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LEARNING AND TEACHING COMPUTER PROGRAMMING IN AN ONLINE ENVIRONMENT

ABSTRACT

The COVID-19 pandemic continues to affect a number of decisions and guidelines in the field of education. Learning and teaching in an online environment presents a great challenge for all participants in the educational process. Exponential growth of technology made computer programming increasingly important skill, attention to which is becoming an imperative today at all levels of education. The online environment allows interaction of students and teachers during this pandemic. This paper presents a theoretical framework and results of research related to online learning and teaching of computer programming and its improvement, implementation and efficacy. Learning computer programming involves gaining theoretical understanding and application of skills in program development. Different platforms for individual and/or joint programming in education, interactivity of students' exercises, comparison of mutual results (coding game) are presented. The most common programming platforms in education are Code Academy, Pluralsight, Khan Academy, Think Big Coding, Code Avengers. These are special platforms for resources for learning coding and programming skills. It includes a wide range of programming languages such as Python, JavaScript, C ++, C #, Ruby, PHP, and so on. We aim to aid in a more detailed understanding of learning and teaching computer programming in a virtual environment and present a list of desirable characteristics for such an approach for future developers.

Keywords: computer programming, platforms, teaching, virtual environment

INTRODUCTION

Learning and teaching in education occupies an important place in research (Peko et al.,

2006; Reić Ercegovac, King & Behnke, 2005). Scientists use synonyms for learning and teaching such as student-centred teaching, process-oriented or child-centred teaching, active

teaching (Nikčević-Milković, 2004; Matijević & Radovanović, 2011; Džaferagić-Franca & Omerović, 2012). Learning and teaching in an online environment is also focused on the advancement of information sciences and technologies. Mutual collaboration is an important element in studying teacher presence in the online environment (Wilson & Stacey, 2004; Ko & Rosen, 2010). The COVID-19 pandemic continues to affect a number of decisions and guidelines in the field of education. Mutual collaboration between professionals from different fields is important with an emphasis on collaborative planning and team virtual teaching (Nevin, Thousand & Villa, 2009). The pedagogical role of teachers is important (Berge, 1995; 2009) which refers to the field of work, expertise, computer communication and facilitation of interaction (Liu, Bonk, Magjuka, Lee & Su, 2005). The collaboration of teachers, administrative staff, students, and the environment contributes to the advancement of virtual teaching (Yang & Cornelious, 2005; Berge, 2009). Learning and teaching in a virtual environment enhances support for information and communication technologies. It has an impact on the successful implementation of online education (Bolliger & Wasilik, 2009; Covington, Petherbridge & Warren, 2005; Reynolds, Treharne & Tripp, 2003; Wilson & Stacey, 2004; Zhao & Frank, 2003). Teaching contents and activities contribute to a more successful coping with technology. Activities, strategies and models play a significant role in the learning and teaching process (Johnson, 2002; Bezjak, 2009; Pierce & Jones, 1996; Putnam, 2001; Putnam & Borko, 2000) for student progress in the context of technology for today's technological society (Kelley & Kellam, 2009; Kovačević, 2012; Milat, 1996; Verbitsky, 2012). The labour market has increased interest in developers, resulting in various information courses in education (Qian and Lehman, 2016), school programming classes (Saez-Lopez et al., 2016; Moreno-Leon et al., 2016). Computer programming includes problem solving (Calao et al., 2015; Fessakis et al., 2013), creative thinking (Gupta et al.; Navarrete, 2013), algorithmic thinking (Hromković et al., 2016), reflective

thinking (Kalelioğlu, 2015). It connects different aspects of mathematics, science, and the natural and social sciences and languages (Baki & Özpınar, 2007; Baytak et al., 2011; Brown et al., 2008; Burke, 2012; Ferrer-Mico et al., 2012; Ke, 2014; Moreno-Leon et al., 2016; Navarrete, 2013; Saez-Lopez et al., 2016). Many states are involved in computer programming in education. Computer programming started in primary school (Han et al., 2016; Heintz et al., 2016). In Switzerland, the plan is called Lehrplan21 and includes a compulsory course for teachers related to computing (Lamprou & Repenning, 2018). Computer programming in a virtual environment presents a new educational challenge in our society. New social changes and accelerated technological progress require adaptation and implementation in the field of society, technology and science. Computer programming enables interaction with computers and platforms for learning programming and provides basic skills for today's job market. Encourages computer thinking, reasoning and modelling with the aim of better understanding mathematics and science. Computer programming includes thinking, coding, abstraction and analysis (Lye & Koh, 2014) and mental skills (Benzer & Erümit, 2017). One of the alternative virtual methods of learning and teaching computer programming is through gamification. Learning becomes interesting, a pleasant virtual atmosphere is created, performances are positive. A competitive spirit is created in a virtual environment. Platforms in a virtual environment focused on computer programming in education were used. It is conceived as open-source software, and gamification concepts are often used at the educational level. Learning in a virtual environment is a required platform of interactive online services that provides students with access to information, tools and resources (Ghirardini, 2011). A platform that verifies the input of source code by students online can bring top educational results on computer programming technologies (Fernandez, 2011). The paper presents models of learning and teaching computer programming in a virtual environment through platforms. The platform includes

