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Uloga i mogućnosti informacijske i komunikacijske tehnologije (IKT) u predškolskom i osnovnoškolskom obrazovanju te obrazovanju učitelja

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Enabling Video Games in Education Through Cloud Gaming

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Abstract

The use of digital games in education has been the subject of research for many years and their usefulness has been confirmed by many studies and research projects. Standardized tests, such as PISA test, show that respondents achieved better reading, math and physics results if they used the computer more for gaming-related activities. It has been proven that the application of video games in education increases student motivation, improves several types of key skills – social and intellectual skills, reflexes and concentration. Nevertheless, there are several challenges associated with the application of video games in schools, and they can be categorized as technical (network and end device limitations), competency (teachers' knowledge in the area), qualitative (lack of educational games of high quality), and financial (high cost of purchasing games and equipment). The novel architecture for delivery of gaming content commonly referred to as "cloud gaming" has the potential to solve most of the present challenges of using games in education. In cloud gaming, the game is completely stored and played on a server located on a cloud with a high-definition video sent to the client, and user commands sent to the server. A well-designed cloud gaming platform would enable seamless and simple usage for both students and teachers. While solving most of the present problems, cloud gaming introduces a set of new research challenges which will be discussed in this paper. These challenges include Quality of Experience based optimization for video coding based on network constraints, simplification of procedures for usage of the platform for students and teachers, and methodology for content adaptation and creation. This paper presents a roadmap of research which needs to be conducted in order to develop a cloud gaming system which can be used in education.

Key words*: cloud gaming; education; video games; quality of experience; optimizations*

Introduction

The use of digital games in education has been the subject of research for many years and their usefulness has been confirmed by research Squire (2003); Van Eck (2006); Charsky, D. & Mims, C. (2008); Duncan, I., Miller, A., & Jiang, S. (2012). Standardized tests, such as PISA test, show that respondents achieved better reading, math and physics results if they used the computer more for gaming-related activities (Biagi & Loi 2013). Newest research done by Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016) and Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016) also confirmed that digital games can improve communication skills, adaptability and resourcefulness in elementary school students and even in university students (Barr, 2017). This field has been the subject of a large number of research projects in the recent years, which have been summed up and evaluated in a European Schoolnet study (Wastiau, P., Kearney, C., & Van den Berghe, W., 2009). The main conclusions of the study were that the application of video games in schools increases student motivation, improves several types of key skills – social and intellectual skills, reflexes and concentration. Several analysed projects also show increased knowledge about the taught subjects. Increased

mathematical knowledge has been demonstrated in DANT and The Consolarium projects (Groff, J., Howells, C., & Cranmer, S. (2012). Through its research institute Joint Research Centre, the European Union has studied the possibility of using video games in education as well as reducing the risk of exclusion of vulnerable groups [8][9], and it finances projects related to the use of video games in education. The Gaming Horizons project has been studying the role of digital games in culture, education and economy. The final report states that video games can create new learning opportunities that are more focused on the student, thanks to their motivational capacity and motivational strength (Bleumers, L., All, A., Mariën, I., Schurmans, D., Van Looy, J., Jacobs, A., ... & de Grove, F. (2012). The objective of the InLife project was to create a new gaming framework in education that will exploit the new concept of Internet of things as well as educational digital games. The current phase of research in this field in the European Union is medium and large studies in schools funded through projects of the member states or the European Union. The Croatian Academic and Research Network – CARNET has been implementing an e-Schools project in Croatia, with the aim of increasing the digital maturity of schools.

Although the potential for learning through video games is great, the instances of application of this learning methodology so far have been rare. The basic challenges associated with the application of video games in schools are divided into technical, competency, qualitative and financial (Wastiau et. at. 2009). One of the main technical issues in the integration of contemporary video games in classrooms is that newer games require that the graphics processor performs a large number of demanding computing operations in real time, and most of the graphics processors built into mobile devices do not have enough processor power to process such a large number of operations and show virtual scenes of video games in real time. The heterogeneity of tablet devices in terms of operating systems and technical features (e.g. display size, storage, processor speed) is also a problem. Competency issues relate to teachers and the lack of information on using video games in teaching and the question which games to use in relation to which teaching material. Additionally, in “classic” computer classrooms, teachers have the major burden of maintaining the ICT structure – computers and games – for which teachers do not have quality competencies. The qualitative group of problems is related to the lack of appropriate educational games, which are mostly significantly inferior to games that are developed exclusively for entertainment purposes (Stewart, J., Bleumers, L., Van Looy, J., Mariën, I., All, A., Schurmans, D., ... & Misuraca, G. (2013). Financial problems include financial justifications for the development of serious games – the market is far smaller and harder to reach, and the lack of information and bad design of the games are hindering market development. In order to support as many mobile devices as possible, game developers need to develop multiple versions of a game for different platforms (e.g. iOS and Android operating systems), which increases costs, and they are further limited by the heterogeneous technical features of devices. Additionally, the cost of purchasing one game per device can be a major burden to school budgets.

The aim of this paper is to present a research roadmap to a possible solution for all of these problems based on the concept of cloud gaming. We present the concept of cloud gaming and how it could tackle many of these problems. Besides briefly explaining the technical concepts and solutions, we focus especially on the issue of content creation and its application in the educational environment. We also focus and present in detail the existing research challenges which need to be solved before such a solution is set to be deployed.

Cloud gaming

Cloud gaming provides a new concept of online games organization, where the game is completely stored and played on a server located on a cloud. A high-definition video is sent to the client, and user commands are sent to the server. The advantage of this approach is that only video content is displayed on the client's device. This computationally less demanding functionality is generally supported by mobile devices, and it is independent of the operating system of the client's device. The most important disadvantage is that the client has to be connected to a network that has a very high bandwidth (one stream goes up to 50Mbit/s) and very low network latency (less then 70ms of Round-Trip Time). Conventional methods of reducing the effects of poor network conditions on the multi-media content streaming (such as temporary storage of data in buffer until they are ready for display) cannot be applied in this case because they introduce additional latency into the system, i.e. they reduce its interactivity and the Quality of Experience (QoE).

There are currently several commercial platforms for cloud gaming on the market, such as GeForceNOW, PlayStationNOW, Vortex etc. This field is very propulsive, so even some of the largest companies on the ICT market, such as Microsoft and Google, announced their Xcloud and Stadia platforms. The research field is very dynamic and deals with the following key issues: 1) virtualization of graphical resources (Shea, R., & Liu, J. (2013), Zhao, Z., Hwang, K., & Villeta, J. (2012); Qi, Z., Yao, J., Zhang, C., Yu, M., Yang, Z., & Guan, H. (2014), 2) new video encoding methods adapted to the needs of highly interactive applications (Shi, S., Hsu, C. H., Nahrstedt, K., & Campbell, R. (2011); Wu, J., Yuen, C., Cheung, N. M., Chen, J., & Chen, C. W. (2015); Lee, K., Chu, D., Cuervo, E., Kopf, J., Degtyarev, Y., Grizan, S., ... & Flinn, J. (2015) and 3) the optimization of the QoE based on available resources, whether they are network related (Jarschel, M., Schlosser, D., Scheuring, S., & Hoßfeld, T. (2011); Lee, Y. T., Chen, K. T., Su, H. I., & Lei, C. L. (2012), related to the game type (Jarschel, M., Schlosser, D., Scheuring, S., & Hoßfeld, T. (2013), or related to the distribution of virtual machines Hong, H. J., Chen, D. Y., Huang, C. Y., Chen, K. T., & Hsu, C. H. (2013). One of the main research problems in cloud gaming is optimisation of the end user's QoE taking into account available server, client, and primarily network resources.

Cloud gaming in teaching – research problems

In Croatia, the problem of outdatedness of the teaching methodology applied in schools has been recognized, and the Strategy of Education, Science and Technology defines that it is necessary to „develop digital educational contents, tools and methods of using ICT in learning and teaching." (Vlada R.H., 2013. Strategija obrazovanja, znanosti i tehnologije). The increase in the number and availability of mobile devices has created predispositions for introducing digital education through gaming in schools, and mobile tablet devices have recently often been mentioned as the potential replacement for paper textbooks in schools. Some of the advantages of mobile tablet devices over the textbooks include: faster learning (Perotta, 2018), reduction of physical load on children who are overloaded with the weight of textbooks (Federal Communications Commission, 2012), the availability of a large number of textbooks in digital form, new approaches to learning and more.

The cloud gaming concept has the potential to solve most of the above problems: the heterogeneity of user devices and their processor power are not a problem, because only video streaming is shown to the clients; teachers do not have to maintain the IT infrastructure because games are stored on a cloud; the platform allows a large number of students to use the same game license, and the developers gain a unique platform for which they develop one version of the game and gain access to a large number of potential users. Previous research in optimizing

the QoE of cloud gaming (Jarschel et. al., 2013; Hong et. al. 2013; Slivar, I., Skorin-Kapov, L., & Suznjevic, M. 2019M; Slivar, I., Sužnjević, M., Skorin-Kapov, L., & Ilić, V. 2016) has not taken into account the specific characteristics of the educational environment, but was based only on the case study of using games in the entertainment context. Cloud gaming offers the potential to solve these problems, but also brings a series of research challenges. The case study of using cloud gaming in classrooms has its own specific user and technical requirements and limitations (e.g., number of users sharing wireless network, background traffic, same game etc.). In order to solve them, the cooperation of researchers in the technical and educational field is necessary. It is necessary to evaluate the knowledge and expectations of students as well as teachers, identify technical characteristics of traffic and traffic infrastructure, create models that optimize the QoE depending on dynamically changing network resources, study the existing games that can be used for educational purposes and define the methodology for adding new games, optimize video streaming on the server side, evaluate the system and refine it based on feedback from end users – teachers and students. An additional challenge is that the data transfer in the last step is performed via wireless networks that have lower performance than wired networks. Figure 1 illustrates the functionality of the cloud gaming concept with application in education as well as open research questions.

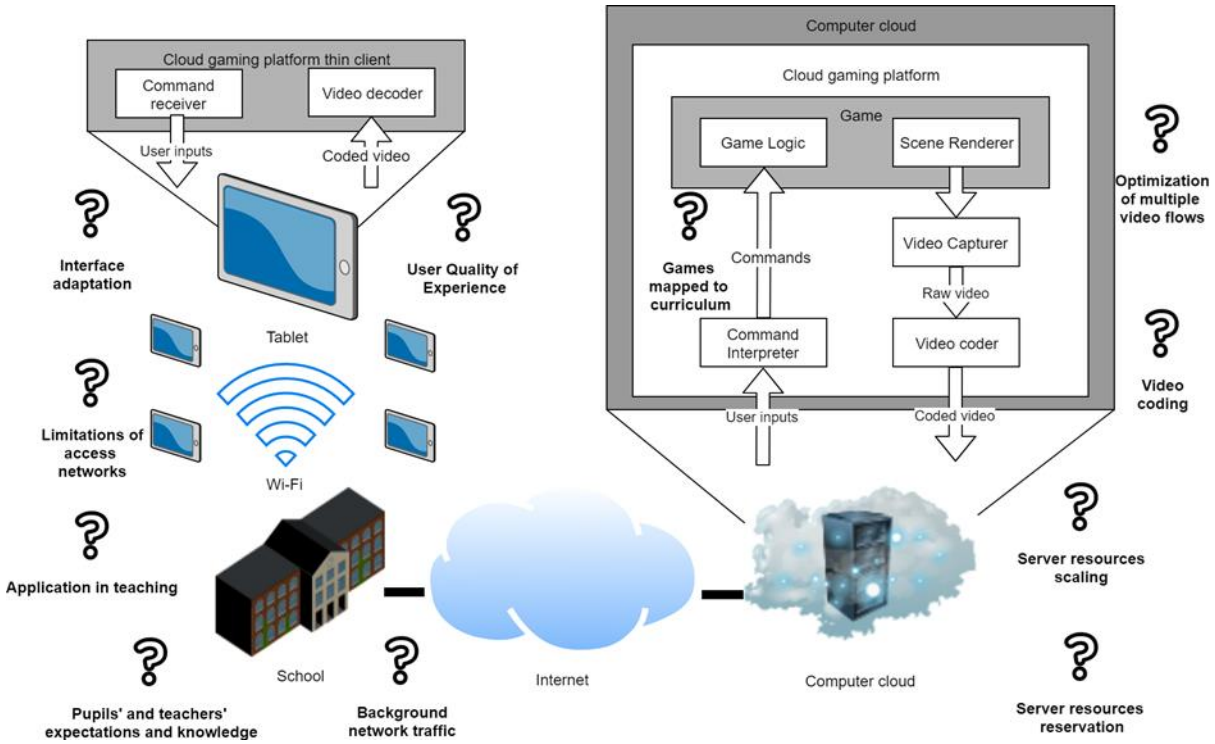

Figure 1 Research questions related to the cloud gaming concept with application in education

Cloud gaming in teaching - methodology of the proposed solutions

The interdisciplinary nature of the research problem requires an approach that will combine technical research with social research in the field of educational application of advanced technical tools. The goal of the methodology is to create cloud gaming platform with specific purpose for streaming games in the classroom as well as devise a methodology for adding appropriate content to the platform. The content may be newly developed, or existing content could be adapted. We propose an approach composing of the groups of basic research activities illustrated in **Error! Reference source not found.**.

The first step in this research would be to define a system specification based on the information collected from teachers and students. This data would be collected through surveys in cooperation with UNIZG-UF and their mentoring schools. Surveys specification has to be performed for these activities. Data collected by surveys may be in the form of responses to questions, as well as free responses. Likert scale might be used to measure the opinions and attitudes of teachers and students, and this data would be analyzed by statistical methods. The design and development of the first version of the system could be based on the defined specification.

The second step is to identify the first test games. Available games could be reviewed with a special emphasis on games in Croatian or those that can be localized. The research question is how to identify an educational game and a commercial game that can be used in the educational context, as defined in Bleumers et.al. (2012) and Stewaer et.al. (2013).

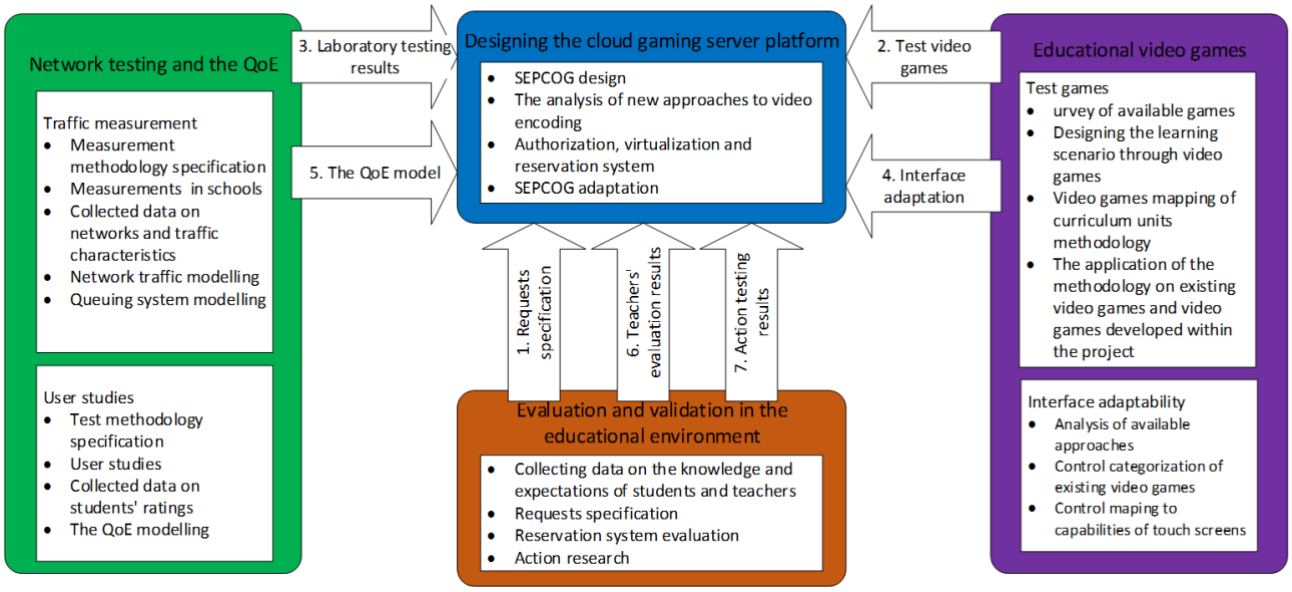

Figure 2 Research methodology

A possible scenario would be a joint developing of the game between teachers and students. Such a scenario may be based on a game development system would be simple enough for children to use. The games for, e.g. understanding physical phenomena, mathematical games and the like, could be generated through this scenario. For this, a methodology for mapping games according to the units of the existing curriculum ought to be created. The methodology needs to be based on the identification of the learning outcomes of gaming and the establishing of non-unique relations to the teaching units. This is a major research question. To achieve this objective, a research related to educational content – games that would be streamed as video content to students – needs to be conducted. Available video games of various categories have to be analyzed, and the availability of content in Croatian has to be investigated. First, test video games that can be used in laboratory research need to be defined. At this point, teachers and their expertise in didactics will be crucial for the success.

The third step would be the iterative subjective laboratory testing of the QoE depending on the network parameters and video encoding parameters, as well as adjustment of the developed system based on the results of these tests. For this research to be carried out, characteristics of the network in schools and the network traffic have to be identified. Also, the methodology for measuring network traffic in schools has to be specified.

The fourth step needs to be the research of the adjustment of the games' interface to the limitations of the tablet interface (that neither has a keyboard nor a mouse). Today's mobile devices host different types of games, even games that are highly demanding in terms of interaction, such as shooting games. The control methods used in these games can be directly replicated for the needs of cloud gaming, but for that approach a detailed review of the field has to be performed, all valid control methods have to be identified, and the appropriate ones have to be selected. In addition, it is necessary to make a general classification of the interaction of games on PCs, and to copy it to touch screen capabilities. Such a research effort needs to be done in accordance with both teachers and students. To achieve this, a methodology for the adaptation of video games to the limitations of mobile device interfaces is needed. The study of methodologies for learning via games development as well as developing own games in cooperation with students. The development of a methodology for mapping educational content to the units of the existing curriculum and grouping the educational content according to the teaching units of the targeted subjects is required.

The fifth step which is needed for the validation of the approach is action research. Questionnaires have to be specified to identify the main advantages and disadvantages of the developed system by using text encoding and statistical analysis. The aim of the teachers' evaluation is to ensure easy use of the system, while experimental action research is an activity within which the system is handed over to users (teachers and students) in their own environment (classroom) with instructions. At the end of use, researchers should collect data from teachers and students through questionnaires and interviews. Data analysis can be done by statistical and text encoding methods to identify key challenges in the functioning of the system.

Once all of these research steps have been conducted, the results implemented in practice could enable a happier and more motivated school attendance of students. It is very important that the establishment of ICT infrastructure in schools is supported by the introduction of services that will use this infrastructure; this is shown on the example of Turkey (Isci, T. G., & Demir, S. B., 2015), which introduced infrastructure to schools without innovative services and has not yielded significant results in the improvement of the educational process.

Conclusion

In this paper we have presented a literature review proving the advantages of using digital games in schools. While the advantages are clear, there are significant challenges in applying the use of digital games in schools in practice. These challenges include primarily technical aspects such as computation power and heterogeneity of tablet devices in terms of operating systems and technical capabilities. Also, the challenges are related to competency of teacher for primarily servicing both hardware and software of the system as well as to financial – how to finance a set of games per student? We present a possible solution based on the concept of cloud gaming – streaming of live game video to end users' devices. We showcase how the cloud gaming approach solves the almost all of the current issues because it uses a principle of thin hardware client and one software client for all available games, but we also define research problems which this approach poses. These research problems are mostly related to network capabilities because cloud gaming requires very high throughput and low latency of the network, but also to content which can be used. We present a detailed roadmap of the research which needs to be conducted in cooperation of educational and technical researches with the focus on the methodology for content creation – which games can be used and how to adapt their interfaces for use on mobile devices. It is important to note that teachers will play a crucial role here, because this potential project could succeed only with their expert help and didactic knowledge.

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Uvođenje videoigara u obrazovanje pomoću računalnog oblaka

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Sažetak

Primjena videoigara u obrazovanju već je godinama predmet istraživanja, a njihova korisnost potvrđena je brojnim studijama i znanstvenim istraživanjima. Standardizirana ispitivanja, poput PISA-testa, pokazala su da su ispitanici ostvarili bolje rezultate u čitanju, matematici i fizici ako su se više služili računalom za igranje videoigara. Dokazano je da primjena videoigara u obrazovanju povećava motivaciju učenika i poboljšava nekoliko ključnih vještina – društvenost, intelekt, reflekse i koncentraciju. Unatoč tomu, postoji niz zapreka u primjeni videoigara u obrazovanju, a one se mogu kategorizirati kao tehničke (mrežna ograničenja i ograničenja krajnjih uređenja), kompetencijske (znanje nastavnika u tom području), kvalitativne (manjak visokokvalitetnih edukativnih igara) i financijske (visoki troškovi nabavke igara i opreme). Računalna arhitektura novog doba koja omogućava igranje videoigara, kolokvijalno znana kao „igranje putem računalnog oblaka“, ima potencijal za rješavanje većine postojećih zapreka u primjeni videoigara u obrazovanju. Kod igranja videoigara putem računalnog oblaka, videoigra je u potpunosti pohranjena i igra se na serveru smještenom u računalni oblak; korisnik pritom prima video visoke razlučivosti, a server prima korisnikove naredbe. Dobro osmišljena platforma za igranje u računalnom oblaku omogućila bi besprijekornu i jednostavnu uporabu učenicima i nastavnicima. Igranje videoigara putem računalnog oblaka riješilo bi većinu postojećih problema, ali i donijelo nove istraživačke izazove, kojima se ovaj rad bavi. Među te izazove ubraja se optimizacija videokodiranja temeljena na kvaliteti usluge s obzirom na mrežna ograničenja, pojednostavljivanje procedure uporabe takve platforme za učenike i nastavnike te metodologija stvaranja i prilagodbe sadržaja.

Ključne riječi: *igre temeljene na računalnom oblaku, iskustvena kvaliteta, obrazovanje, optimizacija, videoigre*

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Desirable knowledge of teachers for the effective integration of ICT in teaching

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Abstract

Although it has been many years since the information and communication technology (ICT) was introduced into classrooms, there are still questions about the impact of technology on students' learning. One of the reasons why it is important to understand the whole process of integration of ICT and the effect of ICT on students' learning is because it also affects the planning of teacher education programmes. Great number of teachers still use computers just as a repository for the content they need in classrooms. ICT could be great help in many other fields as an interactive learning tool, but teachers do not make the most of it. In most cases where ICT is used in teaching, it is considered as a complete substitute for classroom interaction because all that students have to do is to find the materials they need for their classes on web-forums and class webpages. Later they have to do all the learning and understanding of the material downloaded from the webpages by themselves. That is why teachers and educators in general need to understand both pedagogical and technological principles when using ICT in teaching. It is the only way for them to use ICT in an effective way. In this paper suggestions for students and teachers to use ICT in pedagogically and technologically appropriate way are described. Teachers should be prepared to integrate ICT into their teaching practices by designing and developing ICT-supported learning environments. It is important that those learning environments are relevant to the particular purposes and educational contexts of the subjects students are being taught. This paper draws on previous research evidence to identify the gaps between what is known about the usage of ICT in classrooms and the effects on students' learning, and what for should the future teachers be prepared to and what kind of knowledge they should possess before they start teaching in classrooms.

***Key words**: ICT in classrooms; impact of ICT on education; interactive learning tool; learning environment; suggestions for teacher education;*

Introduction

Future learning will increasingly be supported by the use of Information and Communication Technologies (ICTs). Educators who want to use ICT to supplement, extend or even substitute a standard model of teaching and learning have a range of options to do this. One of the key reasons why educators find it difficult to integrate ICT effectively into teaching and learning is the typical assumption that technology is something you add onto existing pedagogy. In practice, the use of ICTs reflects the very transmission and reproduction paradigms of teacher-centered face-to-face learning challenged by the new theories of pedagogy which emphasize the learner-centered implications of new learning technologies (Richards, 2007).

