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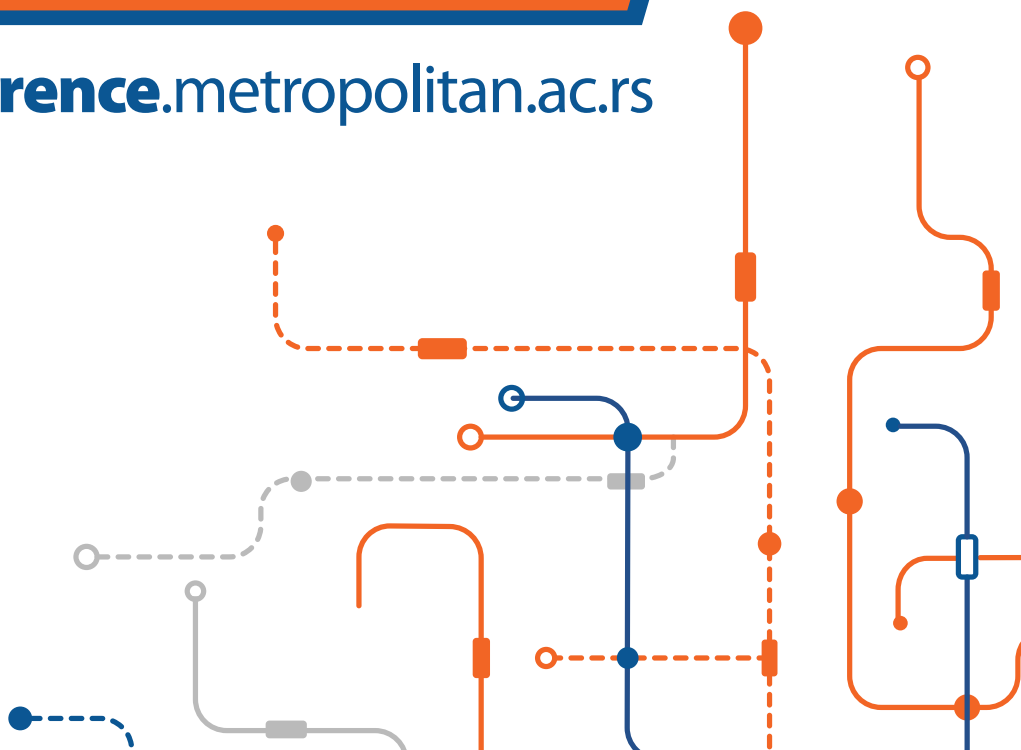

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Introduction of part-time and short cycle studies in Serbia

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ASSESSING WHAT STUDENTS LEARN BEYOND THE INSTITUTION – LEARNING ANALYTICS IN PERSONAL LEARNING ENVIRONMENTS

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Abstract: *Teaching and Learning are processes not restricted to specific context. Students can learn while they are looking for information, chatting with friends, watching TV, etc. That is, they learn not only in educational institutions but during their daily life. Learners can use different tools and devices in these processes in what can be understood as their Personal Learning Environment (PLE). These type of environments presents two main problems: the wide range of possible tools that can be included in them and the difficulty to explore what the student has done there. This work explores different tools that can be applied to analyze and evaluate what is happening in a Personal Learning context. In addition, we describe possible ways to make visible what happens in the PLE from the institutional side. From this analysis it is possible to define what to use to evaluate what happens in some of the most common PLE configurations..*

Keywords: *Personal Learning Environments, Learning Analytics, Evaluation, Informal Learning*

1. INTRODUCTION

Education has been and continuous to be an essential process in all societies over the time. When we think about teaching and learning, as part of the educational process, we use to associate these terms with educational institutions, such as the school, high-school or university. However, do the individuals learn only in so specific contexts? The answer to this is: no, they do not. The individuals can learn in very different contexts and not always linked to the institution. People can learn when they are working, when they look for information in the Internet, when playing games, when interacting with friends, when practicing sports, etc. [1-3].

The learning that takes part outside the institution cannot be considered as formal learning, but as informal or non-formal learning [4-6]. Can this type of learning be important for the individuals, educational institutions and businesses? Of course, it is important. With this information educational institutions could adapt their learning pathways to the specific features of a student, towards personalized learning strategies; businesses can decide if to hire or promote a worker based on his/her knowledge and real skills and not only what is certified by the educational institutions; and the individuals can build their own knowledge about issues that they find interesting for their personal development [7, 8].

The main problem for non-formal and especially informal learning is how to make it visible. That is, how an individual can communicate to the business or the educational institution what she has learned in other contexts [2, 9-12]. This is something quite complicate because: 1) the heterogeneity of the tools that people can use to learn outside of educational institutions; 2) the awareness problem, i.e. a person could have acquired a new competence and have not knowledge about it; 3) the communication of the learning evidences associated with technological and ethical problems; and 4) how to deal with the evidences and data obtained.