its structure, functionality, programming capabilities through gamification and application in practice.

Teaching and learning are two interrelated, yet different processes in the domain of education. Teaching involves the act of imparting information, knowledge, or skills to students. In contrast, learning involves the receiving of that knowledge by individuals and the subsequent application or internalization of the acquired information. One significant difference between teaching and learning lies in the scope of authority. While teaching is usually associated with authority figures such as teachers or instructors who deliver the content, learning puts the learner in an active role, empowering them to actively engage with the learning materials and build their understanding (Hudson, 2007; Loughran, 2013; Caskurlu et al., 2020; Popa et al., 2020).

Learning and teaching in an online environment

Learning and teaching in an online environment using a variety of platforms allows students to expand their knowledge. They develop thinking and programming skills, social competencies, communication (forum, discussion), helping other students encourage empathy and assertive communication. The learning and teaching platforms are Claroline and Moodle. Claroline was developed in 2001 in Belgium. It has easy accessibility and the ability to use people who do not have special technical skills. Moodle is a platform for online learning and teaching with a free LMS system for teaching content management. It provides a greater possibility of knowledge sources in the form of tasks, exercises, files, multimedia, videos, presentations, forums, lessons, tests, quizzes, assignments. It offers interactive communication between teachers and students. One of the interesting learning platforms through computer programming has automatic grading, an online judge (Kosowski et al., 2008). It contains different types of problem issues that can be searched by interest. The system automatically evaluates the obtained code solutions and the dependence

on the number of lines of code, generates student rankings, detects code plagiarism (Ihantola, 2011). The platform does not offer the possibility of communication with students, nor the provision of materials. The possibility of interactive programming on a website supports JavaScript (Guo, 2013). A platform that combines checking code execution and tracking student progress is Code Avengers. These platforms do not include a form of gamification. An extremely popular topic today is gamification. It has attracted particular attention in the educational context. It has become one of the digital environments for learning and teaching computer programming thanks to technological advances. Gamification includes digital games, the possibility of success and failure, re-solving a task without punishment, free choice of learning according to interests and abilities. At the educational level, it uses a number of gamification concepts, which will increase student engagement, rivalry, and teamwork (Swacha & Baszuro, 2014). The goal is to encourage and reward behaviours that support computer programming in a virtual environment by encouraging productivity and social skills. Gamification in recent years occupies an important place in education with the goal of improving student engagement, motivation, class attendance, and achieving better outcomes (Hung, 2017). Barata et al. (2013) conducted a gamified course with the aim of better motivating students through a programming game. The course included multiple levels, points collection, scoreboards, challenges, and badges. The course involved a larger number of students to participate in virtual computer programming through play. The results showed that students' motivation to program increased, but grades did not improve significantly. Berkling and Thomas (2013) launched a network platform for computer-based learning through games. Students had multiple levels, they collected points, a competitive spirit. Students felt that such a virtual environment through a new approach to learning and teaching was not significant to their progress in computer programming. Betts et al. (2013) developed a gamified platform based on