Since the introduction of educational technologies into classrooms, teacher education has obviously been faced with the challenge of improving in-service teacher education and preparing

pre-service teachers for successful integration of educational technologies into their teaching and learning practices. In recent years, teacher education institutes have made efforts to prepare pre-service teachers to integrate technology into their future teaching practices (Sang et al., 2009). Oliver (1993) argues that teachers who received formal training in the use of ICT did not differ in their future use of computers in classrooms from teachers who did not receive such training. As Ertmer (2005) says, the decision regarding whether and how to use technologies for instruction rests on the shoulders of teachers. Despite the increased availability of ICT hardware, support for ICT integration and a larger consciousness about the importance of educational ICT use (Khine, 2001), relatively few teachers are willing to integrate ICT into their teaching activities.

This paper describes the factors that should be considered for an efficient ICT integration. It outlines the key areas that should be covered when educating future teachers and educators and introduces different teacher training approaches. Also, it outlines major failures of ICT introduction in classrooms.

Way to an efficient integration of ICT

The general opinion about ICT-supported learning environments is that they are useful and even important because of how learning with ICTs offers learners opportunities beyond the constraints of actual classroom learning to include the virtual dimensions of online computer-mediated networks and related hypermedia (Paloff & Pratt, 1999). But there is a clear tension between those who interpret ICT-supported learning environments in relation to the educational use of technological infrastructure (Daniel, 1996) and those who emphasize the role of ICT tools and programs in terms of social constructivist learning principles (Duffy & Cunningham, 1996). Computers in education are often seen as a mere repository for content with some add-on use of communication programs such as web-forums and video streaming to substitute for classroom contact. In contrast, social constructivist theorists often emphasize the use of ICT to facilitate development of learning communities and for collaborative interactions (Jonassen & Land, 2000). Such polarization is reinforced by narrow interpretations of how ICT is potentially a way from actual classrooms to the networked learning communities model of educational environment (Barab, 2000).

Except technical knowledge and skills, some other factors seem to contribute to teachers' successful ICT integration. Ertmer (1999) has categorized two barriers for teachers' ICT implementation: external (first-order) barriers and internal (second-order) barriers. External barriers are often seen as the key obstacles, (issues relating to access to the technologies, training and local support). When these barriers are present, it is almost impossible to talk about technology integration. Even if the first-order (external) barriers are resolved, teachers do not automatically use technology. Instead, it then comes to second-order (internal) barriers. Internal barriers are related to a teacher's philosophy about teaching and learning. Examples of these internal barriers are the teacher's beliefs, self-efficacy and attitudes.

When teachers accept to integrate ICT in classrooms, it is not enough just to integrate new technologies in learning contexts but to ensure an improvement in quality. A suitable integration and use of ICT must be considered if richer educational contexts want to be created. According to the general characteristics, ICT must serve the active construction of knowledge by integrating new experiences and continuously reconstructing them. However, the importance of interactive social contexts should be considered because learning is not an isolated process, but an eminently social one. To achieve these, it is important to consider a set of factors which could contribute to an adequate integration of ICT in the education. Those are location and access to equipment, educational applications, integration in curricular activities, collaboration of education and socialization, training of educators and teachers, contact with families and backup technical assistance (Jonassen et al., 2003).

Location and access to equipment

Placing computers in the classroom is a basic principle for a true integration (Haugland & Wright, 1997). However, only placing computers in classrooms is not enough to be sure that computers are actually being used in educational purposes. Papert (2001) considers the placing of computers in special rooms – a computer laboratory – to be an immunological answer for the school to neutralize this foreign body. In fact, the adoption of this procedure, so often seen in schools, is the first step to getting it outside the learning context. When it comes to kindergarten, research showed that when computers are placed out of the classroom where activities take place the children do not experience the same developmental rewards as when the computers are accessible in their classroom, like any other material. This procedure creates two groups of children, one outside the classroom using the computer and one inside the classroom with no possibility whatsoever of seeing what their colleagues are doing. That is why the computer immediately assumes a special status. It is important that computer work is a part of classroom activities and two chairs should be placed in front of the screen to suggest from the beginning the possibility of sharing that equipment (Haugland & Wright, 1997).

Accessibility is important for various reasons. It allows the children to know when the equipment is available, it favors interaction between the children who are using the computer and those involved in other activities, it encourages children to learn from each other and creates opportunities for peer tutoring.

Educational applications

It is up to the educator to select adequate educational programs which can be used by children. In effect, the selection of educational programs is of great importance. The quality of software is a determining factor in the development of adequate learning experiences (Ramos, 2005). However, this is a particularly difficult task as the market is full of graphically attractive programs claiming to be educational but which, when explored, are shown to be deceptive. Taking the present research into consideration, children seem to benefit from the applications that have open-ended characteristics which encourage exploration and imagination, as opposed to very structured programs of the drill and practice type, and which are friendly and intuitive, easy to use, showing menus and figurative icons easily associated with their function. Also, programs should be flexible, responding to various educational needs and objectives, success-oriented through positive feedback and clues which, if necessary, guide the child. Programs should give the child an active role. They should be multisensorial, attractive, interactive, but not so as to deteriorate into a show of sound, music, color and movement with no relevance to the whole. It is desirable for programs to be directed to problem-solving, meeting real needs and the child's interests and to facilitate and encourage cooperation among children (instead of competition) and consequently communication. Programs should establish a link with real life without relinquishing fantasy and give value to diversity, ethnic, cultural or other, so that the children establish identification points with the contents, independent of their background. It is important that programs also make information available to adults regarding syllabus aims, suitable ages and suggestions for accompanying the activity.

Integration in curricular activities

The use of technology in elementary schools and kindergartens is not an aim in and of itself - learning to use the computer should be a secondary objective. Learning to communicate, draw and share are the preschool goals that should be primary and one way of learning them is by using a computer (Pierce, 1994). An appropriate use of new technologies is what makes it possible to expand, enrich, differentiate, individualize and implement the curricular objectives. Therefore, the activities developed around technology should be considered as new educational

opportunities, integrated in a whole. This integration is not only fundamental to taking advantage of the potentials of technology but also for educators to be able to see it as a real contribution to the work they are developing (Jonassen et al., 2003). ICT in the school should be understood as a cultural instrument at the service of educationally relevant experiences and learning.

Collaboration of education and socialization

Apart from the initial role of any educator or teacher in familiarizing the child with technology, continuous backup is always fundamental even though it assumes other aspects. If, on the one hand, it is important for the child to be given the liberty to experiment and work autonomously, it is also important to be alert to their needs, above all with younger children. These tend to benefit from a more systematic attention from the adult, the intervention of the educator being to encourage and at the same time answer their needs and avoid the child feeling frustrated when difficulties arise. With older children who have developed more skills, it is possible to implement more autonomous forms of work and less controlled by the educator, who assumes the role of a supervisor (Van Scoter et al., 2001). Work developed around computers stimulates interaction, motivating the children to communicate both among themselves and with the adult. So, apart from the adult attending to immediate backup needs, it is also important that the educator knows how to stimulate a productive interaction. The literature regarding education and technology highlights the importance of the role of the teacher in guiding (De Corte, 1992) as well as in the development of strategic and meaning-making models which lead to meaningful learning (Jonassen et al., 2003).

Contact with families

The participation of families in the school life of their children is desirable. Regarding the technologies, it is essential that their integration does not neglect the importance of this connection. Giving parents the opportunity to visit their children's classroom, use the computer together with them to accomplish activities, give them access not only to the children's productions but also to the way they were achieved are important contributions for the families and the school to become closer, give more value to the school and develop positive attitudes regarding the role of ICT in this context. Actually, today many children have access to a computer and other electronic equipment at home. The use of these is generally valued by parents. However, it may require guidance in order to become educationally relevant. On the other hand, and especially in the case of families who do not have access to these means, contact and possibilities of exploring ICT in elementary schools and kindergartens assume a very particular relevance not only because they contribute to correcting the inequality of access, but also because they create learning situations for parents and children together where the children can show their skills (Amante, 2007).

Backup technical assistance

It is important that schools and kindergartens provide backup which provides technical assistance, ensuring that the equipment will be maintained and that any functional problems which may arise will be resolved (Amante, 2007). Without this backup, there is a risk of a small technical problem obstructing the use of the equipment for a longer period. This demoralizes the educators and creates insecurity in its use.

Training of educators and teachers

Educators' training is crucial in all process that aim to adequately integrate technologies in education. One of the main reasons stated for resisting the integration of technologies in the

school is based on teachers' and educators' inadequate or limited preparation for their use. When teachers and educators learn to use technology in the context of their classroom, with real children and according to real objectives, they have a greater possibility of benefiting from this training and improving the quality of the learning contexts to develop their activity.

The concept of learning and teaching from a teacher's point of view

There exists a large body of research on teachers' conceptions of teaching and learning. Kember (1997) developed a model that synthesizes all the findings. According to him, all conceptions can be placed on a continuum between a teacher-centered/content-oriented pole and a student-centered/learning-oriented pole, linked by an intermediate conception. Kember's synthetic model contains five conceptions of teaching: imparting knowledge, transmitting structured knowledge, student-teacher interaction, facilitating understanding, and conceptual change and intellectual development. According to the conception of imparting knowledge, teaching is seen as presenting information to students, who only passively receive this information. The focus is on the lecturer and the lecturer's knowledge. According to the conception of teaching as transmitting structured knowledge, the focus is still on the transmission of knowledge, but the student gets more attention. The teacher structures and arranges the presented information so that students have a better chance of receiving that information. The conception of student-teacher interaction forms the transition between the teacher-centered/content-oriented orientation and the student-centered/learning-oriented orientation. The interaction between the teacher and the students is seen as important because of the recognition that student understanding and discovery are essential, manifesting themselves in a degree of interaction.

With regard to facilitating understanding, teachers who have the student-centered conception of teaching see teaching as a process of helping students learn and develop deep understanding. According to the conception of conceptual change and intellectual development, a learning environment focuses on students' prior knowledge and tries to change preexisting conceptions by applying ideas and focusing on conflicts between conceptions, in a sympathetic and supportive environment. In short, teachers seem to have different conceptions of teaching and learning that can be described as teacher-centered/content-oriented or student-centered/learning oriented. The conceptions within the student-centered/learning-oriented orientation are compatible with the ideas of integration of ICT in education. It is expected that teachers having one or more of these conceptions are able to bring ICT into classrooms. In light of the aims of modern education, the teacher-centered/content-oriented conceptions of teachers are problematic for implementing ICT (Koenings, Brand-Gruwel & Jeroen van Merrienboer, 2005). Aims that are pursued by designers of a learning environment will probably not be reached. This indicates that the influence of teachers' conceptions of learning and teaching should not be underestimated while looking at the effects of realizing the integration of ICT in education.

Key areas in training future teachers

It is important to highlight some aspects that may constitute key areas in the development of this training. It is necessary to develop the understanding of teachers and educators regarding educational technology because there is not enough knowledge about the possibilities and aims in the use of ICT in the educational context. Also, training should help them see how the work they will usually do with their pupils and the experience they already have can be adapted through the development of activities which resort to the use of technology. Undoubtedly, they should work on their confidence to use ICT because the lack of self-assurance is one of the main factors preventing teachers/educators from using new technologies (Amante, 2007). It is

important that teachers/educators feel that the new technologies, besides being tools for encouraging educational experiments with children, are also the means of communication and collaboration among professionals, being powerful devices in their own professional development. Sharing materials is one of the crucial habits good teachers and educators should adopt. Actually, these new learning communities could become a new and stimulating pedagogic field for teacher training. The new technologies offer opportunities for professional development. While educators/teachers become more competent and confident users of technology in their professional sphere, they also become more confident in using them adequately with their pupils (Jonassen et al., 2003).

Teacher training approaches

ICT teacher training can take many forms. According to Jung (2005), there are four main approaches. Most of the early ICT teacher training programs in the 1990's focused on ICT use as the main training content. This approach has an emphasis on teacher training in how to use ICT in the classroom. It addresses issues such as selecting appropriate ICT tools and supporting students in the use of those tools, using ICT to promote learning activities, developing new methods of facilitating learning and evaluating student performance, and so on.

The second approach defines ICT as part of training methods that promote teachers' ICT-pedagogy integration in the classroom by demonstrating examples and allowing discussions among teachers throughout the whole training process. Teachers improve their teaching skills by actively experiencing ICT skills as a learner.

ICT as core technology for delivering teacher training is an approach where ICT is used as the major way of providing the learning experience of teacher training. The content of this approach does not necessarily focus on ICT skill itself but rather covers a variety of ICT applications.

The last approach is the one in which ICT is used to facilitate professional development and networking. Whereas the use of ICT as the core technology for delivering teacher training can be found in limited contexts, there are many examples of ICT being used to support teachers' ongoing professional development and networking. Many countries have developed websites to provide online resources for teachers and facilitate teachers' networking based on the assumption that professional development should be an integral part of daily practice for all teachers and the use of the Internet would enhance continuous professional development activities of teachers and connect teachers to larger teaching communities.

Major failures of current ICT applications in schools

A major reason underlying the relative failure of integration of ICT in education is that the medium has been introduced too much as an add-on to an existing classroom setting. In mathematics, for example, the large majority of available software fits into the category of drill-and-practice programs and aims mainly to exercise computational skills replacing in this respect traditional worksheets (De Corte, 1992).

The existing situation has been sharply criticized for a number of years and major efforts have been done to transform mathematics learning and teaching from the individual absorption and memorization of a fixed body and procedural skills transmitted by the teacher into the collaborative construction of meaningful and useful knowledge and problem-solving skills based on mathematical modeling of real-life situations and contexts.

In the domain of language, no less than in mathematics, the available software also focuses on practicing rules from spelling and grammar instead of supporting the more essential aspects of reading and writing, namely comprehension and communication.

Conclusion

Teacher education programs will need to prepare their graduates with solid foundations in instruction, planning, educational psychology, learning theory and classroom management. None of these skills and knowledge are required in a smaller degree if ICT is integrated into the curricula. Nobody is arguing that teachers need only to be able to install and to turn on a learn-to-read or a similar program and then stand back and not interfere with their students. Current teacher education programs need to incorporate ICT as appropriate to specific subject areas but not at the expense of other instructional skills and knowledge.

Students in teacher education programs need opportunities to incorporate the use of ICT in their studies. Pre-service teachers need access to a variety of software and hardware with which they can experiment. They need opportunities to develop skills that will enable them to assess and evaluate software for use in their classes. Classroom use of ICT must be consistent with the goals of each curriculum and be age/grade appropriate.

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Bayes' model of interconnection between mathematical and informatics competences in elementary education

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Abstract

In this paper, the authors define mathematical and informatics competences for the 5th grade elementary school children and present causal model of mathematical and informatics competences. The basic objective was to measure causal interconnection between informatics and mathematical competences in elementary education.

The sample for our research comprised of 21 elementary schools in the Republic of Croatia, with 9 from the rural and 12 from urban areas. The participants were 250 pupils attending 5th grade, under the presumption that there were at least 10-15 pupils within a school per generation attending informatics as an elective subject. The pupils were 10-11 years old (5th grade) of both genders.

Background questionnaire has been administered among teachers in spring of 2018 for the school year 2016/2017, which consisted of grades achieved on mathematical and informatics exams in 5-6 individual topics according to the National Plan and Programme for the subject mathematics and elective subject informatics.

Using statistical set of variables which measured mathematical and informatics competences the authors created representation of distribution using the Bayes model with information about conditional independences between mathematical and informatics competences. Statistical analysis was conducted using free software Tetrad 5.2.1-3 (Tetrad project 2015). In the results section structural equations between mathematical and informatics competitions are described.

This research attempts to help systematize the aforementioned competencies and provide the causality model illustrating the connection between computer science and mathematics. The causality model will enable the comparison of competence levels and contribute to developing educational programs for computer science and mathematics in primary school.

This paper is a result of our previous research on causal modelling of mathematical competences in kindergarten (Tepeš at. all. 2013, 2014 and 2015) and in elementary education: at international conferences in Albania (Tepeš, Lešin and Hrkač 2013) and the United Arab Emirates (Tepeš, Šimović and Tepeš 2014).

Keywords: *Bayes' model, informatics competences, mathematical competences, structural equation model*

Introduction

In the Republic of Croatia's primary education, informatics is an elective subject available to pupils above fifth grade. If we consider the concept of informatics as a subject and everything

that it encompasses, it is inevitable that we will arrive to the curricula of similar subjects in primary education worldwide, as well as different definitions and names for the subject. Worldwide, we encounter concepts such as computer science, computing science, informatics, information science, ICT etc., all of which are at the same time in a constant state of change and flux, since technology changes on a daily basis. Similarly, definitions of informatics competences imply in some cases merging of certain concepts, such as for instance ICT and informatics.

Digital competence is defined as being supported by the following ICT skills: "the use of computer in order to reach information, evaluate them, store them, create, present and exchange information, communicate and participate in collaborating networks using internet" (European Union, 2010), whereas Informatics Europe explains the concept of informatics as "dependant on the country which uses it, computing, computing engineering, information technology (IT) or ICT" (http://www.informatics-europe.org/). This definition has been adopted by the Republic of Croatia. Focusing back on the informatics competences within the context of primary education, BECTA (British Educational Communications and Technology Agency) defines the concept of digital literacy, emphasizing its importance and meaning for children, as "a combination of skills, knowledge and understanding which young people need to acquire in order to be able to participate in the digital world" (http://itte.org.uk).

In his book 'Mathematical Fundamentals of Informatics' (Meinel, 2011, pp. 11), Meinel argues that "informatics as a science of systematic, most often automatic data processing is unimaginable without mathematical way of thinking and mathematical techniques. Whether we are dealing with formulation and research of algorithms or construction and understanding of ICT, mathematical methods, abstract models and formal descriptions play a central role" (Meinel, 2011, pp. 11). Within the context of primary education and the level of knowledge and competences in informatics which are expected from pupils, we arrive to the concept of computational thinking as a mediator between the fields of science, technology and mathematics, not just between informatics and mathematics. Its importance for children, as well as the level of skills and knowledge expected of pupils in elementary schools, is outlined by Wing (2006), who argues that computational thinking "entails problem solving, system design as well as understanding of human behavior through concepts which are the basis of computing" (Wing, 2006, pp. 33). In the document Key Competences for Lifelong Learning (European Union, 2010), mathematical competences and basic competences in natural sciences in technology are defined as "pupils' ability to develop and apply mathematical thinking in problem solving in various everyday situations" (European Union, 2010).

In 2010, Cartelli, Dagiene and Futschek (2010) created a digital literacy evaluation model which was based on three dimensions: technological, cognitive and ethical. They created a model focused on the following fields within the aforementioned three: 1) recognizing the environment and interface, possible solutions to problems as well as choosing the appropriate solution, working with logical operators and operations, process representation, differentiating between actual and virtual phenomena, 2) work with text, data organization, choosing and interpreting text as well as relevance evaluation and information reliability, 3) respectful relationship towards others in the virtual environment (Cartelli et al, 2010). Similarly, research focusing on determining the connection between the use of worksheets and mathematical competences of pupils has been conducted in France as a part of the DidaTab project. The authors outline the competence pairs of equivalents: 1) objects: unknowns and equations – variables and formulae,

2) pragmatic potential: problem solving tool – generalization tool, 3) solving process: application of algebraic rules – arithmetic process of trial and error and 4) the nature of solution: correct solutions – correct or approximate solutions. Research results showed the lack of understanding of algebraic concepts when applied to the practice of formulae input in worksheets (Haspekian & Bruillard, 2010).

One of the studies preceding the current study was conducted in 2016 on the sample of 48 seventh grade elementary school children, 27 male and 21 female, attending the elementary school Dr Ivan Merz. Measured variables included in the study were: the coordinate system, ratio and proportion, proportionality, inverse proportionality, percentage, statistics, probability, similarity of triangles, perimeter and area of similar triangles, polygons, peripheral and central angle, perimeter and area of circle, method of substitution, method of elimination and graphing linear functions. The authors used the freeware software Tetrad. The created causal model sorted the measured variables according to different levels: proportionality (level one), perimeter and area of circle, polygons (level two), peripheral and central angle, inverse proportionality (level three), percentage, coordinate system (level four), similarity of triangles, method of substitution (level five), method of elimination, ratio and proportion (level six), statistics, graphing linear functions, perimeter and area of similar triangles (level seven) and probability (level eight). The created causal model shows causal connections between the measured variables, with those at level one representing the fundamental competences for all other competences, the competences sorted on the third level being the effect causes from the competences on the first and second level etc. (Tepeš, Mrkonjić & Paić, 2016).

Similarly, a relevant study closely aligned with the topic of competence models was a study conducted by Tepeš B., Lešin, Hrkač and Tepeš K. (2016). The authors created a causal Bayes model of mathematical competences of preschool children. The sample consisted of 59 children aged 65-85 months. The measured variables were problems administered among the children and the evaluation of their solutions, where competences were measured in the fields of arithmetic and geometry. The variables measured in the field of geometry were: relations left/right, relations in front/behind, recognizing triangles and rectangles. The variables measured from the field of arithmetic were: counting to 30, understanding numbers to 10, finger counting, differentiating between letters and numbers, adding number one, adding number two, subtracting number one and two. Software Tetrad was again used for the analysis purposes. One of the tools available in Tetrad, Bayes' evaluator, evaluates the relationship between causal competences and effectual competences. Competences were divided into five levels of causal structures: understanding numbers to 10, adding number one, recognizing triangles, subtracting number one and understanding the relations in front/behind (level one), recognizing rectangles, understanding relations left/right (level two), adding number two, subtracting number two and finger counting (level three), understanding relations above/beyond, differentiating between numbers and letters (level four) and counting to 30 (level five). Again, competences on the first level are considered as fundamental for all other competences, whereas for instance those one the third level are in causal connection with the competences on the first and second level. Based on the results, it has been concluded that the Bayes model is an appropriate tool for representation of mathematical competences of preschool children (Tepeš et al, 2016).

In statistics nowadays, the term causality is being used more and more often as a tool for explaining interconnectedness. Causality can be described as a difference between actual results and results which did not occur (Clemens, 2017). By studying causal connections between variables, we arrive to a causal structure, which is defined as an oriented graph on which each edge between variables X and Y, oriented as X->Y represents a causal connection between variable X as cause and Y as effect. Simplified research studying causality demands a sample which needs to be big enough as well as satisfy conditions to be representative of the population,

divided into control and experimental group. A randomized experiment demands of the variables to be directly observable, that it is possible to intervene and that the sample is large enough in order to correctly show the effect of an opposite action. When it is impossible to intervene or change variables, which are observable, statistics resorts to the concept of correlation which determines whether two variables within a data set are behaving in a similar way, but correlation does not imply causality (Clemens, 2017).

One of the commonly used statistical models is Bayes' model. Bayes' classifiers predict the probability of belonging to a certain class, with one of the reasons for their popularity being their high percentage of accuracy as well as speed when applied to large data sets. Bayes' networks are graphic models which enable the representation of dependence between attribute subsets, but they can be used for classification at the same time. They enable creating a graphic model of causal connections (Han, Pei & Kamber, 2011). The advantage of Bayes' concepts and methods is that they can include prior information and technical concepts without appropriate data and enable studying the cause and effect connections on top of just a simple study of correlation. During the past thirty years, researchers have been using Bayes' networks in order to uncover causal structures within the mass of statistical data, opposite to the presumption that this is feasible only within an environment of carefully controlled experiments (Pearl & Verma, 1995; Spirites et al, 2000; Pearl, 2003).

Sample and aims

Mathematical competence as a term is defined by knowledge, ability and skills of applying the mathematical way of thinking or concluding with the purpose of solving all kinds of mathematical or interdisciplinary problems and also understanding mathematics as a cultural value, with the aim of understanding and creating the perception about things that surround us in our everyday existence. It is important to emphasize that intuitive ways of solving tasks are supported by rules of logical opinion in the form of: thinking and making adequate conclusions, using arguments, modeling, formulating and solving the problem.

Mathematical competences are defined by the lesson plan or curriculum with the acceptance of historical development and can be divided into four basic areas: Algebra and functions, Space and shapes, Measurements and Data. Every area contains competences-specific content about knowledge, ability and skills which should be presented.

The sample for our research comprised of 21 elementary schools in the Republic of Croatia, 9 of them from rural and 12 from urban areas. The participants were 250 pupils attending 5th grades, under the presumption that there were at least 10-15 pupils within a school per each generation who attended informatics as an elective subject. The pupils were 10-11 years old of both genders. Background questionnaire was administered to teachers in spring 2018 for the school year 2016/2017, and it consisted of socio-demographic data (age, gender, rural/urban school), final grades in all subjects, average final grades, test grades from mathematical and informatics tests covering 5-6 individual topics according to the National Plan and Programme for the subject of mathematics and the elective subject of informatics. The basic research aim was to measure the frequency, interdependence, dependence and interconnectedness between informatics and mathematical competences.