In order to address these problems, the first issue to take into account is the environment from which non-formal learning is carried out. That is, the tools used and the communication interfaces, that are not necessarily linked to the technology. This is known as Personal Learning Environments (PLEs). PLEs facilitate the users' learning process by allowing them to use those tools they want and not binding them to an specific institutional context or learning period [13] such as the traditional LMS does. With PLEs, learners become more responsible of their learning because they can decide what tools to use, they become a provider of learning and not only a consumer, they can solve their specific problems, etc. [13, 14].

However, the introduction of a PLE does not suppose the demise of the LMS [13] or other institutional tools. The likely coexistence of LMSs and PLEs introduces a requirement for interoperation between the two [1]. The problem in this case is how can we connect these environments and how to deal with the tools heterogeneity. This problem is addressed in the literature by the application of eLearning specifications that will be described in the next sections [3, 15-18].

The awareness issue is also something difficult to address. Sometimes the individuals do not know that they have learned something or even does not want to share what they have learned. In these cases, it is necessary to provide possible ways to facilitate discovering what was learned and how to share it. In this sense projects such as TRAILER [12, 19], IBAK[20] or OpenBadges[21] can help.

The last problem is how to deal with non-formal learning evidences. In this case it is necessary to apply techniques

and methods that allow explore the data and presents results to people in charge of the institutions so they can easily make decision about what is happening outside their learning or working contexts. In order to do so Learning Analytics tools and methods are required. The most accepted definition of Learning Analytics considers that it comprises *"the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs"* [22]. With the information gathered by applying Learning Analytics, institutions and instructors may plan interventions and make the necessary changes to help students, redesign courses, adapt learning content and methods, etc.[23].

Given this context the present work aims to describe the possible tools and techniques that allows assessing what is happening in Personal Learning Environments, but considering the broad context we are exploring.

In order to do so the following section describes how PLEs are defined, main initiatives to connect them with other systems and possible Learning Analytics tools and methods to apply. The third section describes a possible methodology to assess informal learning activities by applying Learning Analytics in PLEs. Finally, some conclusions are posed.

2. THE RESEARCH CONTEXT

In order to understand the existing context, it is necessary to describe the elements involved the recognition of in the informal and non-formal learning activities. Image 1 shows the information flow between the Personal Learning Environment and the Institutional environment. In the figure it is possible to see the institutional environment (left side), where the information gathered can be analyzed and the PLE (right side) with some examples of possible tools employed to learn. Both contexts should be connected by interoperability specifications. Now we are going to describe all these elements.

Institutional environments

When we have described how to make visible the activities carried out in Personal Learning Environments, we commented that this can be useful both for the individuals and for the institutions. We can distinguish between Educational Institutions and Businesses. The educational institutions use to have a Leaning Management System (LMS) to support online, blended and face-to-face classes and also other management tools such as an Enterprise Resource Planning (ERP). The same happens with companies, but in this case the ERP is more important than the LMS (and not all companies have an LMS).

The idea is that institutions could be able to gather and analyze the learning information about the students or workers. The analysis of such information is difficult specially when what happens is outside the institution, and there is no way to gather and control the information. This usually requires the use of interoperability specifications, as is commented below. In addition, it is necessary to store the information in the LMS or the ERP and later apply Learning analytics tools.

LMSs are systems that [24]: 1) fulfil institutional learning management requirements; 2) provide teachers and academic staff with tools for the management of courses, students, resources, activities, etc.; and 3) create specific areas for students in which they may perform their academic activities, supplement their lectures and (to a greater or lesser extent) collaborate with other students and teachers. These systems are focused on the course and provide with tools, which not only support but also extend the traditional concept of classroom. Some of the most common LMS are Moodle, Sakai, Blackboard, Desire2Learn, Sakai, etc.