the Curatr network. Now it's called Stream LXP. Students who were more involved in using the platform scored more total points in programming. Today it provides an opportunity to help children with autism. Partners are teachers through the TES website. They motivate them for various courses with the aim of better teaching and lifelong learning in a flexible and dynamic way. Stream LXP serves as a platform for social, interactive and gamified learning in virtual environments. Brewer and colleagues investigated the problem of lack of motivation in children for computer programming through gamification and the reward system. Motivation of children in performing tasks increased by 24%. De Freitas and de Freitas (2013) introduced the concept of gamification in students in computer science classes called "Classroom Live". They paid attention to game design, introduced points, levels, and rewards. The results showed that students in such an atmosphere were more comfortable learning computer programming, but progress in their engagement is visible. Kapp (2012) indicated that gamification can increase student engagement in the learning process. Nicholson (2015) believes that reward-based gaming has short-term effectiveness. Motivation depends on the context (Hartnett, 2016). An example of an application to increase student motivation is DevHub / Roblox, Stack Overflow where virtual mutual communication is possible. Login required, users are visible, and points and percentages are updated for each user. The platform offers a range of questions and answers, for knowledge exchange and collaboration in C ++, JavaScript, Python, Java, C #, CSS, HTML, MySQL, PHP, RUBY. It offers a free platform and platforms that are paid on a monthly basis. It provides a unique code base running on all platforms supported by Roblox. One of the platforms for those under 18 (Com-Score), players can be included on Roblox every month. Roblox software and cloud infrastructure removes the complexity of multiplayer gaming, game updates, scaling. It offers free lessons through collaborative computer science teaching webinars for teachers and students according to topics of interest and age groups. Mi-

crosoft Ribbon Hero offers the ability to gamify in learning Microsoft Office tools. These are Microsoft Word, Excel, PowerPoint and OneNote in Microsoft Office 2007 and 2010. A story is formed about Clippy and his time travels. He explores time periods and tries to return home. Explores a new board with the challenges he must meet to get to the next level. Challenges include document formatting, inserting charts, images, and a range of subtasks to develop thinking and creativity. Offers the ability to complete, resume, replay, navigation. The user interface is particularly motivating designed. The Khan Academy platform provides opportunities through play. There are many gamified systems that help increase user engagement when learning new techniques (Nah et al., 2014). Computer programming platforms may include instructor teaching, providing dialling options. In online courses, this includes flexible teaching taking into account the age of the student, his interests without pre-defined criteria and rules (Nicholson, 2015). Khan Academy is a free platform. Students only determine which tasks they will solve, in which order. The focus is on the students, not on the technology itself. It offers learning and teaching in the fields of mathematics, computer science, biology, art, economics, reading, language, life skills. The teacher can form a class, add students, programming courses of different programming languages. Additional explanations include video lectures, example codes. It offers learning and teaching opportunities for students and teachers. They practice and progress at their own pace as best suits them according to their own capabilities and abilities. Code game is a free platform that, with the help of gamification, develops logical thinking, enables interdisciplinarity and teamwork. Provides open and closed education. The opportunity is provided to create projects (games, animation). They work with more than 6,500 schools and organizations from 21 countries around the world. Code academy is a learning platform that specializes in computer programming, with gamification (Ryzac, 2012). Provides opportunities and online courses. Students have the opportunity to create

interactive coding exercises, while winning a point when performing the exercise correctly, the possibility of a maximum number of points in one day is provided. Students have the option of being rewarded by receiving a badge when they score a certain number of points, which provides the opportunity for greater motivation. Students have access to teaching materials; teachers have the opportunity to monitor the progress of each student by levels and points. Bonus rewards and time limits for challenges are provided. Code academy is adapted for beginners. Code school offers computer programming through entertainment. It offers various contents, various tasks, have the opportunity to create your own project. They receive badges and points with the aim of better motivating students. It has an interestingly designed interface. Provides the ability to learn HTML & CSS, Python, JavaScript, Java, SQL, Ruby, C ++, R, C #, PHP, Go, Bash / Shell, Swift, Kotlin.

Online learning, despite its growing popularity, is not without its drawbacks. One of the primary disadvantages of online learning is the lack of personal interaction. The traditional classroom offers opportunities for face-to-face engagement, which encourages collaboration, discussion and socialization among students. In contrast, online platforms can lead to feelings of isolation and prevent the development of interpersonal skills. Furthermore, a lack of practical experience in online education can result in a lack of skills, especially in areas that require practical training or the application of theoretical knowledge. The challenge of staying motivated and focused in a virtual learning environment can also detract from the overall learning experience. Addressing the shortcomings of online learning requires proactive strategies to improve the quality of education in virtual environments. One of the key obstacles to overcome is the sense of isolation that students can experience. Educators and institutions can implement virtual collaboration tools, discussion forums, and group projects to promote social interaction and community building among online learners. Additionally, incorporating a mix of virtual labs and hands-on activities can

bridge the gap between theoretical knowledge and practical skills. Higher education providers are increasingly tailoring their online programs to meet diverse learning needs, offering a range of resources, support services and flexible learning options to improve student engagement and success. By adopting these strategies, the disadvantages of online learning can be mitigated, creating a more inclusive and effective learning environment for students. (Gillet-Swan, 2017; Uroková, 2020; Yuhanna, Alexander & Kachik, 2020; Topping, 2023; Wong, 2023). Although online learning presents several challenges such as isolation, lack of hands-on experience, and motivational issues, implementing targeted strategies can help address these shortcomings and improve the overall learning experience. By recognizing the nuances of teaching and learning and actively working to overcome the limitations of online education, we can create a more engaging, inclusive and effective learning environment for students in the digital age.