Prirodni brojevi

U ulici je 5 kuća. U svakoj su kući dvije mačke. Svaka mačka ulovi 3 miša u jednom danu. Koliko su miševa u toj ulici ulovile u mjesecu lipnju?

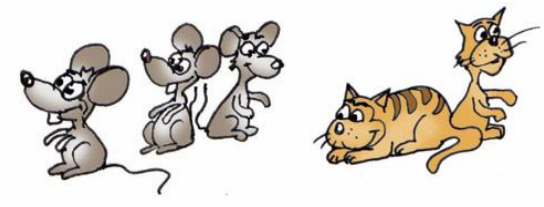
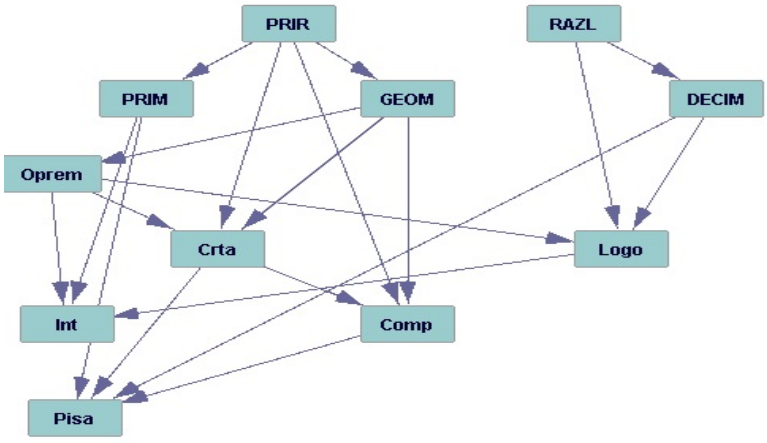


Figure 3. A problem example from the topic 'natural numbers'. In: Paić, G., Bošnjak, Ž., & Čulina, B. (2008). Matematički izazovi 5

The aim was to examine whether causal connection between specific topics within the mathematics and informatics curriculum exists.

Results and discussion

With the aim of examining causal connections, Tetrad software was used. It creates, evaluates, predicts and searches for causal and statistical models. The software itself was created at the Carnegie Mellon University, Department for Philosophy, Pittsburgh, US (http://www.phil.cmu.edu/tetrad/index.html). It offers a friendly user interface containing tools and functions required for determining causality.



Mathematics		Informatics	
PRIR	Natural numbers	Comp	First steps in working with computers
PRIM	Divisibility of natural numbers	Oprem	Storage and computer equipment
GEOM	Basic 2D geometry	Crta	Drawing with the help of computer
RAZL	Fractions	Logo	Programming (LOGO)
DECI	Decimal numbers	Pisa	Learning to write with computers
		Int	Internet

Figure 4. Causal connections between specific topics in mathematics and informatics in fifth grade

After the initial analysis in Tetrad, the measured competencies were divided into six levels, as shown in Figure 1. On level one there were the following competencies: 'natural numbers' and 'fractions'. Level two comprised of 'divisibility of natural numbers', 'decimal numbers' and 'basic 2D geometry', whereas level three was occupied by 'storage and computer equipment'. Fourth level contained 'drawing with the help of a computer' and 'programming (LOGO)', fifth level contained 'first steps in working with computers' and 'internet', whereas 'learning to write with computers' occupied the sixth level.

First, let us examine the causal connection between the following topics: 'fractions', 'decimal numbers' and 'programming (LOGO)'. The topic 'fractions', which can be found on level one, causally implies the topic 'decimal numbers' (level two), which is also being taught in that succession according to the school programme. 'Fractions' are topics 25-28, whereas 'decimal numbers' are topics 28-36. The topic 'programming (LOGO)' (level four) is however being taught much earlier (topic 14). Because of the causal connections between topics 'fractions'/'programming' and 'decimal numbers'/'programming', it can be concluded that the topic 'programming (LOGO)' is being taught too early according to the school programme.

The topic 'natural numbers' is being taught at the very beginning of fifth grade (topic 1-9), so the causal connections 'natural numbers' (level one, topics 1-9)->'basic 2D geometry' (level two, topics 17-24) are understandable. Similar situation is also encountered with the found causality 'natural numbers' (level one, topics 1-9)->'divisibility of natural numbers' (level two, topics 10-16). Likewise, the causality 'natural numbers'->'drawing with the help of a computer' is also understandable, since the aforementioned informatics topic is taught much later (topics 9-13), whereas the mathematical topic 'natural numbers' is taught at the very beginning of the school year. However, the topics 'basic 2D geometry' (topics 17-24) and 'drawing with the help of a computer' (topics 9-13) are being taught approximately at the same time, which naturally depends on a variety of factors.

Let us examine the causality between the topics 'basic 2D geometry', which can be found on level two, and 'first steps in use of computer'. The topic 'first steps in use of computer' is being taught at the very beginning of the school year, whereas the topic 'basic 2D geometry' is being taught at a much later point in time. The inverse causal connection which has been found, i.e. the causal connection which suggests that the competencies in the topic 'basic 2D geometry' causally imply the competencies in the topic 'first steps in use of computer', can be interpreted as an incorrect order in which the topics are being taught. A similar, albeit not so drastic, situation can be found with the causal connection 'basic 2D geometry'->'storage and computer equipment', which is taught right after the topic 'first steps in use of computer' (topics 5-8). The discovered inverse causality, i.e. suggesting that the competencies in the topic 'basic 2D geometry', found on level two, causally imply competencies in the topic 'storage and computer equipment', found on level three, suggest an incorrect succession in which the mentioned topics are being taught.

Causal connections between the topics 'divisibility of natural numbers' and 'internet', 'storage and computer equipment' and 'drawing the help of computer', 'storage and computer equipment' and 'internet' are understandable if they are compared to the succession in which the mentioned topics are taught according to the school programme. It can only be concluded that the succession is justifiable. Similar situation is encountered with the causal connections 'storage and computer equipment'->'programming (LOGO)' and 'programming (LOGO)'->'internet'. The mentioned topics are being taught according to the school programme in the succession in which the causal connections have been found. And lastly, the topic 'learning to write with computers', which can be found on level six, is being taught immediately before the topic 'internet', and so all topics which imply causal connection with the topic 'learning to write

with computers' justify the succession in which they are taught according to the school programme.

Conclusion

After comparing the created causal model for chosen topics in informatics and the school curriculum, several discrepancies have been found. In the fifth grade, discrepancies have been found with regard to the following causal connection: basic 2D geometry -> drawing with the help of a computer, decimal numbers (mathematics) -> programming (LOGO) (informatics), basic 2D geometry -> first steps in working with computers, basic 2D geometry -> storage and computer equipment. The discrepancies discovered using the causal model when compared with the school plan and programme can be considered as pointers to potential problems within the teaching programme.

This work has demonstrated the causal structure of mathematical competences in school education. For the purposes of adopting mathematical competences, causal model refers to the order of adopting of mathematical concepts. For the purpose of further research, it is necessary to increase the statistical set or the number of children examined. Test materials must be standardized and must allow for higher gradation of results. The study should include the part of mathematical competence relating to the data that have both numeric and descriptive characteristics expressed by words and letters. The curriculum for children in elementary schools in Croatia is based on social relations, and should have the educational structure of mathematical competences accustomed to the age and level of knowledge that children acquire by using information and communication technologies of contemporary society.

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Bayesov model povezanosti matematičkih i informatičkih kompetencija u osnovnoj školi

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Sažetak

U ovom članku autori definiraju matematičke i informatičke kompetencije za peti razred osnovne škole i predstavljaju uzročni model matematičkih i informatičkih kompetencija. Osnovni je cilj bio mjerenje uzročne povezanosti između informatičkih i matematičkih kompetencija u osnovnom obrazovanju.

Uzorak za istraživanje sastoji se od 21 osnovne škole u Republici Hrvatskoj, 9 iz ruralnih i 12 iz urbanih područja. Sudionici su bili 250-ero učenika koji su pohađali 5. razred, pod pretpostavkom da je bilo najmanje 10-15 učenika unutar škole po naraštaju koji pohađaju informatiku kao izborni predmet. Učenici su bili dobi 10-11 godina (5. razred), oba spola.

Upitnik je primijenjen među nastavnicima u proljeće 2018. za školsku godinu 2016./2017., a sastojao se od ocjena postignutih na matematičkim i informatičkim testovima u 5-6 pojedinačnih tema u skladu s Nacionalnim planom i programom za matematičke teme i teme izborne informatike.

Koristeći statistički skup varijabli po kojima su izmjerili matematičke i informatičke kompetencije, autori su izradili Bayesov model s distribucijama i informacijama o uvjetnim neovisnostima između matematičkih i informatičkih kompetencija. Statistička je analiza provedena korištenjem besplatnog softvera Tetrad 5.2.1-3 (Tetrad projekt 2015). U rezultatima su opisane strukturne jednadžbe između matematičkih i informatičkih kompetencija.

Očekivani znanstveni doprinos unutar informacijskih i komunikacijskih znanosti jest izrada kauzalnog modela povezanosti informatičkih i matematičkih kompetencija u osnovnoj školi, koji može imati veliki značaj pri oblikovanju budućih nastavnih programa i potencijalno unaprijediti obrazovni proces u nastavi informatike i matematike.

Ovaj je članak rezultat prethodnog istraživanja o uzročnom modeliranju matematičkih kompetencija u vrtiću (Tepeš i ostali, 2013., 2014. i 2015.) i u osnovnom obrazovanju na međunarodnim konferencijama u Albaniji (Tepeš, Lešin i Hrkač, 2013.) i Ujedinjenim Arapskim Emiratima (Tepeš, Šimović i Tepeš 2014.).

***Ključne riječi**: Bayesov model, informatičke kompetencije, matematičke kompetencije, strukturalni model jednadžbi*

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Samoprocjena digitalnih kompetencija studenata

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Sažetak

Utjecaj informacijske i komunikacijske tehnologije omogućuje pojedincima željnim stjecanja znanja i vještina dostupnost svih obrazovnih materijala. Brzina razvoja informacijske i komunikacijske tehnologije predstavlja izazov za učitelje i institucije uključene u organizaciju, vođenje i financiranje učenja i poučavanja. Primjena informacijske i komunikacijske tehnologije ne smije biti samoj sebi svrha, nego se mora kontinuirano i planirano upotrebljavati kako bi se omogućio napredak stjecanja digitalnih kompetencija. Razumijevanje i uporaba informacijske i komunikacijske tehnologije smatraju se jednako važnima kao i čitanje, pisanje i računanje. S obzirom na navedeno, pojam pismenosti više ne podrazumijeva samo posjedovanje kompetencija čitanja, pisanja i računanja, nego podrazumijeva i digitalnu kompetenciju. Na razvoj digitalnih kompetencija mogu utjecati brojni čimbenici, kao što su šira zajednica (država), škola ili razred, obitelj i individualni čimbenici. Cilj ovoga rada je ispitati razlike u samoprocjeni razine digitalnih kompetencija u pet područja između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology. Utvrđena je razlika u samoprocjeni digitalnih kompetencija između ispitanika. Hrvatski studenti smatraju da su digitalno kompetentniji od kanadskih studenata za područje informacija, komunikacije i sigurnosti. Istraživanja ovoga područja trebala bi biti kontinuirani proces kako bi se neprestano stjecale nove spoznaje koje će pridonijeti razvoju digitalnih kompetencija kod svih građana. U bliskoj budućnosti digitalna nepismenost može biti jednaka alfabetskoj nepismenosti jer digitalna kompetencija predstavlja imperativ današnjice.

***Ključne riječi**: digitalne kompetencije; informacijska i komunikacijska tehnologija.*

Uvod

Život i rad u današnjem, suvremenom društvu zahtijevaju nova znanja, vještine, sposobnosti, vrijednosti i stavove te nove kompetencije pojedinca, koje stavljaju naglasak na razvoj kritičkog mišljenja, inovativnosti, stvaralaštva, rješavanja problema, poduzetnosti, informacijske i komunikacijske pismenosti. Ovakve kompetencije nije moguće ostvariti u tradicionalnom odgojno-obrazovnom sustavu, kojemu je cilj prenošenje znanja, nego je potrebna promjena u kurikularnoj politici i planiranju prijelaza s prijenosa znanja na razvoj kompetencija. Transformacije u društvu i gospodarstvu u 21. stoljeću pojam pismenosti proširuju na vještine komuniciranja, vještine korištenja informacijske i komunikacijske tehnologije, kvalitetno razumijevanje prirodnih i društvenih zbivanja, osposobljavanje za rješavanje problema, informirano donošenje odluka, vještinu i sposobnost za timski rad te osposobljenost za trajno učenje (Špirane, Banek Zorica 2008). Informacijska i komunikacijska tehnologija (IKT) obuhvaća djelatnost i opremu zasnovanu na prikupljanju, pohranjivanju, obradi, širenju i razmjeni informacija u različitim oblicima, kao što su zvuk, tekst, znak i slika (http://www.enciklopedija.hr/, n.d.).

Prema Nacionalnom okvirnom kurikulumu za predškolski odgoj i obrazovanje te opće obavezno i srednjoškolsko obrazovanje (2011.), razvoj društva i jačanje svjetskog tržišta i konkurentnosti na globalnoj razini uzrokovali su stvaranje novih potreba na razini društvenoga života i života pojedinca u svim područjima.

Europska unija odredila je osam ključnih kompetencija za cjeloživotno obrazovanje, koje je i obrazovna politika Republike Hrvatske prihvatila. Osim toga, Europska unija je ključne kompetencije definirala kao paket prenosivih, multifunkcionalnih znanja, vještina i stavova potrebnih svim pojedincima za osobnu ostvarivost i razvoj, inkluziju te zapošljavanje (Gobo, 2012). Kompetencije su prenosive u smislu njihove primjene i multifunkcionalne u smislu njihove uporabe za ostvarivanje različitih ciljeva. U osam ključnih kompetencija za cjeloživotno obrazovanje ubraja se i digitalna kompetencija, koja je danas jednako važna kao i umijeće čitanja i pisanja. Nacionalni okvirni kurikulum za predškolski odgoj i obrazovanje te opće obavezno i srednjoškolsko obrazovanje (2011.) definira digitalnu kompetenciju kao osposobljenost za sigurnu i kritičku upotrebu informacijske i komunikacijske tehnologije za rad, u osobnom i društvenom životu i komunikaciji. Njezini su ključni elementi osnovne informacijske i komunikacijske vještine i sposobnosti: upotreba računala za pronalaženje, procjenu, pohranjivanje, stvaranje, prikazivanje i razmjenu informacija te razvijanje suradničkih mreža putem interneta (NOK, 2011.). Posjedovanje digitalne kompetencije podrazumijeva uporabu i kritičko promišljanje o informacijskoj i komunikacijskoj tehnologiji. Važno je ne samo doći do informacija putem informacijske i komunikacijske tehnologije, nego i te informacije na pravilan način upotrijebiti i informaciju "pretvoriti" u znanje. Digitalna kompetencija podrazumijeva samouvjerenu i kritičku upotrebu digitalnih tehnologija za informacije, komunikaciju te rješavanje problema u svim područjima života (School Education Gateway, 2018).

U ovome radu cilj je ispitati razlike u samoprocjeni razine digitalnih kompetencija u pet područja između hrvatskih studenata s Filozofskog fakulteta u Splitu (FFST) i kanadskih studenata sa Southern Alberta Institute of Technology (SAIT). Stoga je u prvome dijelu rada opisan Europski okvir za razvoj i razumijevanje digitalne kompetencije radi izrade upitnika koji su studenti ispunjavali kako bi procjenjivali svoje digitalne kompetencije. Osim toga, navedene su razlike i sličnosti u sustavu obrazovanja između Kanade i Hrvatske, da bi se rezultati jasnije interpretirali. Drugi dio rada obuhvaća opis istraživanja, interpretaciju rezultata i zaključak rada.

Europski okvir za razvoj i razumijevanje digitalne kompetencije

Europski okvir za razvoj i razumijevanje digitalnih kompetencija (DigComp) omogućuje pomoć pri definiranju razine digitalne kompetencije i pruža informacije o stanju digitalne kompetencije građana za traženu zemlju (Ferrari, 2013). Na taj se način pruža podrška tijelima koja djeluju u području obrazovanja. Osim toga, DigComp se koristi za planiranje i osmišljavanje dokumenata iz područja obrazovanja i osposobljavanja (revizija kurikuluma, razvoj obrazovnih tečajeva, razvoj profesionalnih programa za učitelje i nastavnike).

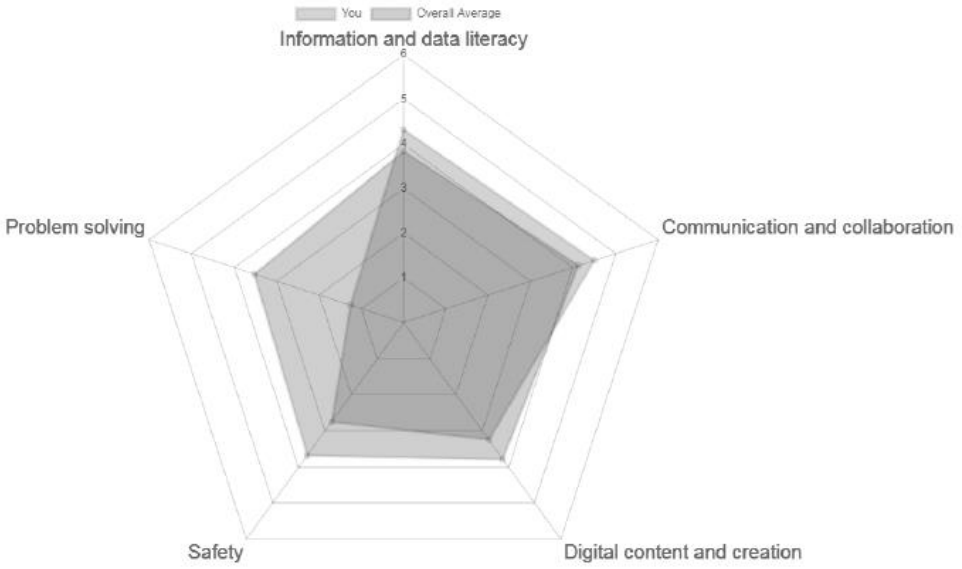
Projekt je pokrenut 2011. godine sa sljedećim ciljevima: identificirati ključne komponente digitalnih kompetencija u smislu znanja, vještina i stavova potrebnih kako bi pojedinac bio digitalno kompetentan, razvijati indikatore digitalnih kompetencija i predložiti smjernice za moguću uporabu i reviziju konceptualnog okvira digitalne kompetencije na svim razinama učenja. U okviru projekta za razvoj i razumijevanje digitalne kompetencije europskih građana istaknuto je pet područja digitalne kompetencije. Tih pet područja digitalne kompetencije su:

- informacija – identificirati, locirati, dohvatiti, pohraniti, organizirati i analizirati digitalne informacije ocjenjujući njihovu relevantnost i svrhu
- komunikacija – komunicirati u digitalnom okruženju, dijeliti resurse putem online alata, povezivati se s drugima i surađivati kroz digitalne alate, komunicirati i sudjelovati u zajednicama i mrežama, razvijati međukulturalnu svijest

- izrada sadržaja – stvarati i uređivati nove sadržaje (od obrade teksta do slika i videa), integrirati i ponovno razraditi prethodno znanje i sadržaje, stvarati kreativne izraze, programirati, primjenjivati prava intelektualnog vlasništva i licenci
- sigurnost – osobna zaštita, zaštita podataka, zaštita digitalnog identiteta, sigurnosne mjere, sigurna i održiva uporaba
- rješavanje problema – identificirati digitalne potrebe i resurse, donositi informirane odluke o tome koji su najprikladniji digitalni alati u skladu sa svrhom ili potrebama, rješavati konceptualne probleme putem digitalnih sredstava, kreativno koristiti tehnologije, rješavati tehničke probleme, ažurirati vlastite i tuđe kompetencije (Ferrari, 2013).

U Europskom okviru za razvoj i razumijevanje digitalnih kompetencija za pet područja digitalnih kompetencija navedene su tri razine stručnosti: početni korisnik, osnovni korisnik i napredni korisnik, kako bi svaki pojedinac mogao samoprocijeniti svoju razinu digitalne kompetencije. Na temelju razine stručnosti napravljena je ljestvica samoprocjene digitalnih kompetencija na mrežnoj stranici *Europass* (2018) (inicijativa Europske unije za povećanje transparentnosti kvalifikacija i mobilnosti građana u Europi).

Na mrežnoj stranici *Digital skills accelerator* nalazi se još jedan *online* alat za samoprocjenu digitalnih kompetencija koji se temelji na pet područja digitalnih kompetencija prema DigComp. Cilj projekta je samoprocjenjivanje digitalnih kompetencija na ljestvici od jedan do šest. Nakon završene samoprocjene prikazuje se mapa vrijednosti razine digitalnih kompetencija za pet područja (Slika 1).



Slika 1. Mapa s prikazom vlastite razine digitalnih kompetencija s mrežne stranice Digital skills

Karakteristike obrazovnih sustava Hrvatske i Kanade

Razlika između Hrvatske i Kanade je u sustavu vlasti na nacionalnoj razini koje su odgovorne za planiranje i implementaciju obrazovne politike na svim razinama. U Hrvatskoj je odgovorno Ministarstvo znanosti i obrazovanja, a u Kanadi je za obrazovanje u potpunosti odgovorna provincija (deset provincija i tri teritorija). Zbog takvog sustava, obrazovanje u cijeloj Kanadi nije jednako. U Kanadi je osnovno i srednje školovanje besplatno i obavezno, a fakultetsko obrazovanje subvencionira država. Obavezno obrazovanje u Kanadi traje dvanaest godina. Kanadski i Hrvatski obrazovni sustav razlikuju se i po duljini trajanja obrazovanja na pojedinim obrazovnim razinama. U Hrvatskoj su četiri odgojno-obrazovna ciklusa. Prvi ciklus čine 1., 2., 3. i 4. razred, drugi ciklus čine 5. i 6. razred, a treći ciklus čine 7. i 8. razred osnovne škole. U četvrti ciklus pripadaju 1. i 2. razred srednjih strukovnih i umjetničkih škola te četiri razreda gimnazije. S druge strane, obrazovanje u Kanadi ovisi o provincijama. Prva razina obrazovanja *International Standard Classification of Education* (ISCED) 1 u provinciji Ontario traje šest godina, druga razina, ISCED 2, traje dvije godine, a treća razina obrazovanja, ISCED 3, traje četiri godine. U provinciji Newfoundland i Labrador prva razina obrazovanja traje šest godina, a druga i treća razina tri godine. U provinciji Alberta prva razina obrazovanja (*Elementary*) traje šest godina, dok druga razina obrazovanja (*Junior High*) i treća razina obrazovanja (*Senior High*) traju tri godine. Razine obrazovanja različito traju jer je svaka provincija odgovorna za obrazovni sustav na svojim prostorima (https://www.cmec.ca/299/Education-in-Canada-An-Overview/index.html). U ovom smo radu prikazali rezultate samoprocjene digitalnih kompetencija studenata iz Kanade i Hrvatske. U istraživanju smo obuhvatili generičku kompetenciju, digitalnu kompetenciju zajedničku svim nastavnim programima. Kako bismo naglasili da ne postoji razlika u obrazovanju u Kanadi i Hrvatskoj na području digitalnih kompetencija, istaknuli smo kakav je status nastavnog predmeta Informatika u Hrvatskoj i u Kanadi. U vezi s tim uzima se u obzir činjenica da se kanadski obrazovni sustav razlikuje među provincijama, za razliku od hrvatskog obrazovnog sustava, koji je ujednačen na nacionalnoj razini. U Nacionalnom kurikulumu nastavnog predmeta Informatika (2016.) predviđeno je 70 sati informatike godišnje u svim razredima osnovne škole, dva puta po 70 sati informatike u općim, jezičnim, klasičnim i prirodoslovnim gimnazijama i općem obaveznom dijelu strukovnih škola te četiri puta po 70 sati predmeta informatike u prirodoslovno-matematičkim gimnazijama. U kanadskoj provinciji Ontario predmet informatika na prvoj razini (ISCED 1) ne postoji, a na drugoj razini (ISCED 2) i trećoj razini (ISCED 3) predmet informatika je izborni predmet. U kanadskoj provinciji Newfoundland i Labrador na prvoj razini (ISCED 1) predmet informatika nije implementiran u nastavu, na drugoj razini obrazovanja (ISCED 2) predmet informatika je obavezan predmet, a na trećoj razini (ISCED 3) predmet informatika je izborni predmet. Provincija Newfoundland i Labrador se razlikuje i od Hrvatske i od provincije Ontario. Prema mrežnoj stranici Learn Alberta (2018.), predmet informatika nije uključen u obrazovanje na prvoj razini (ISCED 1), a od petoga razreda osnovne škole (*Elementary*), odnosno od druge razine (ISCED 2), predmet informatika je izborni predmet. Predmet informatika u Kanadi se naziva *Career and Technology Foundations* i omogućuje učenicima upoznavanje s različitim karijerama i tehnologijom. U ovome poglavlju opisali smo obrazovni sustav u Kanadi i usporedili ga s obrazovnim sustavom u Hrvatskoj, s naglaskom na nastavni predmet informatika. Navedene usporedbe provedene su u svrhu stvaranja teorijske podloge i boljeg razumijevanja rezultata dobivenih nakon provedenoga istraživanja. Sljedeće poglavlje prikazuje metode i rezultate istraživanja samoprocjene digitalnih kompetencija studenata u Kanadi i Hrvatskoj.