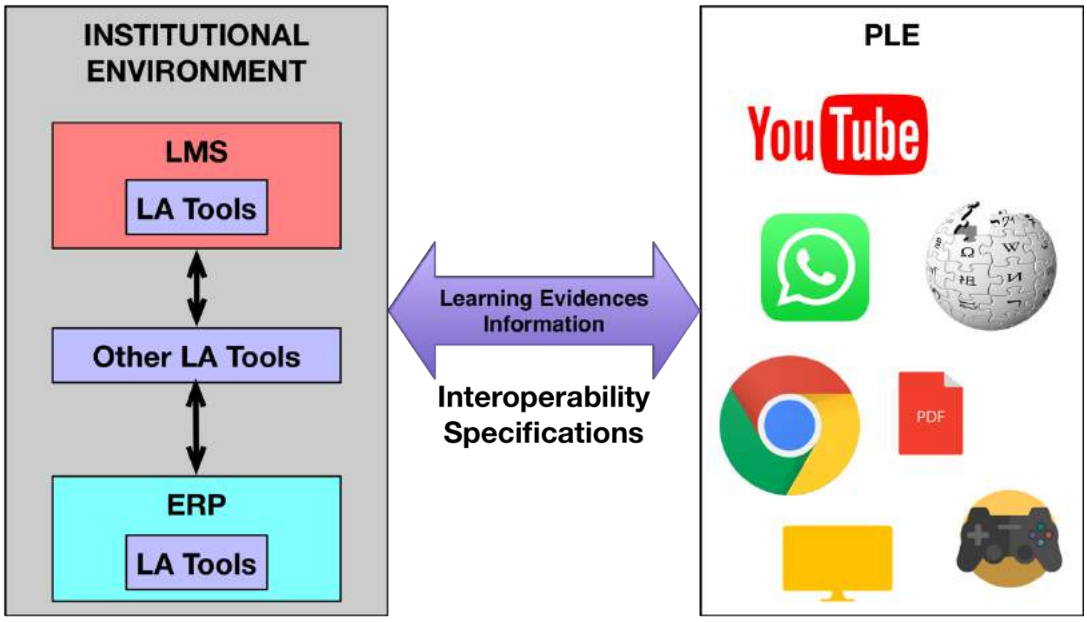


Image 1: Description of the context and the information flow

The ERP, is an integrated software solution that spans the range of business processes that enables companies to gain a holistic view of the business enterprise. It promises one database, one application, and a unified interface across the entire enterprise [25]. This ERPs can include the LMS or gather information related to learning evidences. Some examples of ERPs are those provided by SAP, SAGE, Microsoft, ORACLE, etc.

Personal Learning Environments

When describing a PLE, we have said that is not only a set of tools, but of contexts and interactions. However, these activities are mainly supported by the technology, so it is necessary to think about how to implement a PLE.

The first possibility is to implement a PLE with any technology that the individual could use to learn outside the institution. That includes a wide range of tools and devices such as: mobile phones and the tools that they include, tablets, computers, smartwatches, video game consoles, etc. In these cases, the device by itself and the tools that it includes act as a PLE. This have the problem that how to gather the information of what the user has done, and what of this information is related to learning and can be employed by the institutions. The solution implies to filter and record all the interactions and send it to the institution so it can process them. This can be done through an access point that launches all the applications [26-28].

In order cases the PLE can be defined as a web launcher that facilitate access to other applications in the form of apps or widgets [2, 3, 29]. This can be done through web portals such as: iGoogle (http://www.google.com/ig), MyYahoo (http://my.yahoo.com), Elgg (http://www.elgg.com); Widgets, portlets and web containers for them: Apache Wookie (Incubator), Netvibes (http://www.netvibes.com), Liferay (http://www.liferay.com), etc; in LMS as a personal part of the learning platform; in social networks as social apps such as in Facebook (http://facebook.com); integrated as part of a eportfolio such as: Mahara (http://www.mahara.org), MyStuff (http://mystuff.anniesland.ac.uk/). The problem of these possible implementations is that not all the individuals use the same tools to learn and each tool should be adapted to the web container. The main advantage that the user activity can be easily gathered.

Other possibility is that the user can recognize the informal activities carried out outside the institution and store and manage them through a digital portfolio as shown in TRAILER project [12, 19].

Interoperability Specifications

One of the key issues to be able to analyze what is happening in the personal environment is to exchange information from it to the institutional environment. Several authors describe the necessity to facilitate this communication in such a way that the people in charge of the institution (teacher, manager, etc.), could access to what persons are doing in their PLE. This is essential and requires of the adaptation of PLEs and institutional environments by applying interoperability techniques, something suggested by several works [14, 30-34] and implemented only in some PLE samples [2, 3, 17]. There are several possibilities mostly based in the use of web services and interoperability specifications [18].