The platform learning and teaching

The platform includes an account through which students log in, access to data on each individual student. Tracks student progress and achievements. It also serves for holding individual courses and publishing teaching materials and tasks. Gamification-based platforms have a specialized design, contain individual tasks, ranking by levels, rewarding, review of teaching content, quizzes, forum, discussions. It encourages a competitive spirit. Points can be collected by solving quizzes and tasks related to completed lessons, performing additional exercises, encouraging other students to challenge as a form of competition, correcting mistakes (forum, discussion), helping other students by teaching or showing an exercise. Tasks can be solved in groups or individually according to the difficulty of the tasks. The execution time of the code is measured, the accuracy of the code is checked. By performing certain tasks, the student has the opportunity to win a badge. The platform is conceived as a web application that specializes in interface design, a computer programming environment (Passey & Higgins,

2016; Liu, Lomovtseva & Korobeynikova, 2020; Ouadoud, Rida, & Chafiq, 2021; Alshammary & Alhalafawy, 2023; Sofi-Karim, Bali & Rached, 2023). It can be like a web page made in different programming languages HTML, JavaScript and CSS. Learning and teaching on the platform can use any programming language. JavaScript offers the ability to run any computer programming. Theoretically, the platform can be used to teach any programming language (Python, JavaScript, SQL, C ++, C #, Ruby, PHP, HTML).

CONCLUSION

Computer programming is becoming an imperative and the most important skill nowadays. It occupies an important place in education and needs to be implemented in other disciplines in order for it to become interdisciplinary. There is not much research on the best performance way

of learning and teaching computer programming in a virtual environment. These platforms represent a modern concept of learning and teaching computer programming in a virtual environment. Implementing gamification for virtual learning and teaching has a distinctly positive effect. Motivates and engages students, encourages various activities with the aim of better cooperation, (co) assistance, developing a competitive spirit and the effect of better results. Social skills are developed, which leads to better and more efficient learning and a pleasant atmosphere in the work environment. In this way, it contributes to the improvement and increase of the professional program community and to meeting the needs of the labour market. This area of work requires extensive research due to the topicality of the topic, but also a better understanding of computer programming in education.

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UČENJE I POUČAVANJE RAČUNALNOG PROGRAMIRANJA U MREŽNOM OKRUŽENJU

SAŽETAK

Pandemija COVID-19 i dalje utječe na niz odluka i smjernica u području obrazovanja. Učenje i poučavanje u mrežnom okruženju veliki je izazov za sve sudionike obrazovnog procesa. Eksponencijalni razvoj tehnologije učinio je računalno programiranje sve važnijom vještinom, čija pozornost danas postaje imperativ na svim razinama obrazovanja. Mrežno okruženje omogućuje interakciju učenika i nastavnika tijekom ove pandemije. Ovaj rad predstavlja teorijski okvir i rezultate istraživanja vezanih uz mrežno, kao i učenje i poučavanje računalnog programiranja te njegovo unapređenje, implementaciju i učinkovitost. Učenje računalnog programiranja uključuje stjecanje teorijskog razumijevanja i primjene vještina u razvoju programa. Prikazane su različite platforme za individualno i/ili zajedničko programiranje u obrazovanju, interaktivnost studentskih vježbi, usporedba međusobnih rezultata (igra kodiranja). Najčešće programske platforme u obrazovanju su Code Academy, Pluralsight, Khan Academy, Think Big Coding, Code Avengers. To su posebne platforme za resurse za učenje vještina kodiranja i programiranja. Uključuje širok raspon programskih jezika kao što su Python, JavaScript, C ++, C #, Ruby, PHP i sl. Cilj je pomoći u detaljnijem razumijevanju učenja i poučavanja računalnog programiranja u virtualnom okruženju i predstaviti popis poželjnih karakteristika za takav pristup za buduće programere.

Ključne riječi: platforme; poučavanje; računalno programiranje; virtualno okruženje.