Metode

Cilj istraživanja bio je ispitati razlike u samoprocjeni vlastite razine digitalnih kompetencija u pet područja između hrvatskih studenata s Filozofskog fakulteta u Splitu i

kanadskih studenata sa Southern Alberta Institute of Technology. Osim toga, cilj istraživanja bio je ispitati razlike u samoprocjeni digitalnih kompetencija u pet područja između studenata dvopredmetnih studija i studenata integriranog studija na Filozofskom fakultetu u Splitu. U skladu s postavljenim ciljevima utvrđeni su sljedeći problemi istraživanja:

1. ispitati razinu digitalnih kompetencija u pet područja na temelju samoprocjene kod hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology;
2. utvrditi razlike u razini digitalnih kompetencija u pet područja i nacionalnosti (hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology);
3. utvrditi razlike u razini digitalnih kompetencija u pet područja i studijskih programa na Filozofskom fakultetu u Splitu.

Na temelju definiranoga cilja i problema istraživanja postavljene su sljedeće hipoteze:

H1: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *informacija* između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

H2: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *komunikacija* između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

H3: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *izrada sadržaja* između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

H4: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *sigurnost* između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

H5: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *rješavanje problema* između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

H6: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *informacija* između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.

H7: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *komunikacija* između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.

H8: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *izrada sadržaja* između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.

H9: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *sigurnost* između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.

H10: Postoji statistički značajna razlika u samoprocjeni digitalnih kompetencija za područje digitalne kompetencije *rješavanje problema* između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu. Istraživačka metoda primijenjena u ovom istraživanju je introspekcija, budući da je korištena samoprocjena, a tehnika ispitivanja je upitnik. Istraživački nacrt je deskriptivan, a istraživanje je kvantitativno.

Sudionici istraživanja su hrvatski studenti s Filozofskog fakulteta u Splitu i kanadski studenti sa Southern Alberta Institute of Technology. Istraživanje je provedeno na uzorku od 125 studenata. U istraživanju je sudjelovalo 89 studenata s Filozofskog fakulteta u Splitu i 36 studenata sa Southern Alberta Institute of Technology. Od ukupnog broja studenata s Filozofskog

fakulteta u Splitu koji su sudjelovali u istraživanju, njih 50 pohađa dvopredmetne studije, a 39 pohađa integrirani studij (Učiteljski studij). Od ukupnog broja studenata sa Southern Alberta Institute of Technology, studijski program *Bachelor in Business Admin* pohađa 34 studenta, dok 2 studenta pohađaju studijski program *Bachelor of Science Construction Project Management*. Struktura uzorka ispitanika s obzirom na spol provedena je samo među hrvatskih studentima s Filozofskog fakulteta u Splitu (20 % muškaraca i 80 % žena) zbog nemogućnosti postavljanja takvog pitanja kanadskim studentima. Struktura ispitanika s obzirom na godinu studija provedena je među kanadskim i hrvatskim studentima. S Filozofskog fakulteta u Splitu u istraživanju je sudjelovalo 53 % studenata pete godine, 4 % studenata četvrte godine, 30 % studenata treće godine, 12 % studenata druge godine te 1 % studenata prve godine. Struktura ispitanih studenata (N=36) Southern Alberta Institute of Technology prema studijskoj godini je sljedeća: 3 % studenata pete godine, 19 % studenata četvrte godine, 69 % studenata treće godine, 6 % studenata druge godine i 3 % studenata prve godine.

Instrument za provedbu istraživanja je anonimni upitnik. U svrhu istraživanja napravljena su dva upitnika, jedan na hrvatskom jeziku i jedan na engleskom jeziku. Za izradu upitnika upotrijebljen je Google obrazac. Upitnik se sastojao od trideset i četiri pitanja, od kojih je trideset pitanja zatvorenog tipa i četiri pitanja otvorenog tipa.

Prvih sedam pitanja odnosi se na značajke ispitanika. Od tih sedam pitanja, tri su pitanja zatvorenog tipa (spol, država i dobna skupina), a četiri su pitanja otvorenog tipa (druga država, fakultet, studijski program i godina studija). Dvadeset i jedno pitanje odnosi se na digitalne kompetencije u pet područja. S pomoću ljestvice procjene (loš, prosječan, dobar, jako dobar i izvrstan) studenti su procjenjivali vlastitu razinu digitalnih kompetencija u pet područja. Područje digitalne kompetencije *informacija* ima tri digitalne kompetencije, područje digitalne kompetencije *komunikacija* ima šest digitalnih kompetencija, područje digitalne kompetencije *izrada sadržaja* ima četiri digitalne kompetencije, područje digitalne kompetencije *sigurnost* ima četiri digitalne kompetencije, a područje digitalne kompetencije *rješavanje problema* ima četiri digitalne kompetencije. Na kraju upitnika postavljeno je šest pitanja zatvorenog tipa. U tim su pitanjima studenti trebali procijeniti jesu li digitalne kompetencije važne za njihov budući posao, posjeduju li digitalne kompetencije potrebne za budući posao, način na koji su stekli digitalne kompetencije, razlog zbog kojeg bi trebali steći više digitalnih kompetencija, promiče li njihova država aktivnosti koje omogućuju praćenje napretka digitalnih kompetencija te pridonosi li informacijska i komunikacijska tehnologija procesu učenja i poučavanja.

Ispitivanje hrvatskih studenata s Filozofskog fakulteta u Splitu provedeno je u siječnju 2019. godine tijekom sedam dana. Studenti su upitnike ispunjavali *online.* U upitnicima studenti nisu navodili ime ni prezime, čime se jamčila anonimnost. Na Southern Alberta Institute of Technology ispitivanje je provedeno u ožujku 2019. godine tijekom sedam dana. U upitniku studenti nisu navodili ime ni prezime, čime se jamčila anonimnost, a studenti su bili slobodni u bilo kojem trenutku odustati od ispunjavanja upitnika. Svi upitnici koji nisu ispunjeni do kraja nisu iskorišteni u obradi rezultata.

Rezultati

Kako bi se ispitala razlika samoprocjene vlastite razine digitalnih kompetencija između kanadskih studenata sa Southern Alberta Institute of Technology i hrvatskih studenata s Filozofskog fakulteta u Splitu te studenata dvopredmetnih studijskih programa i studenata integriranog studijskog programa Filozofskog fakulteta u Splitu, izračunat je Hi-kvadrat test. Studenti su se samoprocjenjivali na ljestvici procjene od pet stupnjeva (loš, prosječan, dobar, jako dobar i izvrstan) iz pet područja digitalnih kompetencija kroz dvadeset i jednu kompetenciju.

Stoga je Hi-kvadrat test izračunat za pet područja, a dvadeset i jedna kompetencija je grupirana u područje kojem pripada (tablica 1).

Tablica 1.
Pet područja digitalne kompetencije i pripadajuće kompetencije

Područje	Kompetencija
INFORMACIJA	Pregledavanje, pretraživanje i filtriranje informacija.
	Vrednovanje informacija.
	Pohranjivanje i dohvaćanje informacija.
KOMUNIKACIJA	Interakcija kroz tehnologije.
	Dijeljenje informacija i sadržaja.
	Uključivanje u internetsko građanstvo.
	Suradnja putem digitalnih kanala.
	Prihvatljivo ponašanje na internetu (internetska etika).
	Upravljanje digitalnim identitetom.
IZRADA SADRŽAJA	Izrada sadržaja.
	Integriranje i obrada sadržaja i znanja.
	Razumijevanje autorskog prava i licenci.
	Programiranje.
SIGURNOST	Zaštita uređaja.
	Zaštita osobnih podataka.
	Zaštita zdravlja.
	Zaštita okoliša.
RJEŠAVANJE PROBLEMA	Rješavanje tehničkih problema.
	Identificiranje potreba i tehnoloških odgovora.
	Inovativna i kreativna upotreba tehnologije.
	Prepoznavanje nedostataka digitalne kompetencije.

Rezultati Hi-kvadrat testa za pet područja između kanadskih studenata sa Southern Alberta Institute of Technology i hrvatskih studenata s Filozofskog fakulteta u Splitu prikazani su u Tablici 2, Tablici 3, Tablici 4, Tablici 5 i Tablici 6.

Tablica 2.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *informacija*

Studenti	N	D	Hi Kvadrat	df	p
Kanađani	36	4	19.90*	3	7.82
Hrvati	89	5			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H1: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije informacija između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(3) = 19.90$, $p < 0.05$). Rezultati pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu (D = 5) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje informacija boljom od kanadskih studenata sa Southern Alberta Institute of Technology (D = 4). Razinu digitalnih kompetencija za područje informacije izvrsnom samoprocjenjuje 40 % hrvatskih studenata i samo 18 % kanadskih

studenata. Istu razinu dobrom procjenjuje 27 % kanadskih studenata i samo 17 % hrvatskih studenata. Time je potvrđena H1 uz razinu značajnosti od 5 %.

Tablica 3.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *komunikacija*

Studenti	N	D	Hi Kvadrat	df	p
Kanađani	36	4	26.53*	4	9.49
Hrvati	89	5			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H2: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije komunikacija između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 26.53$, $p < 0.05$). Rezultati pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu (D = 5) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *komunikacija* boljom od kanadskih studenata sa Southern Alberta Institute of Technology (D = 4). Razinu digitalnih kompetencija za područje *komunikacija* izvrsnom samoprocjenjuje 41 % hrvatskih studenata i samo 30 % kanadskih studenata. Istu razinu prosječnom procjenjuje 14 % kanadskih studenata i samo 4 % hrvatskih studenata. Time je potvrđena H2 uz razinu značajnosti od 5 %.

Tablica 4.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *izrada sadržaja*

Studenti	N	D	Hi Kvadrat	df	p
Kanađani	36	3	8.01	4	9.49
Hrvati	89	4			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H3: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije izrada sadržaja između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.

Nakon obrade podataka utvrđeno je da ne postoji statistički značajna razlika ($x^2(4) = 8.01$, $p > 0.05$). Rezultati pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu (D = 4) i kanadski studenti sa Southern Alberta Institute of Technology (D = 3) jednako samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *izrada sadržaja*. Time je odbačena H3 uz razinu značajnosti od 5 %.

Tablica 5.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *sigurnost*

	N	D	Hi Kvadrat	df	p
Kanađani	36	4	9.77*	4	9.49
Hrvati	89	4			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H4: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije sigurnost između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 9.77$, $p < 0.05$). Rezultati pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu (D = 4) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *sigurnost* boljom od kanadskih studenata sa Southern Alberta Institute of Technology (D = 4). Razinu digitalnih kompetencija za područje sigurnost prosječnom samoprocjenjuje 21 % kanadskih studenata i samo 15 % hrvatskih studenata. Time je potvrđena H4 uz razinu značajnosti od 5 %.

Tablica 6.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije rješavanje problema

	N	D	Hi Kvadrat	df	p
Kanađani	36	3	4.46	4	9.49
Hrvati	89	3			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H5: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije rješavanje problema između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology.
Nakon obrade podataka utvrđeno je da ne postoji statistički značajna razlika ($x^2(4) = 4.46$, $p > 0.05$). Rezultati pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu (D = 3) i kanadski studenti sa Southern Alberta Institute of Technology (D = 3) jednako samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *rješavanje problema*. Time je odbačena H5 uz razinu značajnosti od 5 %.
Osim što su studenti samoprocjenjivali vlastitu razinu digitalnih kompetencija u pet područja, također su odgovarali na pitanje kako su stekli vlastite digitalne kompetencije. Najveći broj studenata obiju skupina izjasnio se da su vlastite digitalne kompetencije savladali samostalno (58 % kanadskih studenata i 56 % hrvatskih studenata). Međutim, za razliku od 6 % kanadskih studenata sa Southern Alberta Institute of Technology, čak 28 % hrvatskih studenata s Filozofskog fakulteta u Splitu izjasnilo se da je svoje digitalne kompetencije steklo na fakultetu. Za razliku od hrvatskih studenata, 11 % kanadskih studenata izjasnilo se da je svoje digitalne kompetencije steklo na tečajevima. Niti jedan hrvatski student nije stekao svoje digitalne kompetencije na tečajevima. Kanadski studenti (njih 78 %) sa SAIT-a smatra da njihova država promiče aktivnosti koje mladim ljudima omogućuju praćenje napretka digitalnog znanja. Hrvatski studenti s FFST-a (njih 49 %) smatraju da u njihovoj zemlji postoji vrlo malo inicijativa koje se odnose na razvoj digitalnih kompetencija. Osim toga, 14 % kanadskih studenata i 35 % hrvatskih studenata smatra da je javni sektor slab i da ne pruža sredstva za aktivnosti koje mladim ljudima omogućuju praćenje napretka digitalnog znanja.
Osim što se računala razlika u samoprocjeni vlastite razine digitalnih kompetencija u pet područja digitalne kompetencije između kanadskih studenata sa SAIT-a i hrvatskih studenata s FFST-a, u ovom se istraživanju računala i razlika u samoprocjeni vlastite razine digitalnih kompetencija u pet područja digitalne kompetencije između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.
Rezultati Hi-kvadrat testa za pet područja između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu prikazani su u Tablici 7, Tablici 8, Tablici 9, Tablici 10 i Tablici 11.

Tablica 7.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *informacija*

Studenti FFST	N	D	Hi Kvadrat	df	P
Integrirani	39	5	6.11	3	7.82
Dvopredmetni	50	4			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H6: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije informacija između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.
Nakon obrade podataka utvrđeno je da ne postoji statistički značajna razlika ($x^2(3) = 6.11$, $p > 0.05$). Rezultati pokazuju da studenti dvopredmetnog studija (D = 4) i integriranog studija (D = 5) na Filozofskom fakultetu u Splitu jednako samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *informacija*. Time je odbačena H6 uz razinu značajnosti od 5 %.

Tablica 8.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *komunikacija*

Studenti FFST	N	D	Hi Kvadrat	df	p
Integrirani	39	5	21.89*	4	9.49
Dvopredmetni	50	4			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H7: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije komunikacija između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 21.89$, $p < 0.05$). Rezultati pokazuju da studenti integriranog studija na Filozofskom fakultetu u Splitu (D = 5) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *komunikacija* boljom od studenata dvopredmetnih studija na Filozofskom fakultetu u Splitu (D = 4). Razinu digitalnih kompetencija za područje *komunikacija* izvrsnom samoprocjenjuje 49 % studenata integriranog studija i samo 33 % studenata dvopredmetnih studija. Istu razinu prosječnom procjenjuje 6 % studenata dvopredmetnih studija i samo 2 % studenata integriranog studija. Time je potvrđena H7 uz razinu značajnosti od 5 %.

Tablica 9.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *izrada sadržaja*

	N	D	Hi Kvadrat	df	p
Integrirani	39	4	18.36*	4	9.49
Dvopredmetni	50	3			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H8: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije izrada sadržaja između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.

Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 18.36$, $p < 0.05$). Rezultati pokazuju da studenti integriranog studija na Filozofskom fakultetu u Splitu (D = 4) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *izrada sadržaja* boljom od studenata dvopredmetnih studija na Filozofskom fakultetu u Splitu (D = 3). Razinu digitalnih kompetencija za područje *izrada sadržaja* jako dobrom samoprocjenjuje 31 % studenata integriranog studija i samo 23 % studenata dvopredmetnih studija. Istu razinu lošom procjenjuje 19 % studenata dvopredmetnih studija i samo 8 % studenata integriranog studija. Time je potvrđena H8 uz razinu značajnosti od 5 %.

Tablica 10.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije *sigurnost*

	N	D	Hi Kvadrat	df	p
Integrirani	39	4	14.98*	4	9.49
Dvopredmetni	50	3			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H9: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije sigurnost između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 14.98$, $p < 0.05$). Rezultati pokazuju da studenti integriranog studija na Filozofskom fakultetu u Splitu (D = 4) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *sigurnost* boljom od studenata dvopredmetnih studija na Filozofskom fakultetu u Splitu (D = 3). Razinu digitalnih kompetencija za područje *sigurnost* jako dobrom samoprocjenjuje 42 % studenata integriranog studija i samo 25 % studenata dvopredmetnih studija. Istu razinu prosječnom procjenjuje 18 % studenata dvopredmetnih studija i samo 11 % studenata integriranog studija. Time je potvrđena H9 uz razinu značajnosti od 5 %.

Tablica 11.
Rezultati Hi-kvadrat testa za područje digitalne kompetencije rješavanje problema

	N	D	Hi Kvadrat	df	p
Integrirani	39	4	14.19*	4	9.49
Dvopredmetni	50	3			

* - $p < 0.05$
N – broj ispitanika, D – dominantna vrijednost
df – stupnjevi slobode, p – razina značajnosti za 0.05

H10: Postoji statistički značajna razlika u samoprocjeni vlastite razine digitalnih kompetencija za područje digitalne kompetencije rješavanje problema između studenata dvopredmetnih studija i integriranog studija na Filozofskom fakultetu u Splitu.
Nakon obrade podataka utvrđeno je postojanje statistički značajne razlike ($x^2(4) = 14.19$, $p < 0.05$). Rezultati pokazuju da studenti integriranog studija na Filozofskom fakultetu u Splitu (D = 4) samoprocjenjuju vlastitu razinu digitalnih kompetencija za područje *rješavanje problema* boljom od studenata dvopredmetnih studija na Filozofskom fakultetu u Splitu (D = 3). Razinu digitalnih kompetencija za područje *rješavanje problema* jako dobrom samoprocjenjuje 30 % studenata

integriranog studija i samo 17 % studenata dvopredmetnih studija. Istu razinu lošom procjenjuje 8 % studenata dvopredmetnih studija i samo 2 % studenata integriranog studija. Time je potvrđena H10 uz razinu značajnosti od 5 %.

Na temelju obrade podataka pet područja digitalne kompetencije može se zaključiti da studenti integriranog studija Filozofskog fakulteta u Splitu samoprocjenjuju vlastitu razinu digitalnih kompetencija za pet područja boljom od studenata dvopredmetnih studija na Filozofskom fakultetu u Splitu. Studenti integriranog studija samoprocjenjuju vlastitu razinu digitalnih kompetencija boljom u području *komunikacija, izrada sadržaja, sigurnost i rješavanje problema.* Prema elaboratu o studijskim programima (2015.), studenti dvopredmetnih studija (preddiplomski i diplomski) na Filozofskom fakultetu obuhvaćeni ovim istraživanjem nemaju nijedan obavezan predmet iz područja informatike, dok studenti integriranog studija imaju dva obavezna predmeta iz područja informatike na prvoj godini studija (Informatika i Računalni praktikum). Na pitanje o stjecanju digitalnih kompetencija 10 % studenata dvopredmetnih studija i 49 % studenata integriranog studija tvrdi da je kompetencije steklo na fakultetu. Ovaj rezultat ukazuje na razliku koja je vidljiva i u studijskim programima, a u prilog tome ide i činjenica da 90 % studenata dvopredmetnih studija i 51 % studenata integriranog studija tvrdi da je digitalne kompetencije steklo samostalno. Studenti integriranog studija, njih 100 %, i studenti dvopredmetnih studija, njih 82 %, smatraju da posjeduje digitalne kompetencije potrebne za budući posao.

Rasprava

U ovom je radu provedeno istraživanje u kojemu se ispitivala razlika u samoprocjeni digitalnih kompetencija u pet područja na temelju samoprocjene kod hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology. Rezultati istraživanja uspoređeni su između hrvatskih studenata s Filozofskog fakulteta u Splitu i kanadskih studenata sa Southern Alberta Institute of Technology te između studenata integriranog studija i dvopredmetnih studija na Filozofskom fakultetu u Splitu. Rezultati istraživanja pokazuju da hrvatski studenti s Filozofskog fakulteta u Splitu samoprocjenjuju vlastitu razinu digitalnih kompetencija boljom od kanadskih studenata sa Southern Alberta Institute of Technology za područje informacija ($x^2(3) = 19.90$, $p < 0.05$; Dh = 5 Dk = 4), komunikacija ($x^2(4) = 26.53$, $p < 0.05$; Dh = 5 Dk = 4) i sigurnost ($x^2(4) = 9.77$, $p < 0.05$; Dh = 4 Dk = 4). Dobiveni rezultati nisu u skladu s rezultatima Međunarodnog istraživanja računalne i informatičke pismenosti učenika (ICILS 2013). Prema tom istraživanju, hrvatski učenici osmih razreda zauzeli su četrnaesto mjesto, dok su kanadski učenici u provinciji Ontario zauzeli drugo mjesto, a u provinciji Newfoundland i Labrador deveto mjesto. Jedno od mogućih objašnjenja takvih rezultata je činjenica da se u ovom istraživanju koristila samoprocjena, a ne objektivna procjena kao test znanja u ICILS istraživanju. Još jedan razlog takvih rezultata može biti činjenica da su u ICILS istraživanju sudjelovali učenici osmih razreda, a ne studenti kao u ovom radu. U spomenutom istraživanju sudjelovale su kanadske provincije Ontario, Newfoundland i Labrador, ali ne i kanadska provincija Alberta kao u ovom istraživanju, stoga i taj podatak može biti jedan od mogućih razloga dobivenih rezultata istraživanja. Posebno je važna činjenica da u Kanadi ne postoji organ vlasti koji je odgovoran za obrazovanje na nacionalnoj razini, već je svaka provincija odgovorna za obrazovanje unutar te provincije. Upravo zato obrazovni sustav u cijeloj Kanadi nije ujednačen, nego je uglavnom sličan, uz male razlike u kurikulumu i sustavu ocjenjivanja.

Dobiveni rezultati također nisu u skladu s najnovijim istraživanjem Europske komisije (2017./2018.) o primjeni IKT-a u obrazovanju za drugu razinu obrazovanja (ISCED 2). U istraživanju koje je temeljeno na pet područja digitalne kompetencije prema Europskom okviru za razvoj i razumijevanje sudjelovale su države članice Europske unije te Norveška, Island i Turska.

U online anketi učenici su procjenjivali svoju samouvjerenost u vlastite digitalne kompetencije na ljestvici od jedan do četiri. Rezultati pokazuju malo nižu samouvjerenost u vlastite digitalne kompetencije hrvatskih učenika viših razreda osnovne škole u odnosu na prosjek rezultata učenika iz drugih država koje su sudjelovale, i to u području komunikacije, informacije i rješavanja problema. Međutim, dobiveni rezultati u ovom radu u skladu su s rezultatima istog istraživanja Europske komisije, ali za treću razinu obrazovanja (ISCED 3). Rezultati pokazuju nešto višu samouvjerenost u vlastite digitalne kompetencije hrvatskih učenika srednjih škola u odnosu na prosjek rezultata učenika iz drugih država koje su sudjelovale u istraživanju, i to u području komunikacije, izrade sadržaja, sigurnosti i rješavanja problema.

Jedno od objašnjenja takvih rezultata je razina samokritičnosti između kanadskih i hrvatskih studenata. Studenti sa Southern Alberta Institute of Technology pohađaju smjerove *Bachelor in Business administration* i *Bachelor of Science Construction Project Management* i od njih se očekuje bolje poznavanje digitalnih kompetencija s obzirom na područje zanimanja. Stoga postoji mogućnost da su kanadski studenti bili samokritičniji u procjeni vlastitih digitalnih kompetencija od hrvatskih studenata.