The most suitable interoperability specifications to do this are:

- IMS Learning Tools Interoperability (LTI - https://www.imsglobal.org/activity/learning-tools-interoperability) and Basic Learning Tools Interoperability (BLTI). One of the most popular specifications is IMS LTI (also known as Full LTI) because it facilitates a real and full integration between tools and learning platforms. However, many LMS or tools do not support it due to its difficult implantation. In order to overcome this, a light version of the specification was released, Basic LTI (BLTI). This version, supported by the most representative LMS and in some ERPs [35], will allow the creation of an external tool instance inside the learning platform, launching it and providing a single-sign-on access. BLTI presented a problem; there is not a real integration only authentication, so there is no exchange of information about the activity performed on the tool towards the LMS or ERP (i.e.: the grade of an activity, the users' activity logs and so on). This is solved by versions 1.2 and 1.3 of LTI.
- XAPI (eXperience API, formerly known as Tin Can API - https://xapi.com/overview/) is a new e-learning specification designed to support the learning community in standardizing and collecting both formal and informal distributed learning activities. The xAPI specification describes packaging and transmission of learner actions called ''Activity Statements'' between any tool and a learning record store (LRS), the database model that validates and stores activity statements [36]. It is used for informal learning activities recognition [37-39] and is supported by most LMS.
- Caliper Analytics (http://www.imsglobal.org/activity/caliper). This specification enables institutions to collect learning data from digital resources to better understand and visualize learning activity, product usage data, and present this information to students, instructors, and advisors. Each learning activity has one or several associated metric profiles. A metric profile defines the information model that shapes the types of events emitted by the learning activity. It also provides a semantic for later analysis [40]. It is specially devoted to the connection of different learning components [41].

With these specifications it is possible to integrate activities that happens in the PLE, however the application requires an adaptation both in the LMS and in the tool, which implies an extra work.

Learning Analytics tools and methods

When the student carries out an activity with the LMS or other tool it is possible to record what she has done for a later analysis. However, this information use to be stored as raw data that is difficult to manage when the institution needs to make decisions. In order to explore this

information and make possible to extract knowledge from it new educational disciplines, such as educational data mining [42], academic analytics [43, 44] or learning analytics emerged. They offer different but convergent perspectives, methodologies, techniques and tools aiming to facilitate this transformation process [45].

There is currently a wide choice of tools that facilitate educational data extraction and analysis for learning analytics purposes. A first broad categorization of these tools would include [46]:

- Cross-platform and platform-specific general-purpose dashboards. Dashboards provide information about platform activity of the different learning agents –mainly, students and teachers–, generally in a visual and condensed form. Dashboards can be applied to different platforms [47, 48] such as Google Analytics, or to a specific one [49] such as Moodle Dashboard.
- Ad hoc tools. The design and implementation of ad hoc tools seeks to perform tracking and analysis of very specific types of information adapted to very specific contexts. For instance a specific tool to assess the acquisition of the teamwork competence from Moodle logs [50].
- Learning analytics tools for analysis of specific issues. These tools aim to provide information, and usually have very specific types of representation. It is also very common that they offer cross-platform capabilities. For instance tools for social network analysis such as SNAPP [51].
- Learning analytics frameworks and tools. The design of learning analytics frameworks is directed toward standardization of learning ontologies and their implementation in different systems. They also pursue the exploration of student behaviors in different educational contexts and offer the user customizable visual representations of the information. Such as VeLA (Visual eLearning Analytics) [52] or GISMO [53].

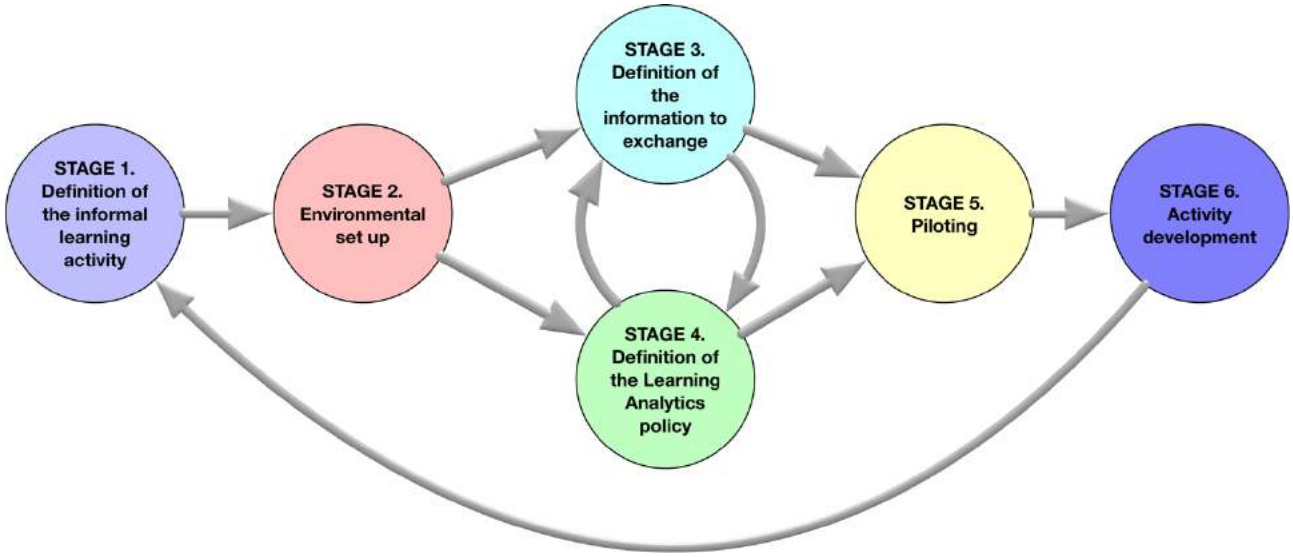
These tools could be included into an LMS (as Moodle Dashboard or GISMO) or ERP or can be external tools that can be applied (as Google Analytics or SNAPP).

