaching primary school students to become active creators of digital contents. Together with the competences of coding, and with the inevitable wave of technological innovation, the understanding of Artificial Intelligence (AI) and introducing its concept to young learners seems to be the next challenge for a modern school. ‘The future lies in artificial intelligence and it is best to start teaching children this new world as young as possible.’ [6] Nowadays, we are experiencing a wide scope of technologies driven by AI, sometimes even without realizing it. It is important to make sure that young users understand its concept and how it may affect their lives. AI literacy seems to be the next skill to be mastered in order to make the most of what AI has to offer. The question that emerges is what the young users want AI to be like in the future, and how they can contribute to their vision becoming realistic. ‘AI Literacy is an organic part of digital literacy for all citizens in an increasingly intelligent society’. [7]

Both European initiatives are the answer to high demand for educational methodological content to be used by teachers and students of primary schools. Materials translated to a few languages: English, Croatian, Finnish, Portuguese, Dutch, Polish, constitute easily accessible database for educators worldwide. Not only do they promote innovation in digital transformation of schools, but they also serve as an example of joint efforts of European institutions to improve the quality of educational systems in general.

III. MEMA METHOD FOR TEACHING PROGRAMMING

With the technological revolution and the necessity to develop digital literacy, technology seems to be the most obvious way to teach coding. But is it the only and most obvious idea? Do we need to computers to teach programming?

‘Coding is not just about computers, but about computational and sequential thinking, logical reasoning, creativity, and problem solving skills. This does not just apply to the work of advanced mathematicians and logicians, but to the simplest daily tasks which are familiar even to children.’ [8] The truth is that children can learn simple algorithms by playing with LEGO blocks or playing cards. Programming had been invented before the technologically advanced devices were created. In order to provide the educators of primary schools with ideas of how to teach coding without technology, especially to very young learners, the innovative MEMA method has been developed. The initiative undertaken by four European institutions: Cybernetics society Rijeka, Croatia; I. osnovna škola Čakovec, Croatia; Zubeyde Hanim Ortaokulu, Umraniye, İstanbul, Turkey; Zamojskie Towarzystwo Oświatowe, Zamość, Poland under Erasmus+ project ‘Cybernetics in Early Childhood Education – MEMA as a Teaching Method’. The project is intended to result in the creation of:

- the Conceptualization of the MEMA method;
- Textbooks for Teachers and Students;
- Lesson Plans corresponding to the Textbooks contents.

What is the MEMA method then? It begins with the simple question: ‘When should we start learning programming?’ and a very easy answer to follow: ‘As soon as possible’. The MEMA method is an innovative method that prof. Ph.D. Marina Čičin Šain designed more than 43 years ago. [9] The MEMA method is an approach to teaching programming to very young learners without any equipment or software. It allows for teachers without any specific knowledge of programming languages to conduct the lessons. It enables children to learn without much effort while doing their regular schoolwork. It involves creativity and teamwork, but without the feeling of being forced to memorize some new contents or having to learn some complex rules and definitions. It involves having fun while revising issues taught in various school subjects. It is about learning in the most natural way, the way we learn a language while being small children, without even realising that. Using the MEMA method is a gradual approach and its biggest advantage is that it can be easily incorporated in most school subjects that children learn at school anyway. Its gradual repetition, learning step by step, revising the school contents the students are familiar with, tasks of different complexity, which stimulate and encourage students to seek for new solutions, all these are the strong points of the method.



Figure 3.: MEMA toy that helps to understand how the main computer memory works

The modernized MEMA method together with the materials constituting the educational database will be available in English, Polish, Croatian, Turkish to enlarge the scope of their effectiveness and equip primary schools with the innovative idea on how to teach coding without computers in a very easy and efficient way, available to everyone interested.

IV. INTERNATIONAL EFFORTS FOR DIGITAL TRANSFORMATION

‘Digital transformation in the education industry helps improve the learning experience for both students and teachers, as well as other people involved in the process. Such changes focus on improving engagement and accessibility through interactive and customizable learning.’ [10] Digital transformation involves cooperation, especially when it comes to transformation of educational systems. However, educational innovations are rarely the result of a simple institution’s efforts. Cooperation of varied institutions, ranging from primary schools, universities, cybernetics and robotics societies, to renowned publishing companies, proves to be an effective initiative making exchange of best practices possible and joint efforts realistic. The creation of educational tools and methodologies that can be applicable in varied educational systems requires high quality collaboration. International cooperation allows for the exchange of best solutions, ideas, with access to initiatives not previously available to all the parties.

Fast-paced technological development poses new challenges to schools. ‘To adapt to changes in the landscape of the jobs market, schools should adjust their curriculum and incorporate coding.’[11] Educational systems need to be adjusted to technology-oriented young students and school curricula equipped in tools providing educators with practical and effective methodological materials to be used in the classroom. Educational institutions need to be open to innovative solutions in order to keep up with the changes that the era of digitalization provides. Cooperation of institutions under international educational projects is much more effective as its impact is much wider. International databases of educational contents, available in many European languages, enhances the scope of the cooperation and constitutes the basis for further improvements worldwide. The international cooperation under Erasmus+ projects constitutes an example of joint efforts to improve educational systems in varied educational environments. Projects ranging from those directly focused on the digital contents, making use of the newest technologies, to projects making use of innovative methods to teach

programming without technology (such as the MEMA method), enable educational institutions experiment with varied and innovative approaches to teaching elements of programming and Artificial Intelligence to primary school students.

The methodological approach of the Erasmus+ CodeInnova, ARTIE and CybeMEMA projects is based on multidisciplinary approach. It allows for the creation of effective tools and learner-oriented methodology that can be used in many school subjects with or without the use of technology. The wide scope of methods, ready-to-use materials such as school curricular, textbooks, guides for teachers, lesson plans not only provides the educators with innovative ideas for digital education, but it also brings educational institutions to a higher level as they can provide service of higher and more effective quality.

The projects bring long-term benefits aiming at one goal - to improve the quality of digital education of primary schools and provide educators with innovative teaching aid databases, also the ones not requiring advanced technological equipment and thus enhancing the possibilities of introducing programming in varied educational environments. Erasmus+ funding made it possible for European institutions to join their efforts in search of such educational innovations.



Figure 4.: Erasmus+ Programme logo

V. CONCLUSION

The transformation of educational processes in the field of digitalization is inevitable and schools need to adjust to the requirements of the technological progress. Digital competences have become the basic ones which all modern school curricula should include and make use of. However, not all educational institutions are in possession of tools and guidelines on how to introduce the concepts of programming and Artificial Intelligence to primary school students, especially the youngest ones. At the same time, the age of the digital contents users is becoming lower and lower, which leads to the rising necessity of educational institutions to adjust their efforts to the needs of young learners. International cooperation fills the gap of missing educational resources, which primary schools are in high demand for. The collaboration of varied institutions, ranging from primary schools, universities, cybernetics and robotics societies, to renowned publishing companies, makes the exchange of best solutions possible and reliable. This guarantees

wide access and high usability of the materials to educators of elementary school in particular, but also to all interested in the idea of introducing teaching programming from the possibly earliest stages.

The creation of school curricula, textbooks, lesson plans, innovative methods to teach programming and AI-related concepts with or without technology, is a huge step forwards and a long-term investment in future initiatives. It contributes to the educational systems' improvement, it ensures effective implementation of innovative educational solutions, and, first of all, it constitutes a crucial milestone towards the digital transformation of schools. All these would not be possible without joint ventures of dedicated international Erasmus+ project partners.

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