Rezultati istraživanja pokazuju i da studenti integriranih studija s Filozofskog fakulteta u Splitu samoprocjenjuju vlastitu razinu digitalnih kompetencija boljom od studenata dvopredmetnih studija s Filozofskog fakulteta u Splitu za područje *komunikacija* ($x^2(4) = 21.89$, $p < 0.05$; Di = 5 Dd = 4), *izrada sadržaja* ($x^2(4) = 18.36$, $p < 0.05$; Di = 4 Dd = 3), *sigurnost* ($x^2(4) = 14.98$, $p < 0.05$; Di = 4 Dd = 3) i *rješavanje problema* ($x^2(4) = 14.19$, $p < 0.05$; Di = 4 Dd =3). Jedno od mogućih objašnjenja takvih rezultata je činjenica da, prema elaboratu Filozofskog fakulteta u Splitu, studenti dvopredmetnih studija obuhvaćeni ovim istraživanjem nemaju nijedan obavezni predmet iz područja informatike, za razliku od studenata integriranog studija koji imaju dva obavezna predmeta iz područja informatike na prvoj godini studija (Informatika i Računalni praktikum). Još jedan od mogućih razloga ovakvih rezultata može biti mali uzorak ispitanika. U istraživanju je sudjelovalo 89 hrvatskih ispitanika s Filozofskog fakulteta u Splitu i 36 kanadskih ispitanika sa Southern Alberta Institute of Technology. Osim toga, u istraživanju je sudjelovalo znatno više hrvatskih studenata u odnosu na kanadske studente. Za buduće istraživanje bilo bi dobro uzeti veći i ravnopravan uzorak ispitanika s različitih fakulteta i gradova, a posebno iz različitih provincija u Kanadi. U svrhu ovog istraživanja također je prvi put napravljen upitnik pa bi za neka daljnja istraživanja bilo dobro provjeriti njegove karakteristike, iako se samoprocjena iz upitnika temelji na pet područja digitalne kompetencije prema Europskom okviru za razvoj i razumijevanje digitalne kompetencije (DigComp). Za buduće istraživanje bilo bi dobro koristiti neku objektivnu procjenu poput testa znanja, a ne samo samoprocjenu kao u ovom radu.

Važno je naglasiti da su diplomski dvopredmetni studiji na Filozofskom fakultetu u Splitu uglavnom nastavničkog usmjerenja ili mogu biti odabrani kao nastavničko usmjerenje između dva moguća usmjerenja. Ta činjenica u današnje vrijeme digitalizacije škola može biti problem. Posjedovanje digitalnih kompetencija danas je nužno kod nastavnika i učitelja. Prema Europskoj uniji, digitalna kompetencija uvrštena je među osam ključnih kompetencija za cjeloživotno obrazovanje, a te je iste kompetencije prihvatila obrazovna politika Republike Hrvatske.

O važnosti digitalnih kompetencija svjedoči i projekt Europske komisije, Digitalna agenda. Digitalna agenda dio je strategije Europe 2020. i za cilj ima povećanje upotrebe IKT-a kako bi se poticale inovacije, gospodarski rast i napredak. Već se u knjizi Digitalna agenda (2012.) procjenjivalo da će do 2015. godine 90 % radnih mjesta zahtijevati osnovnu razinu digitalnih

vještina. Stoga digitalna agenda naglašava da je ulaganje u ljudski kapital ključno za maksimalno iskorištavanje potencijala IKT-a, što nije slučaj s obuhvaćenim studentima dvopredmetnih studija na Filozofskom fakultetu u Splitu.

Zaključak

Danas je digitalna tehnologija zastupljena u svim aspektima života. Današnje društvo obilježeno je prefiksom *digitalno*. Velika zastupljenost digitalne tehnologije dovodi do promjena u načinu rada, učenja i života pojedinca te dovodi do potrebe za novim tipovima pismenosti. Danas su rad, učenje i zabava nezamislivi bez digitalne tehnologije. Kao što je već navedeno, prije 21. stoljeća se osoba koja je znala pisati i čitati nazivala pismenom osobom. Početkom 21. stoljeća i ulaskom digitalne tehnologije u sve segmente čovjekova života stvara se potreba za razvojem novih vrsta pismenosti, pa tako i za razvojem digitalnih kompetencija. Upravo je digitalna kompetencija prepoznata kao četvrta ključna kompetencija u modernom europskom društvu od ukupno osam ključnih kompetencija.

Na razvoj digitalnih kompetencija mogu utjecati brojni čimbenici, kao što su čimbenici šire zajednice (države), škole ili razreda, obiteljski čimbenici, ali i individualni čimbenici.

O važnosti digitalnih kompetencija svjedoči i CARNET-ov program e-Škole: Cjelovita informatizacija procesa poslovanja škole i nastavnih procesa u svrhu stvaranja digitalno zrelih škola za 21. stoljeće. Prema mrežnoj stranici e-Škole (2018.), projekt se sastojao od dvije faze. Prva faza (pilot projekt) završena je 2018. godine i rezultirala je povećanjem razine digitalne zrelosti u 10 % hrvatskih osnovnih i srednjih škola. Druga faza treba završiti 2022. godine, a za cilj ima osigurati IKT okolinu prilagođenu potrebama škole i unaprijediti digitalne kompetencije i strateško vodstvo škole za postizanje digitalne zrelosti. Stoga je danas posjedovanje digitalnih kompetencije kod nastavnika i učitelja nužno.

Na temelju ovog istraživanja vidljivo je da je digitalna kompetencija neiscrpan izvor tema za istraživanje. Istraživanja ovoga područja, kako Gobo (2012.) naglašava, trebala bi biti kontinuirani proces da bi se neprestano stjecale nove spoznaje koje će pridonijeti razvoju digitalnih kompetencija kod svih građana, budući da će u bliskoj budućnosti digitalna nepismenost biti jednaka alfabetskoj nepismenosti. Digitalna kompetencija predstavlja imperativ današnjice.

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Self-assessment of Students' Digital Competences

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Abstract

The influence of information and communication technology enables access to all educational materials for individuals willing to acquire knowledge and skills. The fast information and communication technology development presents a challenge for teachers and institutions involved in the organization, management and finances related to learning and teaching. The application of information and communication technology should not be an end in itself but should find its continuous and planned use to enable the advancement of digital competence acquisition. The understanding and use of information and communication technology are considered as important as reading, writing and counting. Thus, being literate does not imply only reading, writing and counting competences, but also digital competence. The development of digital competences can be influenced by a number of factors, such as: wider community (state), school or class, family and individual factors. The aim of this paper is to examine the differences in self-assessment of levels of digital competence in five areas between Croatian students from the Faculty of Humanities and Social Sciences in Split and Canadian students from the Southern Alberta Institute of Technology. The difference in self-assessment of digital competences was found among the respondents. Croatian students think they are more competent than Canadian students in the area of information, communication and safety. Research in this area should be a continuous process to gain new insights that will contribute to the development of digital competences in all citizens. In the near future, digital illiteracy could be equal to alphabetical illiteracy as digital competence in today's imperative.

Keywords: *digital competences; information and communication technology.*

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Računalno razmišljanje budućih učitelja razredne nastave

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Sažetak

Računalno razmišljanje je postalo široko prihvaćen pojam za univerzalno primjenjive koncepte, stavove i vještine svojstvene za STEM područja znanosti, kao i područje informacijskih znanosti. Smatra se neophodnim za uspješno funkcioniranje u tehnologijom-prožetom društvu 21. stoljeća. Neophodna je integracija računalnog razmišljanja u nastavni proces, pri čemu je značajna uloga učitelja. U Republici Hrvatskoj se novim kurikulumom nastave informatike „Škola za život“ računalno razmišljanje apostrofira kao jedan od četiri temeljna elementa.

Naglasak ovog rada je na učiteljima primarnog obrazovanja – sadašnjim i budućim, i osnaživanju njihova računalnog razmišljanja (uz druge aspekte koje potiču STEM način razmišljanja) kroz cjelokupnu nastavu, ne ciljajući samo putem matematike ili programiranja. Ideja je osposobiti učenike i studente nesklone STEM područjima da usvoje bitne koncepte i vještine karakteristične upravo za STEM, no preduvjet je da učitelj nema problema s tim konceptima i vještinama.

U radu se analizira anketa studenata prve i druge godine Učiteljskog fakulteta u Zagrebu o sklonostima STEM područjima znanosti. Od 144 studenta svega 24 % studenata na maturi je položilo višu razinu matematike (A razina), a svega 8 % anketiranih izrazilo je „izrazitu“ sklonost STEM područjima (83 % je izrazilo „osrednju“ a 9 % „nimalo“). Istodobno, hrvatski učenici na PISA testiranjima pokazuju ispodprosječne rezultate u svim kategorijama u četiri posljednja ciklusa testiranja u kojima je Republika Hrvatska sudjelovala. Kvalitetno obrazovanje postavlja pred učitelje zahtjev da suvereno primjenjuju strategije i sadržaje koje će kod učenika razviti kreativnost i motiviranost za široki spektar predmeta. Može se očekivati da će pomanjkanje interesa za STEM područje budući učitelji prenijeti na nove generacije učenika, što će rezultirati lošim uspjehom na objektivnim testiranjima.

Nadalje, u radu se daje osvrt na primjere dobre prakse u razvoju računalnog razmišljanja učitelja razredne nastave i njihovih učenika.

Na kraju se daju prijedlozi za integraciju koncepata računalnog razmišljanja u nastavu studenata – budućih učitelja na učiteljskim fakultetima kroz zaseban kolegij kao i postojeće kolegije.

***Ključne riječi**: računalno razmišljanje; STEM; učitelji razredne nastave*

Uvod

Tehnološki napredak 21. stoljeća nameće digitalnu pismenost ostalim općepriznatim temeljnim vještinama: kritičkom razmišljanju, pismenom izražavanju, čitalačkoj pismenosti, matematičkoj pismenosti. Nameće se potreba da se postane digitalni „proizvođač“ a ne samo

„konzument“ u svijetu u kojem se nove tehnologije stvaraju brzinom nepremostivom za tromi sustav formalnog školovanja.

Prema pedagogu Karlu Fischu, profesoru srednje škole u SAD-u i autoru motivirajućih prezentacija o promjenama koje 21. stoljeće donosi (Fisch, 2007) „Trenutno pripremamo studente za poslove koji još ne postoje, za koje će se koristiti tehnologijama koje još nisu izumljene da bi rješavali probleme za koje još i ne znamo da su problemi.“

Svaka rasprava o razvoju tehnološke inovativnosti i kreativnosti se reflektira na obrazovni sustav i njegovu nužnost stvaranja inovativnih i kreativnih generacija. U ovom radu se naglašava važnost nastavnika u procesu uspješne edukacije, konkretnije učitelja razredne nastave i to naročito s aspekta edukacije u domeni STEM područja i računalnog razmišljanja.

Edukacija u STEM (eng. Science, Technology, Engineering, Mathematics je područje prirodnih znanosti, tehnologije, inženjerstva i matematike) području apostrofira se kao ključna u razvoju inovacija i tehnologija, a samim time i gospodarskog napretka (Atkinson i Mayo, 2010). Kratica STEM je općeprihvaćena i prepoznatljiva već dulje vrijeme, no potaknuto razvojem informacijsko-komunikacijskih tehnologija (IKT) uviđa se potreba nadgradnje pojmova i vještina koje STEM podrazumijeva.

Nakon rada Jeannete M. Wing iz 2006. godine općeprihvaćen je pojam *Računalnog razmišljanja* (eng. *Computational thinking*) (Wing, 2006), koji zagovara univerzalno primjenjive stavove i vještine koje obično povezujemo upravo sa STEM područjima znanosti kao i s područjem informacijskih i komunikacijskih znanosti.

Računalno razmišljanje nema jednoznačnu definiciju nego predstavlja skup fundamentalnih vještina za svakoga, ne samo informatičare; to je misaona aktivnost formuliranja i rješavanja problema na način kako to čine računala. Pritom postupak rješavanja problema ne uključuje nužno sama računala (Wing, 2011).

Opširniju definiciju daje publikacija *Computational thinking toolkit* iz 2010. objavljena od strane The International Society for Technology in Education (ISTE) i Computer Science Teachers Association (CSTA) sinergijom velikog broja vodećih znanstvenika, profesora na edukacijskim fakultetima, školskih profesora i učitelja SAD-a (“Computational thinking for all | ISTE,” 2010):

Računalno razmišljanje je proces rješavanja problema koji uključuje (među ostalim) karakteristike:

- Formuliranje problema na način da je moguće koristiti računala i druge alate pri njihovu rješavanju
- Logičko organiziranje i analiziranje podataka
- Reprezentiranje podataka kroz apstrakcije kao što su modeli i simulacije
- Izvođenje rješenja u algoritamskim koracima
- Identificiranje, analiziranje i primjena mogućih rješenja s ciljem postizanja najefikasnije kombinacije koraka i resursa
- Generalizacija i prijenos postupka na rješavanje drugih problema

Nadalje, s obzirom na karakteristike i stavove, računalno razmišljanje uključuje (“Computational thinking for all | ISTE,” 2010):

- Samouvjerenost u kompleksnim problemima
- Upornost u radu s teškim problemima
- Prihvaćanje mogućih višestrukih rješenja
- Sposobnost nošenja s problemima
- Sposobnost komunikacije i rada s drugima radi postizanja zajedničkog cilja ili rješenja

S obzirom na važnost računalnog razmišljanja u edukaciji, ovim radom se daje kratki osvrt na stanje u hrvatskom obrazovnom sustavu preko rezultata PISA testiranja i novog kurikuluma „Škola za život".

Direktna motivacija ovom radu je anketa provedena nad studentima Učiteljskog fakulteta Sveučilišta u Zagrebu o sklonostima STEM područjima znanosti. Na kraju slijedi zaključak i popis literature.

Hrvatski obrazovni sustav

U posljednja četiri ciklusa PISA testiranja hrvatskih učenika u svim ispitivanim kategorijama (prirodne znanosti, matematika, čitalačka pismenost) pokazani su ispodprosječni rezultati u odnosu na prosjek učenika u svijetu (uzrast 15 i 16 godina) (PISA, 2019). Rezultati ukazuju na nužnost promjene u edukaciji. Upotreba suvremenih IKT-a u obrazovanju vodi do boljih rezultata u uspjehu učenika u odnosu na učenje bez upotrebe IKT-a (Tomljenović i Zovko, 2016), no tehnologija postaje nešto što se podrazumijeva u suvremenoj školi, a naglasak je na kvaliteti obrazovnog procesa.

U hrvatskom obrazovnom sustavu trenutno je u provedbi eksperimentalna faza kurikularne reforme pod nazivom „Škola za život" ("Nacionalni kurikulum | Ministarstvo znanosti i obrazovanja," 2019) koja uz ostalo naglasak stavlja na stjecanje znanja, razvoj sposobnosti i spremnost učenika za rješavanje problema, donošenje odluka, metakogniciju, kritičko mišljenje, kreativnost i inovativnost. Učenike treba osposobiti i za komunikaciju, suradnju, informacijsku i digitalnu pismenost i korištenje tehnologija, a za to treba iskoristiti i igru kao prirodnu aktivnost djece.

Kurikulum predmeta informatika navodi da je računalno razmišljanje jedno od četiri domene kojima će se realizirati ciljevi predmeta: e-Društvo, Digitalna pismenost i komunikacija, Računalno razmišljanje i programiranje te Informacije i digitalna tehnologija. Osim u nastavi predmeta informatika nigdje se drugdje ne spominje računalno razmišljanje.

Posebnu pozornost treba posvetiti edukaciji samih učitelja (kako sadašnjih tako i budućih), naročito učitelja razredne nastave, jer oni prvi koji svojim angažmanom formiraju i motiviraju najranije uzraste učenika. U tim ranim godinama djeca učenje još doživljavaju kao igru, a ne obavezu. U toj dobi, dok se još formira njihov interes, važno je usmjeriti njihov proces učenja na načine koje promovira računalno razmišljanje (Adler i Kim, 2018).

Aspekti računalnog razmišljanja se mogu učiti u nizu školskih predmeta i ne bi ih trebalo vezati samo za matematiku, informatiku ili prirodne predmete. Yadav, Mayfield, Zhou, Hambrusch i Korb (2014) u svom istraživanju nakon provedene radionice s budućim učiteljima zaključuju da budući učitelji doživljavaju računalno razmišljanje kao integriranje tehnologije u nastavu, dok eksperimentalna grupa nakon provedene edukacije shvaća računalno razmišljanje kao pristup rješavanju problema, univerzalno primjenjiv u nastavi.

Yadav, Stephenson i Hong (2017) predlažu da edukacija budućih učitelja mora uključivati suradnju sa stručnjacima informacijskih znanosti, kako bi temeljne kvalitete računalnog razmišljanja ukomponirali u pedagošku i metodičku edukaciju. Autori predlažu da takva edukacija mora voditi računa o:

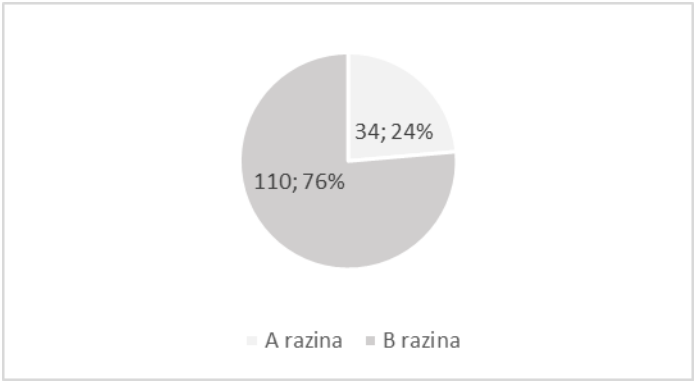
- Kurikulumu: kurikulum mora pripremiti učitelje za uključivanje računalnog razmišljanja u nastavu
- Ideje: budući učitelji moraju imati predodžbu o temeljnim idejama i konceptima računalnog razmišljanja
- Metodički kolegiji: dizajnirati kolegije metodike za usvajanje principa računalnog razmišljanja u kontekstu predmeta
- Suradnja: edukatori informacijskih znanosti i edukatori učitelja moraju surađivati u izradi kurikuluma učiteljskih studija
- Edukacija učitelja: koristiti postojeće resurse i standarde za asimilaciju računalnog razmišljanja u edukaciju budućih učitelja

Anketa studenata Učiteljskog fakulteta

Anketirano je 144 studenta prve i druge godine Učiteljskog fakulteta Sveučilišta u Zagrebu, u akademskim godinama 2016./2017., 2017./2018. i 2018./2019. Anketa je provedena na početku uvodnih kolegija informatike koji imaju različite nazive s obzirom na vrstu studija. Na kolegiju Osnove informatike za buduće učitelje s modulom Informatika anketirana su 62 studenta, na kolegiju Uvod u informatiku za buduće učitelje ostalih modula anketirano je 52 studenta te na kolegiju IKT u odgoju i obrazovanju za buduće odgojitelje anketirano je 30 studenata.

Studente prve ili druge godine koji polaze uvodni kolegij informatike na početku akademske godine se anketira o vrsti završene škole, predznanju iz informatike, razini korištenja određenih alata itd. Za potrebe ovog rada istaknuti su rezultati na dva postavljena pitanja, koja ilustriraju razinu matematičke pismenosti te sklonost STEM područjima znanosti, a time i razini računalnog razmišljanja koja se može očekivati od polaznika za eventualno praćenje sadržaja kolegija.

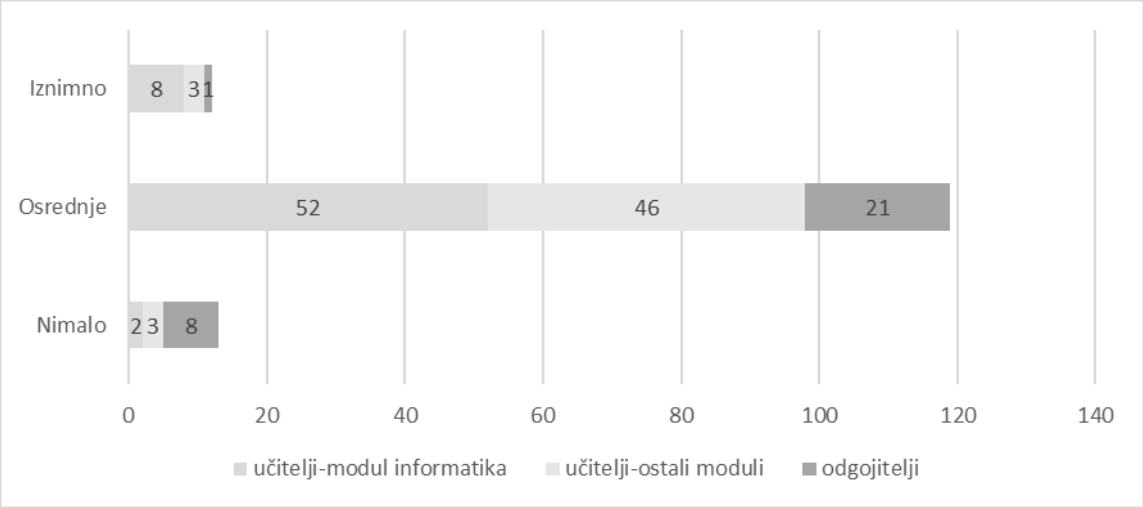
Na pitanje o višoj (A) ili nižoj (B) položenoj razini matematike na državnoj maturi koja prethodi upisu na fakultet, 34 studenta (24 %) odgovorila su da su položili višu razinu (A), dok je nižu (B) razinu položilo 110 studenata (76 %) (Grafikon 1.).



Grafikon1. Razina položene matematike na maturi

Na pitanje o osobnoj procjeni sklonosti STEM područjima znanosti studentima su ponuđeni odgovori: „nimalo“, „osrednje“ i „iznimno“. 13 studenata (9 %) je „nimalo“ zainteresirano za STEM područje, 119 studenata (83 %) je „osrednje“ zainteresirano a 12 studenata (8 %) je „iznimno“ zainteresirano.

Na Grafikonu 2. su prikazani podaci za pojedinu kategoriju, posebno razdvojeni na studente učitelji-modul informatika („iznimno“ 8 studenata, „osrednje“ 52 studenta, „nimalo“ 2 studenta) , studenti učitelji-ostali moduli („iznimno“ 3 studenta, „osrednje“ 46 studenata, „nimalo“ 3 studenta) i studenti odgojitelji („iznimno“ 1 student, „osrednje“ 21 student, „nimalo“ 8 studenata).



Grafikon 2. Sklonost studenata STEM područjima

Rasprava

Rezultati provedene ankete pokazuju da većina studenata nije polagala višu razinu mature iz matematike. S obzirom na to da je viša razina matematike nužan uvjet za bilo koji studij iz STEM područja, rezultat ankete sugerira da studenti pri odabiru fakulteta nisu razmatrali kao atraktivne takve fakultete. Rezultati drugog promatranog anketnog pitanja potvrđuju takvo razmišljanje, odnosno pokazuju da Učiteljski fakultet privlači dominantno studente osrednje zainteresirane za STEM područja.

S obzirom na „univerzalnost“ profesije učitelja, koji bi trebao biti podjednako dobar u svim područjima koja poučava, učitelj bi trebao motivirati učenika u svim predmetima. Očekivano je da će učitelj koji je nesklon STEM područjima znanosti takav svoj „neinteres“ prenijeti na svoje učenike (Brophy, 1986; McClure, Guernsey, Clements, Bales, Nichols, Kendall-Taylor i Levine 2017). Upravo činjenica da učitelj odgovoran za široki raspon disciplina u realnosti često znači slabu podlogu u STEM područjima (Swift i Watkins, 2004).

U američkoj studiji koja se među ostalim bavi STEM sklonostima budućih učitelja autori zaključuju da studiji predškolske edukacije i primarnog obrazovanja privlače studente barem djelomično zbog minimalnih zahtjeva za kolegijima STEM područja, kao i kasnijih zahtjeva za podučavanje istih (McClure i sur., 2017). Druga studija, na uzorku od 830 učitelja za uzraste od

predškolske dobi do 3. razreda osnovne škole pokazuje da su učitelji svjesni važnosti STEM edukacije od najranijeg uzrasta, no 30 % ispitanika ne vjeruje u prikladnost i važnost STEM edukacije u toj dobi (Park, Dimitrov, Patterson i Park, 2017).