The problem in the case of informal learning contexts is that first of all we need to define what type of learning activity we are going to track, what information it is going to produce and finally how we will explore the information. Taking into account that if the user could choose the tools of their PLE this lead to great variety of tools or information. In the next section we propose some steps to deal with these problems.

3. METHODOLOGY FOR ASSESING INFORMAL LEARNIGN ACTIVITIES

Given the previous context it is clear that a methodology or a set of steps are necessary in order to address the previously mentioned problems. We are going to divide the methodology in six possible stages:

- **Stage 1 - Definition of the informal learning activity.** This involves, first to think about what I would like to explore about the individuals' behavior or interaction in their PLE. Later, we should define an activity to carry out in such context and how to assess it. For instance, it will be interesting the definition of an activity that consists of looking for videos related to a specific issue and publish a post in a blog about it.
- **Stage 2 - Environmental set up.** This requires to explore the tools that the user is going to use to carry out the activity, considering the type of institutional platform that we have and the kind of tools or platforms employed as PLE. If we could choose the best will be to have the tools centralized, a platform for the PLE and a platform in the institutional side, both with support for interoperability specifications. However, commonly what we find is a predefined environment that cannot always be changed. In this case the institutional platform and the PLE tools used to carry out the activity should be adapted to support the interoperability specifications. The interoperability specification to use will depend on what are supported or not. For instance, it would be possible to use Moodle with a xAPI plugin and try to integrate the activity of the users carried out in YouTube and in their blogs.
- **Stage 3 - Define the information to exchange.** Stages 3 and 4 are carried out at the same time and one can feed the other. During this stage it is necessary to describe what information should be exchanged between the institutional environment and the PLE. The information must be not only the configuration settings for the activity or users outcomes, but also all the information that can be explored depending on the Learning Analytics policy. For instance, it would be necessary to exchange the user information, the outcomes, or the publication date; but also for the Learning Analytics policy could be interesting to know the number of times that a video is played in YouTube.
- **Stage 4 - Define the Learning Analytics policy.** Once defined the activity to carry out, the following step is to evaluate which indicators, beyond the students' outcomes, can provide evidences of the competences acquired by completing the learning activity, and also which could facilitate decision making. Once this information is defined it should be included as part of the data to be exchanged. During this stage it is also necessary to consider how to explore the information and represent the results. In addition, the Learning Analytics tools to apply should be included in the institutional environment. For instance, it would be interesting to know the number of times that users have seen a video and also with whom they have share it. With this data it would be interesting to have a general dashboard to show the information in the LMS and also to use SNAPP to represent a network with the social interaction between students. This strategy may not only facilitate to know who is working more or better but who is sharing with peers.



- **Image 2:** Methodology for assessing activities carried out in the PLE

- **Stage 5 - Piloting.** Once defined the main elements of our methodology the following is to test the activity with a sample of students. This can lead to changes in the previous stages. For instance, after testing the activity with 20 students we have seen that 5 are using other tools different to YouTube to look for videos and in addition it is possible to see that they have better grades. This means an adaption in the previous four stages.
- **Stage 6 – Activity development.** In this case the activity is carried out by a bigger number of students in a real environment. From these activities, errors could be detected so new changes in the strategy are required. Once the stage finishes, the cycle begins again with stage 1 considering the lessons learned.

Image 2 shows the possible stages of the methodology and how some of them interact with others.

3. CONCLUSIONS

This work has explored the main issues related with the assessment of learning activities that happens beyond the institution. That is, those that take place in individuals' personal environments. As described during this work, such kind of evaluation is very difficult, because they require of changes both in the institutional and the personal environments and these are not always possible or easy to develop. In addition, not only technological changes are required but we should deal with issues such as the awareness of the activity carried out by the user, or the application of the best analysis tools by the institution.

This work has posed a possible methodology to facilitate dealing with all these problems. The methodology involves several steps to carry out in order to evaluate what happens in the PLE. In would necessary to check the methodology by testing it in further works and if possible with different type of PLEs and institutions.