Primjer Finske, koja se često u hrvatskim medijima apostrofira kao zemlja s uspješnim obrazovnim sustavom i čija se rješenja zazivaju, ističe kako se na učiteljske studije (za učitelje razredne nastave i predmetne nastave) upiše svega 15 % prijavljenih maturanata, što sugerira velik izbor u privlačenju kvalitetnih kadrova (Barrows, Dumitrescu, Popa i Pîslaru, 2003).

U svom radu autori Bakırcı i Karışan (2017) prikazuju rezultate ankete po kojima nema značajne razlike u STEM svjesnosti budućih studenata učitelja matematike u odnosu na buduće učitelje prirodnih znanosti (eng. science) i budućih učitelja primarnog obrazovanja. Autori to obrazlažu činjenicom da je u prijašnjem razdoblju kroz nekoliko novih kolegija na učiteljskim fakultetima u Turskoj značajno povećana edukacija u STEM područjima. Pritom se autori nastavljaju na rad Sümen i Çalışıcı (2016), koji su ustanovili da uvođenjem novih kolegija u kurikulum turskih učiteljskih fakulteta budući učitelji primarnog obrazovanja nalaze STEM obrazovanje učinkovitim, laganim i zabavnim, te posljedično imaju pozitivan stav prema STEM područjima.

Nužne su aktivnosti u osnaživanju računalnog razmišljanja kod studenata – budućih učitelja. Poseban je naglasak na obrazovanju budućih učitelja kako bi oni u svoje nastavne sadržaje uspješno ukomponirali koncepte računalnog razmišljanja. Pritom nije fokus na korištenju tehnologije kao takve nego uvođenju vještina i kompetencija računalnog razmišljanja u sve sadržaje i pedagoške temelje edukacije, uz tehnologiju kao potporu, a ne kao nužnost (Sengupta, Kinnebrew, Basu, Biswas i Clark, 2013).

Jedan od mogućih pristupa za promjenu razine računalnog razmišljanja kod studenata Učiteljskog fakulteta jest da se pri upisu na studij daje prednost (ili postavi čak kao uvjet) studentima s položenom višom razine matematike na maturi.

Moguće rješenje je uvođenje posebnog kolegija kroz koji bi studenti usvojili bitne koncepte računalnog razmišljanja, u skladu s navedenim dobrim rezultatima turskih učiteljskih fakulteta (Bakırcı i Karışan, 2017; Sümen i Çalışıcı, 2016). S obzirom na već veliki broj kolegija koje studenti moraju položiti tijekom studija, to se čini malo vjerojatno (primjerice studenti učiteljskog studija – modul informatika imaju 20 kolegija samo na prvoj godini studija).

Realniji prijedlog je u skladu s već spomenutim radom Yadav i sur. (2017) u kojem se predlaže intervencija u kurikulum i silabuse u suradnji pedagoga, metodičara i informacijskih stručnjaka, da se kroz nastavu svih predmeta inzistira na konceptima i vrijednostima koja podrazumijeva računalno razmišljanje.

Edukacija učitelja ne smije stati na formalnom obrazovanju tijekom studija. Osim što su studijski programi često zastarjeli ili je proces redizajniranja silabusa previše trom, sama brzina promjena u informacijsko-komunikacijskim tehnologijama uvjetuje kontinuiranu edukaciju učitelja. Pozitivna okolnost je u velikom broju alata i resursa dostupnih za slobodno korištenje u nastavi, besplatnih za korištenje, unaprjeđivanje i daljnje dijeljenje. Lockwood i Mooney (2017) u preglednom radu navode više od 50 raznih alata, softvera, programskih jezika itd. koji su bili temelj istraživanja računalnog razmišljanja u edukaciji. U Tablici 1. oni su nabrojani, uz napomenu da se broj stalno povećava kao i sadržaji za slobodno dijeljenje i korištenje temeljeno na tim alatima.

Tablica 1. Alati korišteni za istraživanja računalnog razmišljanja

Agentsheets/AgentCubes Algo.Rhythm Alice App Inventor Ardublock Arduino Bebras Binary toy BingBee Blockly Bord Game - Pandemic Bunny Bright CargoBot CHERP Code Bits CS Unplugged CTArcade CTSiM CyberPLAYce DigitMile Dragon Architect Drawing Machine Model Entry Escape Machine Game Maker Greenfoot HTML	Java Lego Mindstorms Lego WeDo Lightbot Lilypad Arduino littleBits Logo Maple MATLAB Minecraft NetLogo Program your robot Pyonkee Python RaBit EscApe RAPTOR RuBot Scratch Simulation Creation Toolkit STAGE SUMO The Incredible Machine VPython

Za ilustraciju su istaknuta dva dobra primjera iz prakse kako osnažiti računalno razmišljanje kod učitelja razredne nastave:

- GLAT projekt- *Games for Learning Algorithmic Thinking* (eng. igre za učenje algoritamskog razmišljanja) ("GLAT project", 2019). Učenje s pomoću igre je novija teorija učenja, prihvaćena kao motivirajuća za učenike, no pritom se pravi razlika između igranja igre i izgradnje same igre. U potonjem slučaju motivacija učenika je veća, a time i proces učenja efikasniji (Vos, Van Der Meijden i Denessen, 2011).

  GLAT je Erasmus+ projekt Odjela za Informatiku Sveučilišta u Rijeci, s partnerima iz Slovenije, Estonije, Makedonije i Bugarske. U fokusu projekta su učitelji razredne nastave i posredno učenici u razredima tih učitelja. Organizirane su tri radionice i dizajniran Moodleov e-tečaj na kojima su učitelji upoznati s principima učenja s pomoću igre, konceptima

algoritamskog razmišljanja, digitalnim alatima za izradu igre i scenarijima poučavanja. Kroz radionice i dizajnirane aktivnosti, koje naglašavaju „if-then-or else“ logiku igre ili priče, polaznike – učitelje razredne nastave se educira o algoritamskom načinu razmišljanja, što je jedan od koncepata računalnog razmišljanja. Primijenit će naučeno u svojem radu s učenicima 1. do 4. razreda, nakon čega slijedi evaluacija uspješnosti projekta (Hoić-Božić, Dlab, Prskalo, Rugelj i Šerbec, 2018).

- *CS Unplugged project* je projekt osmišljen za učenje kako funkcionira računalo, za uzrast od 5 do 10 godina, kroz niz osmišljenih igara i aktivnosti bez upotrebe računala (“CS Unplugged”, 2018). Kreatori su sa Sveučilišta Canterbury, Novi Zeland i surađuju s privatnim tvrtkama kao što su Google, Microsoft itd. Autori su razradili niz aktivnosti za razvoj aspekata računalnog razmišljanja u razredima, koje se slobodno mogu dijeliti među učiteljima, modificirati i unaprjeđivati te svaki učitelj može kreativno pridonijeti na dobrobit svih.

Zaključak

Iako je pojam računalnog razmišljanja potekao iz informacijsko-komunikacijskih znanosti, danas treba razlikovati domenu informatike (programiranje, informacijske znanosti) od domene računalnog razmišljanja.

Da bi se ostvario napredak u razvoju računalnog razmišljanja u općoj populaciji, potrebno je u što ranijoj dobi edukaciju oblikovati u tom smjeru, s naglaskom na edukaciju samih učitelja. Računalnom razmišljanju u obrazovanju nije cilj osposobljavanje za programiranje ili obrazovanje informatičara nego učenje vještina rješavanja problema digitalnog svijeta, odnosno obrazovanja učenika 21.stoljeća.

Anketa prikazana u ovom radu pokazuje da studenti Učiteljskog fakulteta Sveučilišta u Zagrebu nisu skloni STEM područjima znanosti, čime se dovodi u pitanje razina računalnog razmišljanja koju će prakticirati u budućem radu s učenicima najranijeg uzrasta.

U ovom radu se predlaže privlačenje studenata s višom razinom položene matematike na maturi, što implicira i višu sklonost STEM područjima. Također se predlaže intervencija u edukaciji budućih učitelja, na način da se aspekti računalnog razmišljanja mogu učiti kroz niz fakultetskih kolegija (a posljedično u nizu školskih predmeta); odnosno, ne bi trebalo aspekte računalnog razmišljanja vezati samo za matematiku, informatiku ili prirodne predmete.

Nadalje se u radu naglašava da edukacija učitelja ne smije stati diplomom na studiju. Pozitivan je entuzijazam velikog broja učitelja, znanstvenika i privatnih tehnoloških tvrtki da svoje ideje i radove učine masovno dostupnima u svrhu bolje edukacije i popularizacije računalnog razmišljanja. Time neformalno obrazovanje učitelja dobiva nove mogućnosti za cjeloživotnu edukaciju kroz niz dostupnih aktivnosti – projekata, natjecanja, repozitorija koji implementiraju suvremene načine učenja: učenje temeljeno na igri, kroz razne oblike interaktivnog nadmetanja, učenje kroz solidarno dijeljenje znanja i resursa među sudionicima procesa učenja itd. Pri tome je suvremeni IKT postao katalizator inovativnosti i kreativnosti, a ne tek puko sredstvo za rad.

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Computational Thinking of Future Junior Primary School Teachers

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Abstract

Computational thinking has become a widely accepted term for universally applicable concepts, attitudes, and skills characteristic for the STEM field of science as well as the area of information science. It is considered essential for successful functioning in the technology-perceived society of the 21st century. It is necessary to integrate computational thinking into the teaching process, with a significant teacher's role. In the Republic of Croatia, in the new Curriculum of Computer Science "School for Life", computational thinking is accentuated as one of the four fundamental elements.

The paper analyzes the first and second-year students' surveys at the Faculty of Teacher Education in Zagreb about the preferences of STEM areas of science. Out of the 144 students, only 27 percent of graduate students had a higher math level (A level), and only 9 percent of respondents expressed a "pronounced" tendency to STEM areas (88 percent expressed "moderate" and 3 percent "none"). At the same time, Croatian students show below-average scores on PISA tests in all categories, as recorded in the last four test cycles in which the Republic of Croatia participated. Quality education places demands for teachers to apply the strategies and content that would help students develop creativity and motivation for a wide range of subjects. It is to be expected that the lack of interest in the STEM area will be passed on by future teachers to new generation students, and result in poor performance on objective testing.

In addition, the paper gives examples of good practice in the development of computational thinking of classroom teachers and their students. The Project for Learning Algorithmic Thinking (GLAT) is presented, whose focus is on primary education teachers and indirectly on their students.

Finally, proposals are presented for integrating the concepts of computational thinking into the teaching of students - future teachers at the faculties of teacher education through a separate course, as well as the existing courses.

***Keywords**: computational thinking; junior elementary school teachers; STEM*

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Training for Lifelong Learning and Information and Communication Technology

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Abstract

This paper presents the authors' vision of the role Information and Communication Technology (ICT) plays in the process of training for lifelong learning. It is based on project questionnaire data on Developing Teacher Competencies for a Vocational Education Training (VET) Comprehensive in Albania (TEAVET), for an in-depth analysis of needs concerning LifeLong Learning (LLL) training. The main aims of the questionnaire were to define ways in which LLL on pre-university education issues could be encouraged effectively through the precise definition of the topics of the teacher training modules that derive from their real needs, to define the desired learning outcomes of the training courses for teachers and to enhance teacher competences for a comprehensive VET system. It is handled through seven modules. Authors make estimations based on data from questionnaires from 394 participants in the northern part of Albania, including pre-university teachers, school leaders, university staff, teacher association members, administrative staff at university/laboratory technicians, in order to support the teaching process. General information such as gender and age are followed and focused by the topics that are related to ICT, as they are: personal knowledge and need for ICT use, social software, Learning Management System (LMS) that they use, ICT equipment that meets needs, wireless network, use of ICT according to the curriculum, utilization of digital teaching materials, need to enhance digital skills, improve their digital pedagogy and wider digital competences, use the internet to update knowledge or skills in various learning situations, are base of the study. The results show these topics as a priority at the present stage.

Key words: *digital competences, digital devices, e-pedagogy, pre-university education*

Introduction

Teachers face a lot of challenges in a rapidly changing world which requires a new set of sophisticated and broad competences more than ever before. Digital devices are in our everyday lives, and they require teachers to develop their digital competence. The European Framework for the Digital Competence of Educators (DigCompEdu) is a scientifically sound framework which describes what it means for educators to be digitally competent. DigCompEdu defines six areas needed to seize the potential of digital technologies for enhancing and innovating education: educators` professional competences, educators` pedagogic competences and learners` competences, professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners` digital competence. Redecker, C. (2017).

"The European Commission updated the Recommendations for Key Competences for Lifelong Learning in 2018. Among other things, these include recommendations to promote a variety of learning approaches and contexts, including the adequate use of digital technologies, in education, training and learning settings" LLLP, n.d.-b (2018).

The MENTEP project (Mentoring Technology-Enhanced Pedagogy) looks at self-assessment of teachers' pedagogical competence as a promising new approach to encourage teachers' self-reflection and intrinsic motivation to develop their pedagogical ICT competencies.

It has the potential to result in a more relevant, effective or innovative use of ICT in schools. They developed the TET-SAT tool for the self-assessment of teachers, which can be adapted to anyone's context. This tool can help improve teachers' competence and confidence when it comes to using ICT in the classroom. MENTEP, n.d.(2018).

When it comes to "digital competence", Tabetha Newman says: "A digitally competent person has effective ICT skills, an ability to critically evaluate information, and social awareness. That is to say, they can use the most common technologies to safely find and/or publish digital resources, commonly via the internet. They can critically evaluate what they find, remembering that people and knowledge – even with good intention – can be fallible. They understand internet 'etiquette', and consider the appropriateness, consequences and longevity of information before broadcasting information online." Newman. T (2018).

Everyone should benefit from digital technologies. Therefore, it is important to foster digital and media literacy among learners. This is the only way learners can benefit from the potential of new technologies for their further education. The main barriers to this are of technological nature, but also linked to attitudes, interests and abilities. All these issues have to be considered when using technologies for learning. LLLP, n.d.-b (2018).

Key competences for lifelong learning are the competencies expressed through the use of knowledge, skills, values and attitudes in the full and comprehensible handling of contextual situations. The aforementioned developments and the need for educational change make it clear that there is a necessity for lifelong learning. Citizens of an educated society need to develop knowledge, skills, values, and attitudes as well as personal and social connections related to the world of work and the free market. The education process will enable each student to master the key competencies needed for life and work. The ways and methods through which people access information and services today are constantly changing. For this reason, all ages need to be equipped with new competences that help them adapt to today's digital world, not only through gaining technical knowledge and skills, but also through a deep understanding of opportunities, challenges and ethical issues, legal and social issues that arise from or accompany new economic, social and technological developments. These changes raise the necessity of possessing the competences that enable individuals to manage changes and new situations. CFPUEA. (2014)

In the Curriculum Framework of Pre-University Education in Albania (CFPUEA, 2014), based on the best European experience, Digital Competence is considered one of the core competences. It is one of the seven competences that students should have upon completing this study cycle. Digital Competence is paraphrased as follows:

1. Student uses technology to foster innovation
2. Uses some applications like: Word, spreadsheets, databases etc.
3. Gathers and processes information available from the Internet or electronic communications.
4. Evaluates the risks arising from the Internet or electronic communication.
5. Judges on the authenticity of information and on ethical and legal principles in the interactive use of ICT.
6. Uses ICT to develop critical and creative thinking.
7. Identifies, analyses, and uses problem-solving application systems.

In short, it should be understood as a competence that which encompasses critical and effective use of ICT in work, leisure and communication. It relies on the basic skills of computer use in the 21st century to find, produce, create, present and exchange information, and to participate in information networks on the Internet.

Teacher Training in Albania

This was carried out over the years in Albania with the aim to improve the preparation of teachers at all levels of pre-university education, which in recent decades has changed the structure and contents towards reaching European standards. This is something both the country and the army of teachers want to be a part of. Professional training of pre-university teachers is managed by Instruction No. 1/488, date 20.01.2017/ of MESY: "On the functioning of the system of continuous professional development of educational employees",
this instruction is quoted:

1. Teachers and principals train at least three days a year.
2. A training day consists of 6 hours, with 3 hours of training with a trainer or study of program / module material by the trainee and 3 hours of individual work by the trainee to prepare their tasks.
3. Three training days contain 18 hours of training and reflect 1 credit MESY. (2017).

This process was preceded by an important document, namely the Development Strategy of the Pre-University Education 2014-2020. DSPE. (2014-2020)

The pre-university education has been in the process of reforming of its curricula under the guidelines of the DSPE2014-2020, whose main focus is on learning outcomes. The Strategy also reflects “the consensus between the academic community, education professionals, civil society and educational stakeholders in the higher education. It offers to teachers qualification, the design of coherent systems for the (…) professional development of the in-service teacher (based on clearly defined competencies (…) and the improvement of the digital competence of the teachers on duty.” DSPE. (2014-2020)

This process was preceded by the National Report “Identifying the Needs for Training of School Principals and Teachers in Pre-University Education” INTSPTPUE. (2016)
With the latest developments in all spheres of life, especially ICT, there has been a need to update teachers' knowledge, so naturally in our country a new type of education called Life Long Learning (LLL) will also be implemented. It is an education that has been developed mainly through various projects with local and foreign donors such as Erasmus Plus.

The Ministry of Education Sports and Youth (MESY) has the task to lead this process via the institutions under its supervision. The project in question, TEAVET (TEAVET, 2017-2020), has also served as the need to move to a new stage of training where even MESY through Quality Assurance Agency for Pre-University Education QAAPE - (ASCAP) is a partner.

Portal Training in Albania **PTA** (https://trajnime.arsimi.gov.al/)

This is a novelty for Albania and a consequence of the development of this sector which improves the training of teachers of pre-university education and brings them closer to their European counterparts.

- It is managed by the Quality Assurance Agency for Pre-University Education QAAPE (2019)-(ASCAP), which is part of the former Institute for Development of Education (IDE-IZHA). The QAAPE's mission is to provide the Ministry of Education, Youth and Sports and educational institutions of all levels with expertise and advice on a high professional level, based on the results of scientific/research work and education practice.
- To apply for the module training included in the TEAVET project, all one has to do is click on the following link, and teachers select courses by agency or/and module. This was originally done with the pilot projects implemented by each university on this project. https://trajnime.arsimi.gov.al/Trajnimes/TrajnimeTeavet
- AAN-(RASH) – Albanian Academic Network (Interuniversity Center of Services and Telematics Network) carries the information from these services. RASH (2019)

TEAVET Project

Developing Teacher Competences for a comprehensive system in Albania - TEAVET (Developing Teacher Competencies for an Inclusive ATP System, Vocational Education & Training) (https://teavet.org/) in Albania, supported by European Commission (Erasmus Plus Project Capacity Building), aims at:

- Defining a strategy for a comprehensive teacher system emphasizing the contribution of universities as the main providers of continuing vocational education for a high quality in the qualification process. This objective will be achieved by European and Albanian partners in Albania in cooperation with the Ministry of Education, Sports and Youth (MESY);
- Creating new expertise and training standards for teachers at Albanian universities through the organization of training seminars for Albanian universities and training visits to European universities;
- Establishing specialized Teacher Training Centers according to the MESY strategy and the needs of the teachers;
- Developing teacher training courses programs for different levels of science education, methodology, pedagogical issues, ethics and ICT use in learning according to European standards;
- Designing and developing a new academic methodology that consists of applying credits at the MESY for teacher training;

This also includes the creation of digital structures (video projectors, interactive labs, smart boards, laptops, etc.) at Albanian universities that support the process of training and qualification of teachers.

Methods

The basis for the observation method of this study is a survey.

Firstly, a questionnaire was created carrying the title “An in-depth analysis of needs concerning lifelong learning training of pre-university teachers, school leaders and teacher associations, as well as university staff”. The lifelong learning system as a whole offers studying opportunities that are of good quality, modern, flexible and cater to the special needs of the learner. The survey was anonymous and completely voluntary. The findings from this survey will be used to inform and enhance our program in order to meet interests and needs.

The main aims of the questionnaire were:

A. To define ways in which lifelong learning relating to pre-university education issues could be stimulated effectively.
B. To define the desired learning outcomes of the training courses for teachers in order to enhance teacher competences for a comprehensive VET system.

It includes handled-through-modules: Introduction; Personal knowledge and need for ICT use; Training received; Motivation to participate in courses; Resources; Teacher training needs; The gap perceived.

University of Shkoder (USH)

USH is one of the most important institutions and the biggest center of education, scientific research and culture in Northern Albania (it is the only one in this region). It was first founded as High Pedagogical Institute and later became a university, so it also has an impact on the regional level as part of the TEAVET Project. It has 6 faculties and 21 departments and offers study programs in Bachelor, Master and PhD in Albanian Studies. USH's faculties have had a very good experience in the process of teacher training over the years.

General Information on the survey in Shkoder Region

The Region of Shkoder, Northern Albania, has 250 000 inhabitants. The population of pre-university education staff (teachers, leaders of schools) there is presented in the tables below:

Table No. 1.

Population[1] of pre-university education staff in the Region of Shkoder

No.	Category of Participants in Questionnaire	All	Female
1	Pre-university Education/Low education KI-K6	638	559
2	Pre-university Education/Low middle Education	970	644
3	Pre-university Education/High middle Education[2]	629	400
4	Pre-university Education /teacher associations member[3]	NA	NA
5	Pre-university Education/others[4], if they specify	NA	NA
	Total	2237	1603
	Participants[5] in questionnaire from these categories (1+2+3+4) =277.They present 12.38 % of the population		

Table No. 2

Population[6] of University Education staff from University of Shkoder "Luigj Gurakuqi"

No.	Category of Participants in Questionnaire	All	Female
1	University Education full time teaching staff	200	131
2	University Education part time teaching staff [7]	278	199
3	University Education full time staff (administrative staff)	97	75
4	University Education full time staff (laboratory technician in support teaching process)	17	9
	Total	672	444
	Participants[8] in questionnaire from these categories (1+2+3+4) = 117. They present 17.4 % of the population	117	

Methodology

Stakeholder mapping (target groups) was by category of participants: Pre-university teacher; School leader; University staff; Teacher association's member; Administrative staff at university/ laboratory technician in support of the teaching process. We consider teachers in service as well as pre-service in Albania.

[1] Distribution of participants: questionnaires were distributed randomly to accomplish approximately proportions of population by all above categories including gender

2 This number also included teachers of Vocation Education Training (VET) schools (they are not at administration of Ministry of Education, Sport and Youth, but under administration of Ministry of Finance and Economy.

[3] This number is included at the categories 1+2+3

[4] This number is included at the categories 1+2+3

[5] Number of questionnaires that are correctly fulfilled.

[6] Distribution of participants: questionnaires were distributed randomly to accomplish approximately proportions of population by all above categories include gender

[7] University Education part time teaching staff have the following background: Faculty of Education/Foreign language/Social Sciences have their main job at Pre-university Education; Faculty of Natural Sciences/Economy are partially from Pre-university Education.

[8] Number of questionnaires that are correctly fulfilled.

Survey

This survey was conducted through the delivery of questionnaires (both forms, paper-based and electronic, were used). Danube University Krems developed a questionnaire to find out what the needs of Albanian teachers and university staff were. Distribution of participation questionnaires was done randomly to reach approximate proportions of population by all categories. General information concerning the participants includes categories (target groups) such as: pre-university teacher, school leader, other university staff, teacher associations member, gender, age, years of experience in the pre-university/university education and subject field. They are as shown in table below.

Table No. 3.

Categories of participants in questionnaires

	Category of participants	
1	Pre-university teacher	253
2	School leader	24
3	University staff	106
4	Teacher associations member	0
5	Administrative staff at university/ laboratory technician in support teaching process)	11
	Total	394

Results & Discussion

First Module

It relates to general information: gender, age and work experience in education of the interviewed people.

The following charts present information concerning gender, age and work experience in education of the interviewed people (pre-university and university).

1. Gender of participants:

Table No. 4

Distribution of participants by gender

	Gender		%
1	Female	269	68
2	Male	125	32
	Total	394	100

The majority of participants from questionnaires are female, as is the case in reality at schools. Work in education Institutions, especially in pre-university education is preferred more by women than men.

2. Age of participants:

Table No. 5.