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DIGITAL SCHOLARSHIP AND OPEN SCIENCE: THE CHALLENGES OF OPENNESS FOR EDUCATION

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Abstract: *Digital scholarship, that is, teaching and research activities that take place thanks to digital networks and that are being deeply modified by social media, is a premise of open science. Digitalization has, in fact, brought new perspectives to the concept of scholarship that reified in the "open science" initiatives and that need to maintain the twofold scientific domains: research and education. Openness in education addresses different aspects covering technical, administrative, managerial and specifically didactical areas. The main challenges of the open education at University level refer to the creation of a supporting framework for faculties; the development of policy and infrastructures, a formal recognition of reputation that concerns both the researcher and the artifact.*

Keywords: *Open science, Digital scholarship, Education.*

1. INTRODUCTION

Open science is currently being discussed as paramount of innovation not only in the research field, but also as a domain in the educational area.

Open science is an umbrella phrase that embraces several directions: research access, funding and research production process, metrics and accreditation. Openness is, thus, meant as present in all actions and phases embedded in the research's output developmental process, from the initial design to the transparency in the research methodology and the open access publication of datasets and final results for reusability by different actors in the scientific community.

That movement is strictly connected with the concept of "digital scholarship" which can be considered a primary prerequisite since the diverse initiatives in open science have spread thanks to the digital world and the networked communities born with the social web.

But digital scholarship is a broader concept, it encompasses, in fact, both the research and the teaching activities and in this mainstream can help better understanding why open science can become a relevant driver also for education.

Scholarship was reconsidered since 1990 [1] when it was already clear the necessity to innovate the higher education system through four distinct functions: "scholarship of discovery", "scholarship of integration", "scholarship of application" and "scholarship of teaching". In those functions the connection between teaching and research for the educational ecosystem is highlighted. Research and its dissemination in scientific communities ("scholarship of discovery" and "scholarship of integration") finds, in fact, its completion in the supporting activities for the students and the synergy between theory and practise applied in the teaching process ("scholarship of application" and "scholarship of teaching").

Digitalization has, then, brought new perspectives to the concept of scholarship that reified in the "open science" initiatives and that need to maintain the twofold scientific domains: research and education.

Even though the scientific community is more and more often referring to open science as an imperative, the concept is still object of confusion among policy makers, stakeholder and faculties. Several initiatives, at international and European level, have been developing to train all interested actors in the acquisition of the proper knowledge and skills to deal with the two domains. An example in this direction is the FOSTER (Facilitate Open Science Training for European Research) project [2] where open science was "embedded" in e-learning: a portal was designed to be used as an e-learning platform to host open resources and deliver training to all interested actors.

2. EDUCATION AND OPENNESS

When we refer to the domain of education openness can address different aspects covering technical, administrative, managerial and specifically didactical areas.

In table 1 four directions are summarized: open source, open content, open course/open syllabus, and open accreditation.

The open source initiative is well known and since the origin of web 2.0 the development of open source software was meant as a means of progress as also underlined by the Mozilla Manifesto in 1999. Community sharing and improvement coming from a collaborative effort were the key motivations to extend the movement to the educational field with the creation of communities of developers around virtual learning platforms as the Learning

Management System (LMS) Moodle widely used in all levels of education system for e-learning and blended learning delivery.

But probably the highest level of awareness towards openness in the worldwide education communities was reached by Open Educational Resources (OER). The OER initiative which have been promoting the sharing of digital educational resources to be used, modified and re-used by the community for a sustainable development of education and lifelong learning was reinforced by the Cape Town Open Education Declaration whose subtitle is "Unlocking the promise of open educational resources". The declaration underlined as OER are just a single block of a more complex system where also research and its outputs should be openly shared to fulfil a mission of openness.

The open access to scientific publications was supported by several movements such as the 2002 public declaration BOAI (Budapest Open Access initiative) which highlights that the open publication of research is not just an issue between authors and publishers, but it is related also to policy issues tied to ethical/legal aspects and; technical/technological choices.

The technical aspect is particularly relevant when speaking about datasets sharing and standards required. Open data are available online in dedicated archives to be re-used by researchers and educators: "These datasets can be used by educators as Open Educational Resources (OER) to support different teaching and learning activities, allowing students to gain experience working with the same raw data researchers and policy-makers generate and use. In this way, educators can facilitate students to understand how information is generated, processed, analysed and interpreted." [3, p. 377].

A wider step forward was then, made, with the provision of whole Massive Open Online Courses (MOOC) where the access to the learning platform makes users autonomous in their learning process and more involved in the community of learners. Such massive online courses began delivering accreditation after completion through digital badges.