Distribution of participants by age

	Age	No.	%
1	18-25	36	9.1
2	26-35	83	21.0
3	36-45	123	31.2
4	46-55	48	12.1
5	56 +	104	26.3
	Total	394	100

The prevailing ages are 36-45, 56 +, 26-35, which should be considered as middle and end-of-career teachers, whereas the smallest group are the people age 18-25, i.e. the generations that have just come out of university auditoriums. Generally, some of these clusters of generations are those that are most in need of lifelong learning, especially when it comes to ICT.

3. Years of experience in pre-university education

Table No. 6.

Distribution of participants by the years of experience in pre-university education

	Years	No.	%
1	1-5	30	7.6
2	6-10	43	10.9
3	11-15	76	19.2
4	16-20	84	21.3
5	20 +	161	40.8
	Total (1-20+)	394	100

This table is more significant. The largest number of participants have more than 20 years of experience in pre-university education, but the number participants from all other groups (1-5, 6-10, 11 -15, 16-20 years) is still higher. This indicates that training should focus more on generations that have more years of work on duty as well as supplementing and updating their knowledge.

4. Years of experience in university education:

Table No. 7.

Distribution of participants by years of experience in the university education

No.	Years	No.	%
1	1-5	14	11.9
2	6-10	16	13.6
3	11-15	19	16.2
4	16-20	22	18.8
5	20+	46	39.3
Total	1-20+	117	100

The situation here is very similar to the chart above, but in this case it has nothing to do with pre-university education but with university education. It has almost the same correlation with the previous table that relates the years of experience to the number of participants in relative terms or percentage.

Second Module

1. Which social networks do the participants use?

Table No. 8

Distribution of participants by social networks

	Social network	
1	Facebook	344
2	Twitter	86
3	Google+	68
4	LinkedIn	138
	Total	

Considered trendy for generations of participants, they primarily use Facebook, followed by LinkedIn, Twitter, Google+. We see very positively that in the second instance it is LinkedIn where participants share professional experiences, which is more characteristic for academic staff of universities.

2. Would you like to exchange professional experiences on a social network?

Table No. 9

Distribution of participants relating to the exchange of professional experiences on a social network

	Exchange of professional experiences on a social network	Yes	No
1	Participant	149	255

Even the interviews show that the majority of participants consider social networks as something separate from their teaching profession. Indirectly, we can say that most of them are from LinkedIn, where this is normally accomplished. This tradition has to do with the degree of their awareness, but also with an even greater extension of Information and Communication Technology in all fields of life including education.

3. Which devices do the participants use?

Table N. 10.

Distribution of participants by the devices they use

	Device type	No.
1	Smartphone	345
2	Tablet	66
3	Laptop/Computer	211
	Total	394

Smartphones are the most prominent category, followed by the Laptop/Computer category, while tablets come in last.

- Smartphone functions today not only as a means of communication, and we can say that these devices are ubiquitous, but also trending especially among younger teachers. It remains to be argued how much these are used in teaching, given that their use is prohibited on the premises of schools for pre-university education in Albania.
- The use of laptops/computers is considerable (more than half of the participants use them), and it is currently the basic device through which all tasks are completed.
- The tablet ranks third, and it depends on the economic level of the family/participant whether they will have it. The tendency in other developed countries is towards complementing and implementing all the necessary activities of a teacher with this device, coupled with the facilities, to allow for easy and efficient use. The mindset that this is just for fun activities and news must be broken.

The authors have formulated a table (this was not foreseen in the questionnaire) with possible interferences/combinations of devices used by the group of participants on the basis of the table above. The goal was to get a wider picture considering that the use of one device does not exclude the other.

4.1 Which combination of devices do participants use?

Table No. 11

Distribution of participants by the combination of devices that they use

	Name of devices that use	
1	Smartphone+ Tablet	411
2	Smartphone+ Laptop/Computer	556
3	Tablet + Laptop/Computer	277
4	Smartphone+ Tablet+ Laptop/Computer	632

- At the top is the Smartphone + Laptop / Computer category, ahead of even all three (Smartphone + Tablet + Laptop / Computer) options. This stems from the widespread use of the smartphone, but also as a combination of the work of generations of ICT devices stemming from the variety of users' ages. This obliges teachers to generate even more work with these devices (including tasks that teachers solve at home and provide for their students more exercises at home for the reason that the use of some devices in schools is banned in this education system), but it also comes as training opportunities for teachers in this regard.

- In the second place is the Smartphone + Tablet category. This should be considered as a development tendency in our country, but they are also complementary devices. Something to be considered by the organizers of training modules in their work and their material planning should include devices like smartphones and tablets in the second phase of the project as they have been seen at western partners.

- Third place: Tablet + Laptop / Computer. This should be regarded as a figure almost stable having in mind the trends of sales / their use such as reduction of computers and increase in sales of laptops / tablets, but also further wide.

We can argue that they are complementary to each other in terms of functions, but their proximity to use persists also as global trends. It should be used as an opportunity of even more significance in the relevant modules training courses, especially those related to ICT and their applications in education.

5. Personal knowledge and need for ICT use.

Table No. 12

Distribution of participants by personal knowledge and need for ICT use

		1	2	3	4	5	6
	Personal knowledge and need for ICT use	I don't know	I know	I use personally	% related column 3	I use for teaching	% related column 5
1	Moodle	326	68	47	69 %	31	65 %
2	Mahara	390	4	2	50 %	1	50 %
3	Prezi	359	35	31	56 %	26	83 %
4	Kahoot!	392	7	4	57 %	2	50 %
5	Padlet	391	9	5	55 %	3	60 %
6	OneNote Class Notebook	364	30	12	40 %	6	50 %
7	Socrative	371	23	11	47 %	5	45 %

8	Google Forms	273	121	83	67 %	31	37 %
9	Google Classroom	207	187	101	54 %	48	47 %
	Total				Average 55 %		Average 54 %

We think that the figures in column 1 and 2 are complementary to each other as columns 4 & 6 are derived from columns 2 & 3.

- Google Classroom and Google Forms stand out first and foremost in terms of the participants' knowledge when analyzing the positions of the second column. This is a good basis where we should rely on the principle of preparing teaching materials in these practical and contemporary forms as models originally used in higher education and the training for pre-university education. Normally there is a flow from *I know* to *I use personally* and *I use for teaching* but that needs to be considered. Considerable is the number of those who do not know, this will be solved by including them in the training modules of these elements, but also by inclusion of such knowledge in higher education curricula that prepare teachers, both in Bachelor and Master programs (in disciplines directly or indirectly related to ICT and teaching or Education Technology)
- In third place is *Moodle, a* promising figure for pre-university education given its beginnings in higher education. Since the training materials of all training modules will be on this platform, a detailed plan will be needed to achieve the apprenticeships and work commitments with it in the first training sessions. So you should invest heavily without underestimating the two previous products. The advantage is its use in Albanian language which is free/open source (of course the connection with relevant guides is indispensable).
- In fourth place are *OneNote Class Notebook* and *Prezi*. These give some help to the notes and the attractive form of presentations as an advanced version of PowerPoint. Likewise, *Socrates* should be seen as necessary in the professional development of teachers at the present stage of their development which must be achieved naturally.
- *Mahara, Kahoot !, Padlet* have smaller and almost negligible figures and any interest in them when it comes to teaching is not noticeable.
- The figures of column 4 represent the percentage the numbers in column 3 have in the overall number of people who know of these programs. They range from 40 % to 69 %, with the average being 55 %.
- The figures of column 6 are the percentage related to column 5. They range from 37 % to 83 %, with the average being 54 %.
- We see that the descending gradients of column 2, *I know* towards the other two columns *I use personally* and *I use for teaching* are almost equal at 55 % and 54 %, respectively.
- Analyzing the data of the first column, which presents *I do not know* as a lack of knowledge, we note that in this respect there is a significant lack of knowledge according to the required items. There is superficial knowledge in most of them, although incomplete, which makes even more evident the increasingly specific weight of ICT content in relation to other training modules. It should be noted that pedagogical disciplines are inert and change slowly in comparison to those related to ICT.
- Implementing modern technologies in teaching, especially ICT, can be made easier by “e-pedagogy”, understood as a type of pedagogy developed in the digital area with the accompanying tools; or as the pedagogy of e-learning that is used in different forms.

- The authors note that the questionnaire should be calibrated for the first time with the country's specific conditions in mind - responses of participants especially in this question show this issue.

6. Please answer the following questions with Yes/No

Table No. 13

Some questions that are related generally to ICT.

	Questions	1	2	3
	Please answer the following questions with Yes/No	Yes	% of yes	No
1	My employer has provided me with ICT equipment that meets my needs.	68	17 %	326
2	I receive sufficient technical support with sufficient speed for ICT use at my school.	42	11 %	352
3	Does your school have a wireless network that is also accessible to students and visitors on their own devices?	36	09 %	358
4	Does your school have a pedagogical support person available to help with using ICT in education?	28	07 %	366
5	I know how to utilize digital teaching materials in my teaching.	59	15 %	335
6	It is hard for me to find high-quality digital materials for the topics being taught.	219	55 %	175
7	I am familiar with the principles of using Creative Commons licences.	35	09 %	359
8	I find good ways to utilize ICT in various learning situations.	64	16 %	330
9	It is easy to make use of information and communications technology (ICT) according to the curriculum.	66	16 %	328
10	I know that I need to enhance my digital skills, but I am unsure how and where to start.	165	42 %	228
11	I actively seek out best practices, courses or other advice to improve my own digital pedagogy and wider digital competences.	117	30 %	277
12	I only rarely, if at all, use the internet to update my knowledge or skills.	87	22 %	307
	Total		100	

- From the above table, we see that rows 1-4 have content that is related to Infrastructure and support services.
- Although in the previous year interventions have been made in this regard, again the situation is neither favorable nor appropriate for normal condition. Technology is changing faster than anything else, so ICTs devices are "getting older" quicker than anything else and need to be constantly updated according to a well planned strategy.
- This indicates the situation needs to change immediately, especially with regard to the the budget on the local and national level (pre-university education is now the responsibility of local governments).
- There is a lack of support services that are a prerequisite for normal course attendance, as well as the pedagogical support available for using ICT in schools. This should include the maintenance of ICT equipment and should be budgeted in the absence of specialized services. These services are often charged to teachers who do not have the task.
- Special attention should be paid to "digital pedagogy" or what was formerly called e-pedagogy, incorporating it into the pedagogical disciplines of the curriculum also as a separate part or module at the Bachelor and Master of Teaching programs, all of this being closely related to Education Technology.

- Also from the above table, we see that rows 5-12 have content related to knowledge, skills and information and this leaves much to be desired and is undoubtedly a reflection of the above infrastructural problems shown in rows 1-4.
- Principles of using Creative Commons Licenses are little known by teachers, especially those of (K1-K9), perhaps with the view that this only applies to those working in higher education institutions.
- Internet searches, Internet use with the goal to update knowledge or skills, ICT materials according to the curriculum as well as others may not be sufficiently present in Albanian language. Therefore, we need to work massively in this direction by translating and adapting into Albanian the most crucial materials initially.

7. Have you participated in any training for continuing professional development?

Table No. 14
Participation in any training for continuing professional development

	Question	Yes	No
1	Have you participated in any training for continuing professional development?	160	234
		41 %	59 %

The above shows that a good portion of pre-university education teachers (41 %) have attended training sessions, but not the majority, indicating that the training market has begun to expand, as evidenced by both their portal and their profiles, where they can fill the gaps that exist, especially those related to ICT.

8. Is the information about courses easily accessible?

Table No. 15
Distribution of participants by easily accessible information about courses

	Is the information about courses easily accessible?	No.
1	Yes, I know where to find such information	124
2	No, I don't know where to find such information.	106
3	Yes, but it might be more efficient.	83
4	No, I cannot find any information.	26
5	I have never searched for such information	20
6	I have no opinion.	35

- First and second rows for *easily accessible information about courses*, first with 124 and second with 106 (together 230), followed by *It might be more efficient* with 83, have to do with their knowledge, but also with improvement of information and the fulfillment of their demands in Albanian.
- The questions in row (4-5) are smaller, but row (6), together with the above reasoning, allows us to say that teachers have not yet created such information-seeking habits on the internet yet, which would be a part of our everyday culture and bring us closer towards the formation of what is called digital culture. Hasmujaj, Bushati (2015)

9. What form of studies would be most appropriate for training courses?

Table No. 16
Distribution of participants by the most appropriate form of studies for training courses

	Most appropriate form of studies	No.	%
1	Short intensive face-to face course	107	27 %
2	E-learning with face-to face meetings	185	47 %
3	Only E-learning course	67	17 %
4	I have no opinion	35	9 %
	SUM	394	100 %

- E-learning with face-to-face meetings is considered the most appropriate for training courses with 47 %. This shows that this element is recognized by the participants and continues to be required as a priority, which we consider as blended learning and is intended to be provided in the modules of the project.
- Short intensive face-to face course is a second-degree requirement with 27 %, and this represents the older generation of participants, so teachers on the verge of retirement normally consider this manner to be an efficient way of training.
- E-learning course is only third in demand with 17 % and represents the new generation of participants that have just emerged from the desks of auditoriums but are also passionate and have trust in technology. This has to be deliberated carefully because it should not be considered that everything has to be solved by technology, although the project provides the possibilities of this type of training, they will not find such equipment everywhere, especially not in rural schools.
- The *other* part is 9 %, and it should be discussed how these people can be brought into the blended learning trend.

We will mainly focus on the second module in accordance with the topic, but without breaking away from the full context. The analysis of these data, the deductions derived, give us the opportunity to evaluate the situation, the level of ICT as well as many other elements in these layers, such as the needs and requirements for their completion, but also the role that ICT should play in LLL training**.**

Results

It was found out what the needs of the Albanian teachers and university staff are (TEAVET Project):

- They need more professional competencies.
- They have needs for better ICT competencies.
- Educational innovation: Training for innovative teaching methods is desired - not just in general but in their own subject area.

The mode of delivering teachers training in Albania should be:

- Blended learning is the preferred mode of delivery, but face-to-face is also an important part of further education.

The infrastructure of Albanian schools is:

- Almost all teachers have smartphones.
- Facebook is the preferred social network.
- Infrastructure needs to be improved: many teachers/students do not have internet access at school all time.

- The most used programs in class are third-party products: Google Forms and Google Classroom.

Some of the desires of Albanian teachers are:

- Developing digital competences (searching, researching, building, developing, putting in practice, interpreting)
- Digital competences in the use of equipment and multimedia programs in the teaching process (smart boards, PPT, Prezi, learning management systems, …)
- Competence-based curricula (moving from objectives to competences, understanding competences, key competences, field competences, critical thinking)
- Innovative teaching methods: methods for specific subjects, student-centered approach, mobility (cooperation with other teachers in EU country)
- Pedagogical innovation in primary education (learning by doing, role play, national/international cooperation)
- ICT for Headmasters in school.

Conclusions

The existing infrastructure and staff competence (in pre-school and elementary education) in ICT should be evaluated. Teachers should be offered more ICT training that incorporates the principles of e-pedagogy. The training should be organized for all teachers to suit their professional needs. More investments should be distributed to pre-school and elementary education. Bilali, Bushati, Dibra, Barrolli. (2013)

E-pedagogy should be incorporated in ICT training for the teaching staff. In order to change the current situation in Albania, not only governmental efforts but also the efforts of NGOs as well as local and foreign foundations, will be required. Bilali at al. (2013)

Lewis and Whitlock (2003) conclude that e-learning is playing an increasing part in the lives of learners, learning and training organizations and Knight (2003) describes e-learning as the catalyst that is changing the whole model of learning in this century.

University training units should serve as the first indication of a formal, stable and long-term national network of teachers on duty, school headmasters, government and community stakeholders and LLL instructors, in order to restore the lost confidence of pre-university actors in the availability and usefulness of the VET system in Albania.

The proposals of LLL Modules related to Information and Communication Technology are:

On basis of the needs analysis was proposed (TEAVET 2017-2020):

1. Presentation with Digital Tools

Content: This module provides strategies how to plan, structure and deliver presentations. Participants will create a presentation for a specific didactic setting. This module will help participants engage with different target groups. Different kinds of presentation software (PPT, Prezi or Google slides) will be introduced and used during the training.

Learning Outcomes:

After successful completion of this module learners are able to …

- explain the role of a presentation within the educational design of a lesson.
- identify criteria to consider their target group's needs in their communication.
- apply main functions of presentation software (PPT, Prezi or google slides). Bates, T. (2015)

2. Blended learning with Learning Management Systems

Content: "'Blended learning' designates the range of possibilities presented by combining Internet and digital media with established classroom forms that require the physical co-presence of teacher and students." Friesen, (2012) Blended learning approaches can be effective

means of optimizing student learning and improving student performance in the class. Blended learning is supported by learning management systems (LMSs). On the example of *Moodle,* the participants will get an introduction into blended learning concepts.
Learning Outcomes:
After successful completion of this module learners are able to …

- describe the concept of blended learning.
- align different Moodle activities with Bloom's revised taxonomy of cognitive processes.
- evaluate the educational design of a blended learning scenario.

3. Digital tools for learning/teaching (TEAVET 2017-2020):

Content: In this module teachers will learn new pedagogical models, which will help them choose the right platform/tool for their classroom.
Learning Outcomes*:*
After successful completion of this module learners are able to …

- analyze a learning scenario using digital tools based on Bloom's revised taxonomy.
- analyze a didactic scenario using digital tools based on the SAMR Model.
- choose digital learning activities based on predefined learning outcomes.

4. Media Literacy and online communication

Content**:** How to build a network for exchanging good practices of teaching experience? This module will help participants to share learning and teaching experiences with colleagues to improve their teaching and that of their colleagues. It will help them exchange and connect with teachers and other stakeholders in Albania and other countries to improve the quality of education.
Learning Outcomes:
After successful completion of this module learners are able to …

- use online tools for collaboration (sharing, assessing, giving and receiving feedback).
- moderate online learning communities.
- communicate through a variety of social media channels.

5. Media Literacy in a digitalized world (TEAVET 2017-2020):

Content**:** Topics of this course are digital Footprint, WhatsApp, Instagram, Facebook, Snapchat, chain letter, cyber-mobbing, copyright, passwords, publication online, antivirus programs, add-ons, protection from tracking, sexting, cyber-grooming, Internet of Things.
To handle these topics in the class, teachers need good media literacy. In this module teachers get basic knowledge about Internet, social media and possible problems for students.
Learning Outcomes:
After successful completion of this module learners are able to …

- evaluate information presented through a range of digital channels.
- navigate between online sources and select information.
- protect their devices from online risks and threats.
- recognize cyber-bullying in the classroom.

6. Training courses for school principals

One of the main issues for Albanian partners is the management of schools. There is a need for improvement in this sector. This is why the modules are proposed to tackle the issues that Albanian principals have to handle, also aid them in the direction of Information and Communication Technology.

Technology, especially Information and Communication Technology that is evolving the world, is something that is rapidly changing and has a tendency to become increasingly involved in other sciences (be that in content or teaching), so this must be the line that should be to guide us in training for lifelong learning of our pre-university education teachers in today's stage of

Albanian society development, to bring out better and better students, because they are our future. We also think that discussing the above issues, while serving as an academic treatment, may also help trainers of different profiles in further dealing with the modules that they will be presenting on teachers' training website.

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Multimedijski e-udžbenici u primarnom obrazovanju

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Sažetak

Znamo da učenici lakše savladavaju nastavni sadržaj korištenjem multimedijskih sadržaja. Multimedijski e-udžbenici olakšali su takvu nastavu jer obuhvaćaju videozapise, fotografije, zvučne zapise i razne medije na jednom mjestu. Multimedijski su e-udžbenici prije nekoliko godina ušli u škole. Da bismo saznali koliko se zapravo učitelji koriste multimedijskim e-udžbenicima u nastavi, kojim se elementima koriste unutar multimedijskih e-udžbenika, što smatraju korisnim, a što nepotrebnim te što im nedostaje unutar multimedijskih e-udžbenika, proveli smo istraživanje na prigodnom uzorku hrvatskih učitelja. Multimedijski e-udžbenici danas nude različite mogućnosti pripreme, provedbe i evaluacije nastavnih sadržaja. Velike mogućnosti primjene e-udžbenika otvara i način pristupa njima putem tableta i mobitela, što zasigurno povećava njihovu uporabljivost i dostupnost današnjim učenicima. U hrvatskim školama mogu se naći različiti multimedijski e-udžbenici koji se mogu koristiti u skladu s kurikulumom primarnog obrazovanja. U ovom radu prikazat će se mogućnosti multimedijskih e-udžbenika i njihova primjena u nastavi i izvannastavnim aktivnostima.

Ključne riječi: *multimedija; multimedijski e-udžbenici; obrazovanje; obrazovna tehnologija*

Usprkos mogućnosti primjene novih tehnologija i didaktičkih spoznaja, većina nastave u školama još uvijek je orijentirana na učitelja te je uglavnom frontalnog oblika. Nažalost, ovaj oblik nastave ne motivira učenika na sudjelovanje u nastavnim aktivnostima. Učenici ne žele biti pasivni promatrači ili pasivni sudionici nastavnog procesa. Matijević smatra da je jedan od mogućih problema zapravo i vremenski okvir od 45 minuta nastavnog predmeta, koji ne ostavlja dovoljno vremena učiteljima za rad s multimedijskim nastavnim sadržajima. (Matijević & Topolovčan, 2017)

Primjena informacijsko-komunikacijskih tehnologija u pripremi i izvođenju nastave omogućuje promjene u nastavnom procesu. Karakteristike digitalnih medija nadilaze ograničenja klasičnog nastavnog modela. Svjesni smo da digitalne multimedijske tehnologije omogućuju promjene u nastavnom procesu tako da cjelokupne ili dijelove nastavnih sadržaja prikazuje s pomoću digitalnih medija. (Dumančić, Greguric, & Bushati, 2010) Mayer navodi kako multimedijsko učenje poboljšava proces učenja i učenici bolje pamte sadržaje koji su prikazani s pomoću multimedijskih elemenata poput fotografija, videozapisa, simulacija, zvučnih datoteka, 3D prikaza nego kroz sadržaje prezentirane samo s pomoću teksta. (El Saddik, 2001; Mayer, 2014)

No, s obzirom na ova znanstvena iskustva ali i dostupnost IKT tehnologije u školama i kod kuće, možemo pretpostaviti da postoji okvir za veću i kvalitetniju primjenu multimedijskih nastavnih sadržaja. Ovo su primijetili i učitelji entuzijasti pa samostalno i kroz različite web grupe i portale kreiraju i slobodno razmjenjuju multimedijske nastavne materijale. Zadnjih nekoliko

godina u Republici Hrvatskoj to su prepoznali i nakladnici školskih udžbenika te su započeli nuditi učiteljima i roditeljima multimedijske e-udžbenike koji nadopunjuju i obogaćuju nastavni proces.

Multimedijski e-udžbenici

Do danas udžbenik uglavnom predstavlja osnovnu literaturu nastavnog predmeta u osnovnim i srednjim školama. Iako se udžbenici razlikuju ovisno o nastavnom predmetu za koji su namijenjeni, ipak ih karakterizira metodičko i didaktičko oblikovanje. Postoji više definicija udžbenika. Zbog važnosti udžbenika u obrazovanju, Zakonom je propisan pojam udžbenik:

> *Udžbenik – nastavno sredstvo namijenjeno višegodišnjoj uporabi, usklađeno s Udžbeničkim standardom, koje se objavljuje u obliku knjige, a može imati i drugu vrstu i oblik ako je tako propisano Udžbeničkim standardom, a služi učenicima kao jedan od izvora znanja za ostvarivanje odgojno-obrazovnih ciljeva utvrđenih nacionalnim i predmetnim kurikulumom. (Zakon o udžbenicima za osnovnu i srednju školu (NN 27/10))*

Iz ovog određenja vidimo da udžbenik mora biti prilagođen učenicima s ciljem stjecanja uvjeta ostvarenja odgojno-obrazovnih ciljeva. Naime, da bi udžbenik bio izabran kao literatura za nastavni predmet on mora zadovoljavati zahtjeve i standarde propisane zakonom. U Zakonu se Udžbeničkim standardom utvrđuju *„...znanstveni, pedagoški, psihološki, didaktičko-metodički, etički, jezični, likovno-grafički i tehnički zahtjevi i standardi..."* (Zakon o udžbenicima za osnovnu i srednju školu (NN 27/10))[9] koje svaki udžbenik mora zadovoljavati.