Since 2011 open digital badges (ODB) began developing thanks to Mozilla Foundation and the promotion of a platform to archive, display badges as visual representations, and share them. An ODB is a recognition of a completed learning process in terms of skills acquired, evidence of activities and criteria of completion. They can be integrated in ePortfolios and are currently adopted both by informal and formal courses.

The open education ecosystem, in all its features, can represent a transformative opportunity for the teaching/learning process mostly taking into account two major characteristics of the current landscape: digital content and global networks (technical and social) as referred by [4].

Since in the digital and networked world there are plenty open access informal outputs (e.g. videos, podcasts, presentations, 3D models for objects) besides formal contributions (e.g. peer reviewed articles) educators can easily use them in a virtual environment (PLE or LMS) for either self-archiving and self-regulated learning or for students. Social technologies, well known as web 2.0, have been facilitating practices of openness by fostering users to share and re-use content and find suitable licences (e.g. Creative Commons) to acknowledge authorship. Using open content help students acquire a set of skills by selecting and identifying quality artefacts: critical thinking, information literacy, reciprocity in being open in their learning process by acting as an active peer in online communities

Table 1: Open education ecosystem

Directions	Initiatives in the educational area
Open source	LMS (e.g. Moodle, OLAT, etc.) PLE (e.g. Elgg) ePortfolio (e.g. Mahara) Virtual worlds (Open sim)
Open content	MERLOT project (California State University , 1997); OER (UNESCO, 2002); Open access repositories: institutional (e.g. eScholarship); disciplinary (e.g. arXiv); universal (e.g. Zenodo); Open datasets archives: Pew Research Center; European Data Portal, etc.
Open courses/open syllabus	The Open University (UK, 1969) Open courseware (MIT, 2001); Open Learning initiative (OLI-Carnegie Mellon University, 2001); MOOC (Stephen Downes and George Siemens, 2008) The Open Syllabus Project (OSP-2014).
Open accreditation	Open Badges: Mozilla (2011) IMS Global Learning Consortium (2017) The Open Badge Network (OBN-2014/2017) Blockcerts: MIT's Media Lab (2016)

The educational area addresses different professional profiles who can take advantage of openness at different levels:

- Initiatives towards openness can help better connect disjoint scientific communities;
- Open access to up-to-date publications in the field can support educators, as subject matter experts, in their learning in a lifelong training perspective;
- Open educational resources can foster the adoption of innovative teaching practices (e.g. a flipped classroom methodology);

- Open data can satisfy multiple target audiences since they can be used with multiple views [5] by different actors (teachers, policy makers, stakeholders, researchers, etc.).

3. THE CHALLENGES OF OPEN PRACTICES

Open practices' full exploitation is possible when the whole educational system acquire a systemic vision where the strict complementary relationships between teacher/students, academia/accreditation, and research output/publisher become weaker and external forces (the community, employers, standards bodies, associations, etc.) integrate in the system and contribute with their values.

Such an integration is the major challenge of open education due to accreditation procedures, credibility and reputation systems, and quality control.

A premise to the envisioned integration is the needed support scientific communities and academy should provide to scholars, faculties and school teachers first to become aware of the opportunity of open science and then to be able to identify open content/data, to develop skills to select the research outputs and related data sets and, consequently, to find a proper way to use them in their scholarly and teaching activity.

If open educational resources are specifically designed and produced to be used in a teaching/learning context, are ready-made materials with an educational rationale, datasets are not. Open data are not open educational resources, but it may be used as they were. They are an integral part of a research process and they require specific skills to be read, understood and re-used as learning inputs in a teaching context.

Open practices need to be institutionalized to acquire a permanent value. In this direction the University of Edimburgh has established an is OER policy, which (1) explains the rationale of the vision towards openness and (2) offers supporting materials (guidelines) to put it into practice in the didactical activity:
"The University encourages staff and students to use, create, and publish OERs to enhance the quality of the student experience, enhance the provision of learning opportunities for all, and improve teaching practices. It also recognises that use, creation, and publication of OERs are consistent with the University's reputation, values, and mission to «make a significant, sustainable and socially responsible contribution to Scotland, the UK and the world, promoting health and economic and cultural wellbeing»". [6].

In the above statement/mission the main challenges of the open education at University level are shown: the creation of a supporting framework for faculties; reputation and visibility, develop policies and infrastructures.

Those challenges can be faced just if the academia widen its borders and embrace the inputs coming from the community. If at pedagogical/didactical level the institutional guidelines can support faculties towards an open approach, stakeholders and accreditation bodies need to contribute at policy/standard level.

The different levels are strictly connected. If students are fostered to use open content, those artefacts should be properly designed (e.g. interoperability, copyright), similarly publications and data sets should be well reported in terms of methodological information correctly/fully reported [7] and in terms of their organization and visualization (e.g. data description, data mark-up) to be productively used by both students (for training objectives) and by other researchers (for reproducibility of results).