Multimedijski e-udžbenici su elektronički nastavni sadržaji koji u potpunosti ili djelomično prate nastavni kurikulum. To su uglavnom samostalni multimedijski nastavni sadržaji kojima se učitelj može koristiti u nastavnom procesu kao osnovnim ili dodatnim nastavnim sadržajima i aktivnostima, no važno je da je obogaćen raznovrsnim interaktivnim sadržajima koji u svakom trenutku mogu učenicima pružiti povratnu informaciju. Multimedijski e-udžbenici mogu biti dostupni putem web središta ili na drugim digitalnim medijima (CD, DVD, USB itd.) Prvi primjerci e-udžbenika nisu bili multimedijalni nego su bili primjerci elektroničkog dokumenta najčešće u pdf obliku koji je prilično vjerno pratio tiskani udžbenik, prenesen tekst nastavnog sadržaja uz grafičke elemente bez puno interaktivnosti. Multimedijski e-udžbenik omogućuje da sadržaji i zadatci učenicima budu prikazani uz pomoć multimedijske tehnologije, zatim slijede primjerene aktivnosti (rješavanje zadataka, rad na problemu, istraživanje, komuniciranje itd.) te

9 Udžbenički je standard provedbeni propis ministra kojim se utvrđuju standardi za udžbenik. Tim se dokumentom utvrđuju zakonske i druge osnove, znanstveni, pedagoško- psihološki standardi i zahtjevi, didaktičko-metodički standardi i zahtjevi, etički i jezični zahtjevi, likovno-grafički zahtjevi, tehnički standardi za izradu tiskanih udžbenika, pojam elektroničkoga udžbenika, posebni zahtjevi u izradi udžbenika za pripadnike nacionalnih manjina i zahtjevi u izradi i prilagodbi udžbenika za učenike s posebnim potrebama (učenike s teškoćama i darovite učenike) i licencija za nakladnike. Udžbenički standard utemeljen je na Ustavu Republike Hrvatske, važećim zakonskim propisima, nacionalnim programima, deklaracijama i konvencijama. (Udžbenički standard. // Narodne novine 65(2013). Str.1. [citirano: 2018-04-22]. Dostupno na: https://mzo.hr/sites/default/files/migrated/udzbenicki_standard.pdf)

nakon toga pruža povratnu informaciju. Da bi multimedijski e-udžbenik bio funkcionalan, mora biti didaktički oblikovan. (Bognar & Matijević, 2002) Stoga Matijević potrebu korištenja i oblikovanja e-udžbenika postavlja u novo digitalno medijsko okruženje koje prati uvjetovanost didaktičkog oblikovanja udžbenika, napominjući da će s njom povezane spoznaje bitno utjecati na metodičke i didaktičke scenarije koji će dominirati u nastavnom procesu. (Matijević & Topolovčan, 2018; Matijević, Topolovčan, & Rajić, 2017)

Danas multimedijski e-udžbenici posjeduju zavidnu multimedijsku razinu obogaćenu s više razina interaktivnosti: od jednostavne reprodukcije zvuka i videozapisa do višestruke interaktivnosti korištenja materijala, interaktivnog grupnog rada, elemenata igrivosti, praćenja aktivnosti učenika kroz rad s multimedijskim sadržajima, 2D i 3D aktivnih simulacija, komunikacije između učenika te učenika i učitelja itd. Udžbenik mora biti osmišljen da bi potaknuo aktivno učenje, razvijao kritičko mišljenje učenika, naučio primjenjivati različite strategije učenja i omogućio trajno učenje određenog sadržaja. (Zubac & Čanić, 2016) Kvaliteta multimedijalnog e-udžbenika ovisi o korisnosti takvih udžbenika u nastavi. Učenici lakše uče uz istraživanje, otkrivanje i iskustvo. Stoga nam ovi multimedijalni e-udžbenici omogućuju da smjestimo učenike u situaciju istraživanja i otkrivanja. ('CEMCA :: Educational Multimedia: A Handbook for Teacher-Developers', n.d.)

Zadnjih nekoliko godina multimedijski e-udžbenici se značajno koriste u hrvatskim školama, no koliko se zapravo koriste u nastavi? Kako bismo utvrdili koliko se koriste u nastavnom procesu provedeno je istraživanje koje ima za cilj utvrditi koliko se isti provode u pripremi i provedbi nastavnog procesa u primarnom obrazovanju. Posebice nas je zanimalo koriste li se njima više učitelji razredne ili predmetne nastave, te čime se učitelji najčešće služe u nastavi. Ova zanimljiva istraživačka pitanja pretočili smo u istraživanje u okviru diplomskog rada.

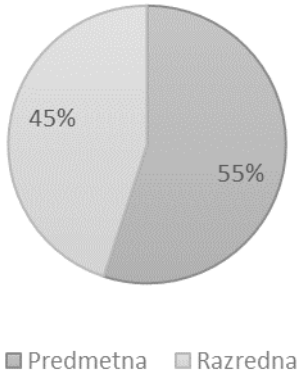
Istraživanje

Istraživanje je provedeno na 267 ispitanika putem klasičnog anketnog upitnika i online anketnog upitnika. Radi lakše obrade podataka, nakon istraživanja podaci su spojeni u jednu cjelinu. Anketni upitnik koji smo kreirali namijenjen je učiteljima razredne i predmetne nastave koji imaju mogućnost korištenja multimedijskih e-udžbenika u svojoj nastavi. Anketni upitnik se sastoji od tri čestice: prvi dio se odnosio na osnovne informacije o učiteljima, drugi dio se odnosio na primjenu multimedijskog e-udžbenika, treći dio se odnosio se na mišljenja i stavove učitelja o multimedijskim e-udžbenicima. Podatci su obrađeni uz pomoć PSPP programa za statističku obradu. Prije provedenog istraživanja provedena je analiza dostupnih e-udžbenika u Republici Hrvatskoj s ciljem utvrđivanja kvalitete multimedijskih elemenata: koje nastavne sadržaje pokrivaju, kako se njime koristi učenik a kako učitelj itd.

Prikaz rezultata

Istraživanje je provedeno na odabranom uzorku škola Grada Zagreba i škola središnje Hrvatske. Od ukupnog broja ispitanih (267), njih je 242 (90,64 %) ženskih ispitanika, te 25 (9,36 %) muških ispitanika. Od ukupnog broja ispitanika njih 120 (45 %) su učitelji razredne nastave dok

su ostalih 146 ispitanika (55 %) učitelji predmetne nastave, što čini približno jednak broj ispitanika razredne i predmetne nastave. (Grafički prikaz 1)



Grafički prikaz 1. Područje nastave ispitanika

Prosječan broj godina staža ispitanika je u rasponu od 11 do 15 godina. Najviše ispitanika ima od 1 do 5 godina radnog staža (66 ispitanika), dok najmanje ispitanika ima više od 35 godina radnog staža (samo 6 ispitanika). (Tablica 3.) Na osnovu ove raspodjele možemo vidjeti da više učitelja s manje radnog staža koristi e-udžbenike. Očekivano je da mlađi učitelji više upotrebljavaju tehnologiju jer su netom završili svoje obrazovanje, tijekom kojega su uvidjeli mogućnosti primjene tehnologije u nastavi, za razliku od starijih učitelja, koji su i dalje za tradicionalni način podučavanja ili nisu dovoljno vješti u korištenju tehnologije u nastavi.

Najviše ispitanika koristi multimedijske e-udžbenike u nastavi i u pripremi sata. Mali broj ispitanika koristi multimedijske e-udžbenike samo u nastavi ili samo u pripremi sata. Neki ispitanici imaju pristup multimedijskim e-udžbenicima, ali ih uopće ne koriste u nastavi i pripremi sata.

Uspoređujući primjenu multimedijskih e-udžbenika s obzirom na to jesu li ispitanici predmetne ili razredne nastave, pokazalo se da najviše ispitanika predmetne i razredne nastave primjenjuje multimedijske e-udžbenike i u nastavi i u pripremi sata. Razlika se pojavljuje u daljnjim rezultatima: u predmetnoj nastavi više se koriste multimedijskim e-udžbenicima samo u nastavi 11,67 %, a manje ispitanika samo u pripremi sata 5,83 %. Dok se u razrednoj nastavi, više ispitanika koristi u pripremi sata 12,93 %, a manje samo u nastavi 9,52 %. (Tablica 1. i 2.)

Tablica 1. Primjena multimedijskih e-udžbenika ispitanika predmetne nastave

Value Label	*Value*	*Frequency*	*Percent*	*Valid Percent*	*Cum Percent*
U nastavi i pripremi sata	1	92	76,67	76,67	76,67
U nastavi	2	14	11,67	11,67	88,33
U pripremi sata	3	7	5,83	5,83	94,17
Uopće ne koristim	4	7	5,83	5,83	100,00
	Total	120	100,0	100,0	

Tablica 2. Primjena multimedijskih e-udžbenika ispitanika razredne nastave

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
U nastavi i pripremi sata	1	108	73,47	73,47	73,47
U nastavi	2	14	9,52	9,52	82,99
U pripremi sata	3	19	12,93	12,93	95,92
Uopće ne koristim	4	5	3,40	3,40	99,32
Poduke	5	1	,68	,68	100,00
	Total	147	100,0	100,0	

U istraživanju smo obuhvatiti samo one ispitanike koji upotrebljavaju multimedijalne udžbenike. Zanimalo nas je koji od njih pripadaju kojem nastavnom predmetu, području. Utvrdili smo da najmanji broj ispitanika koji upotrebljavaju e-udžbenike otpada na učitelje Prirode i društva i Likovne kulture. Ova činjenica nas je iznenadila jer postoje značajni i kvalitetni multimedijski sadržaji iz ova dva predmeta u e-udžbenicima koji su dostupni učiteljima.

Najveći broj ispitanika koji upotrebljavaju e-udžbenike su učitelji Engleskog i Njemačkog jezika. (Tablica 3.) Prethodnom analizom e-udžbenika došli smo do zaključka da unutar e-udžbenika postoji znatna količina zvučnih zapisa, koji su zamijenili dosadašnje korištenje CD-playera u nastavi.

Tablica 3. Područje učitelja

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Razredna nastava	1	120	44,94	44,94	44,94
Predmetna nastava - Engleski jezik	2	36	13,48	13,48	58,43
Predmetna nastava - Njemački jezik	3	15	5,62	5,62	64,04
Predmetna nastava - Biologija	4	9	3,37	3,37	67,42
Predmetna nastava - Fizika	5	7	2,62	2,62	70,04
Predmetna nastava - Geografija	6	7	2,62	2,62	72,66
Predmetna nastava - Povijest	7	8	3,00	3,00	75,66
Predmetna nastava - Hrvatski jezik	8	24	8,99	8,99	84,64
Predmetna nastava - Kemija	9	4	1,50	1,50	86,14
Predmetna nastava - Tehnička kultura	10	4	1,50	1,50	87,64
Predmetna nastava - Matematika	11	19	7,12	7,12	94,76
Predmetna nastava - Informatika	12	6	2,25	2,25	97,00
Predmetna nastava - Glazbena kultura	13	4	1,50	1,50	98,50
Predmetna nastava - Priroda	14	2	,75	,75	99,25
Predmetna nastava - Likovna kultura	15	2	,75	,75	100,00
	Total	267	100,0	100,0	

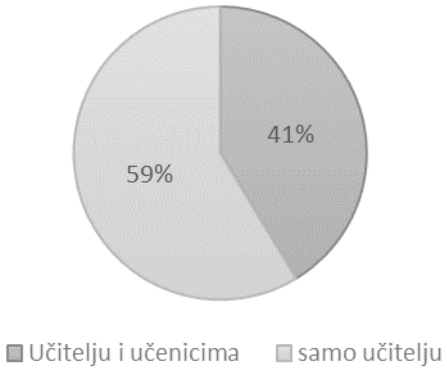
Kako bi učitelji mogli upotrebljavati multimedijske e-udžbenike u nastavi, potrebna im je dostupna tehnologija s pomoću koje će im pristupati. Gotovo svi ispitanici imaju računalo u razredu, a ovisno o opremljenosti pojedine škole posjeduju i projektor ili pametnu ploču. No, još u školama možemo pronaći učionice u kojima učitelji nemaju ni računalo. (Tablica 4.)

Tablica 4. Dostupna tehnologija u učionicama

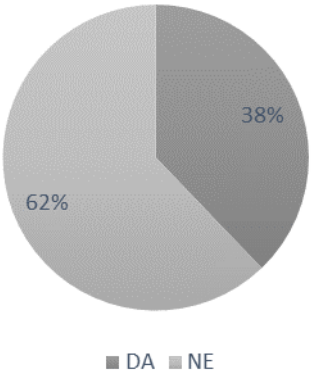
Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Računalo	1	23	8,61	8,61	8,61
Računalo i projektor	2	165	61,80	61,80	70,41
Računalo, projektor i pametnu ploču	3	48	17,98	17,98	88,39
Računalo, projektor, pametna ploča i tablet	4	4	1,50	1,50	89,89
Računalo i pametna ploča	5	21	7,87	7,87	97,75
Računalo, projektor i TV	6	2	,75	,75	98,50
Računalo, projektor i tablet	7	2	,75	,75	99,25
Računalo, projektor i mobiteli	8	1	,37	,37	99,63
Nije dostupno	9	1	,37	,37	100,00
	Total	267	100,0	100,0	

Da bi se učenicima mogle pokazati mogućnosti multimedijskih e-udžbenika, oni moraju biti dostupni i učenicima, a ne samo učiteljima. Vidljivo je da je 41 % učitelja odgovorilo da njihovi učenici imaju pristup e-udžbeniku u učionici. To nije tako loš rezultat, no potrebno je učiniti i daljnje korake. Uvođenje e-škola i opremanje škola pristupom širokopojasnoj mreži, kao i uvođenje tableta u nastavu, može zasigurno unaprijediti korištenje e-udžbenika u nastavi.

Grafički prikaz 2. Dostupnost e-udžbenika tijekom nastave



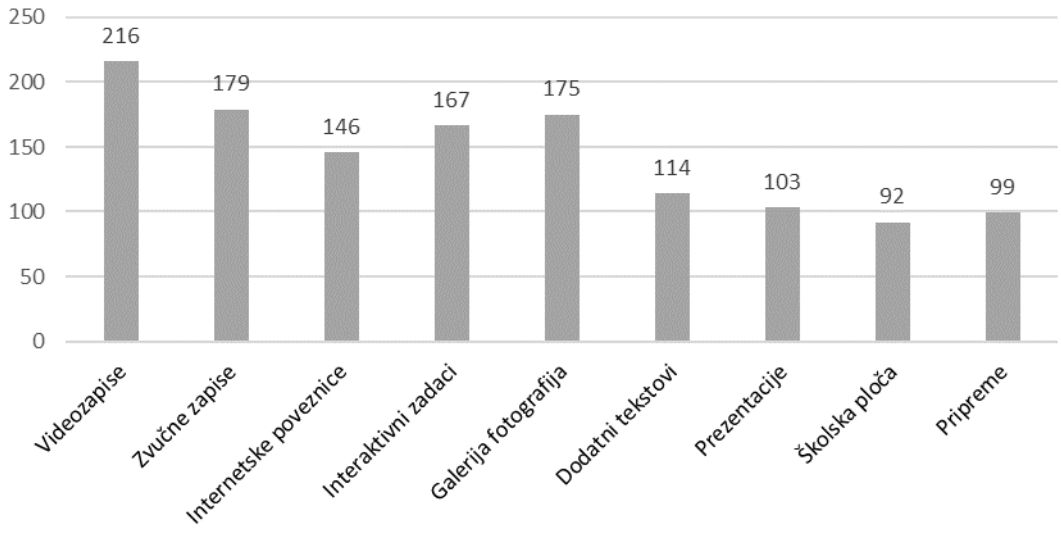
Više od polovine nastavnika odgovorilo je da njihovi učenici nemaju pristup e-udžbeniku tijekom nastave, dok je veći broj ispitanih naveo da učenici nemaju pristup multimedijskim e-udžbenicima kod kuće. Smatramo da je tu problem licenci i cijena e-udžbenika. Neki e-udžbenici su besplatni, no za neke se plaća pristup izvan učionice. (Grafički prikaz 3.)



Grafički prikaz 3. Pristup učenika multimedijskim e-udžbenicima kod kuće

U sljedećem dijelu anketnog upitnika zanimalo nas je koji se multimedijski elementi koriste u nastavi. Postavili smo pitanje korištenja elemenata u multimedijskim e-udžbenicima tijekom nastave, a 16 % ispitanika navelo je da upotrebljava sve elemente koje sadrže multimedijski e-udžbenici.

Najviše ispitanika upotrebljava videozapise koji su uključeni u multimedijski e-udžbenik. Više od polovine ispitanika je navelo da koriste zvučne zapise, galeriju fotografija te interaktivne zadatke. Od elemenata multimedijskog e-udžbenika najmanje se koristi virtualna školska ploča (92 ispitanika). Učiteljima je i dalje klasična školska ploča praktičnija od virtualne školske ploče. Svega nekoliko ispitanika (njih 7) navelo je da ne upotrebljava nijedan element unutar e-udžbenika tijekom nastave, a razlog tome je nedostupnost tehnologije ili interneta. (Grafički prikaz 4.)



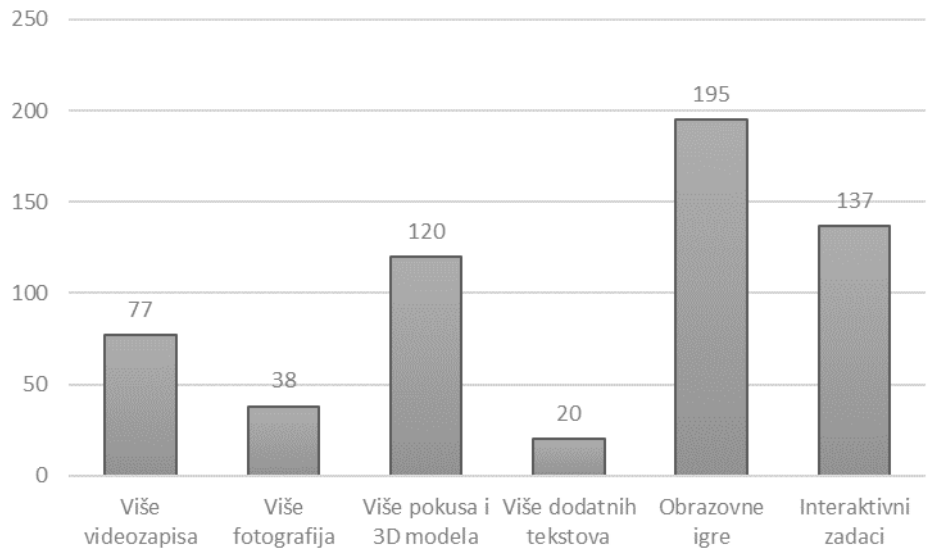
Grafički prikaz 4. Elementi koji se koriste tijekom nastave u multimedijskim e-udžbenicima

U postupku pripreme nastave, ispitanici podjednako upotrebljavaju sve elemente unutar e-udžbenika i nema značajnih odstupanja od uporabe u nastavi; vjerujemo da učitelji smatraju sve korisnijim upotrebljavanje e-udžbenika i njegovih mogućnosti u pripremi nastave.

Nastavno na prethodno pitanje, ostavili smo mogućnost da ispitanici kroz pitanje otvorenog tipa iznesu svoje mišljenje o korisnim multimedijskih elementima unutar e-udžbenika. Većina ispitanika je navela elemente multimedijskog e-udžbenika koje smatraju korisnima poput videozapisa, galerija fotografija i slično. Nekim ispitanicima je korisno što mogu brzo i lako doći do dodatnog sadržaja i olakšati si pripremu jer sve se nalazi na jednom mjestu. Svega nekoliko ispitanika prepoznalo je prednost e-udžbenika u zornom prikazivanju nastavnog sadržaja koje može zamijeniti izvornu stvarnost. Interaktivnost multimedijskog e-udžbenika može povećati motiviranost učenika, smatra većina ispitanika. Smatraju da je koristan jer učenik ne mora nositi kući brojne udžbenike kada ih ima na jednom mjestu. Navodimo neke od odgovora: *„Udžbenik postaje dinamičan radni materijal. Gubi svoju plošnost. Ubacuju se slika, ton, pokret. Povećava se interes učenika za sudjelovanjem u radu.“ „Videozapisi i zvučni zapisi, galerije fotografija vezane za pojedinu temu pomažu u stvaranju predodžbe (živih bića, kemijskog spoja).“*

„Učenicima je sve zorno i vidljivo, sve se nalazi na jednom mjestu, moguće je brže povezivanje sadržaja udžbenik-stvarni život.“

Podjednako tako zanimali su nas i mogući nedostaci e-udžbenika, odnosno čime bi ih autori trebali obogatiti. Većina ispitanika navodi nedostatak obrazovnih igara te nedostatak kvalitetnih interaktivnih zadataka. S obzirom na to da se lakše uči kroz igru, kao i da učenike motiviraju igre (brza povratna informacija), razumljivo je da su učitelji na to skrenuli pozornost. (Grafički prikaz 5.) Smatramo da je ovo važna činjenica jer nas upućuje na moguća poboljšanja e-udžbenika.



Grafički prikaz 5. Što nedostaje u multimedijskim e-udžbenicima?

Od ukupnog broja ispitanika njih čak 258 (96,63 %) smatra da će u budućnosti i dalje upotrebljavati multimedijske e-udžbenike. Ovo je potvrda da je velika većina ispitanika prepoznala mogućnosti i prednosti korištenja multimedijskih e-udžbenika u pripremi i provedbi nastave.

Zaključak

Svaki učitelj svoje učeniku mora omogućiti najkvalitetnije nastavne sadržaje, prikazati određene sadržaje što vjernije te ga naučiti koristiti se tim znanjem. Mediji mogu zamijeniti izvornu stvarnost i prikazati određene nastavne sadržaje ako izvorna stvarnost nije moguća. (Furht, 2006; Kong, Zhang, Yu, & Xia, 2011) Naravno, ne treba se prepustiti medijima i informacije prikazivati samo na taj način. Treba uskladiti i procijeniti koji nastavni sadržaj možemo prikazati u izvornoj stvarnosti, a za koji možemo upotrebljavati medije. Na nama je da odlučimo kako ćemo pomoći učenicima da lakše savladaju nastavni sadržaj. Danas djeca provode puno vremena s tehnologijom, stoga bi bilo idealno iskoristiti elemente e-udžbenika. Razne igre, zadaci i videozapisi procesa mogu zainteresirati učenike i putem njih nesvjesno ih učiti nastavni sadržaj. (Furht, 2006; Lee & Owens, 2004)

U provedenom istraživanju prikazano je koliko i što učitelji upotrebljavaju od medija unutar multimedijskog e-udžbenika. Neki učitelji imaju i dalje problem s dostupnom tehnologijom dok neki nisu zadovoljni nakladnikovim oblikom multimedijskog e-udžbenika, stoga ga i ne koriste u velikoj mjeri. Budući da je ovo istraživanje provedeno početkom 2018. godine, danas možemo reći da je kurikularna reforma ubrzala proces nadogradnje multimedijskih e-udžbenika. Multimedijski e-udžbenici su postali besplatni učenicima i pristupačniji za korištenje. Obogaćeni su raznim medijima i interaktivnim sadržajima koji su jednostavni za korištenje. Pretpostavka je da će učitelji sada imati više materijala u nastavi, stoga će se broj učitelja koji se koriste multimedijskim e-udžbenicima povećati. Nakladnici su napravili izvrstan posao u multimedijskim e-udžbenicima, a na učiteljima je da to prepoznaju i iskoriste u nastavi.

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Multimedia e-Textbooks in Primary Education

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Abstract

We are aware that multimedia facilitates the learning process for pupils. Multimedia textbooks facilitate teaching because they comprise videos, photographs, audio files, and other media files in one place. Multimedia textbooks were introduced into schools a few years ago. In order to find out how teachers use multimedia textbooks in class, which elements of multimedia textbooks they use, what they find useful or unnecessary, as well as what multimedia textbooks lack in their opinion, we researched a number of Croatian teachers. Multimedia textbooks allow various possibilities in the preparation, performance, and evaluation of teaching contents. The possibilities of e-textbooks use are made even greater with enabled access via mobile phones and tablets, which makes such textbooks more useful and easily available to pupils today. In Croatian schools, various multimedia textbooks can be used in accordance with the primary education curriculum. This paper presents the possibilities of multimedia textbooks, as well as their application in school and extracurricular activities.

***Keywords**: education; education technology; multimedia; multimedia e-textbooks*

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