A different discussion can be made about value "recognition" of open practices. In academy and in the scientific communities a strong value is attributed by researchers and faculties to recognition in terms of professional development. The same rationale can be extended to students or learners in their lifelong learning process in the relevance to have a proper accreditation after a course completion.

In the first case the challenge is represented by the peer review processes in the open science framework. Open review procedures have been developing in the last decades offering hybrid options such as pre and post publication reviews or creating new processes like crowdsourcing peer review.

Those new options, which in some cases integrated the traditional single/double blind review and in other cases replaced it, are struggling to acquire a full recognized value. If it's true that the academy need to rely on quality peer review and on expert reviewers, it is undeniable that variables such as delay and transparency in the traditional peer review process showed its lack and that researchers would receive a richer and quicker feedback from a variety of scholars through different means made available in the web (e.g. open comments and/or discussion fora in the publisher website).

As discussed in [8] "Hybrid forms of review, which can integrate a formal peer review with an open comment opportunity on the Web, proved successful for both improving the author's draft and enhancing its chances of publication and for the reviewers who can use this valuable activity to enrich their reputation by collecting and showing their reviews as research output".

Similarly the educational community needs to find suitable way to let learners, at any step of their training process, to find a due accreditation for both online informal and formal courses. A step in this direction is represented by ODB and credentials enriched by the further pulse of endorsement's features. Endorsement provides validation of the badge's value in terms of quality and efficacy since third-parties (stakeholders) are allowed to publicly acknowledge it: "Endorsement encourages the development of trust networks and connections among stakeholders in communities such as education, government, standards bodies, employers, and industry associations"[9,p.221].

E-credentialing, through open courses and badges, and "Value Recognition Networks", through endorsement, are part of an open ecosystem whose conditions are multi-layered at technical level (infrastructure) educational level (pedagogical frameworks), institutional level (the formal/informal issuer), political one, etc.

4. CONCLUSION

Education and research are a common good. Digitalization has brought relevant changes in both systems and offered opportunities to a wider audience to access knowledge. The exploitation of such opportunity is represented by the open access initiatives whose directions are affecting the whole instructional and research processes (design, production, publication, dissemination, accreditation).

The teaching/learning process can be affected by the open initiatives at multiple dimensions. The openness is, in fact, not only connected to the availability of single resources or whole open courses, but it also affects the accreditation process with e-credentialing systems.

Innovation within open initiatives include new training perspectives to adopt in higher education and skills to be reconsidered at the light of the networked digital environments as it happens for "information literacy".

In terms of training several projects promoted by international and European bodies within the academic context and outside of it are working to outline the requirements and design a framework for openness both at pedagogical/didactical level and technical one.

The many challenges in supporting and adopting open practices lie in the effort to create a synergy among the different interested actors embracing, at formal level, new parameters for accreditation, quality control and reputation.

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TOWARDS ENHANCING ONLINE COURSE DESIGN USING LEARNING ANALYTICS

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Abstract: *In this paper, we present an ongoing study on how learning analytics can be used to enhance learning designs of online courses. The needs of the learners are becoming more varied, and learners keep demanding, flexible, personalized and easy to reach learning methods. The available learning design models require that the teacher manually changes the learning design and propose changes to the learning design at the end of a course. A conceptual model is proposed based on results of literature review about learning analytics and learning design. The conceptual model defines different analytics metrics that can inform learning designs, how learning analytics can be packaged into personalized learner feedback and how learning designs self-adapt to suit needs of learners. We believe that if the learner is given personalized feedback and the learning designs adapt to suit the learner, then learning will be more engaging and learning outcomes will be achieved.*

Keywords: *Online learning, Learning Design, Learning Analytics*

1. INTRODUCTION

Institutions of higher learning continuously work to improve their teaching and learning methods by adopting online learning. This is because these institutions face challenges regarding course completion and retention rates of students [1]. The needs of the learners are becoming more varied, and learners keep demanding, more flexible, personalized and easy to reach learning methods [2]. Teachers need to keep up-to-date with the activities and progress of the learners in order to provide the appropriate support [3]. This can be achieved by analyzing the online data generated as students engage in their online learning activities, using learning analytics. If insights from learning analytics are well embedded into the learning design of courses, they can enable personalized learning.

Learning design consists of all the learning activities required of the students, the resources required and the support activities that teachers provide to facilitate student learning [4]. Teachers react to individual student's behavior to make interventions for those particular students, and the trend of the overall behavior of all students can be a basis for teachers to change their learning designs. These decisions can be made with the use of learning analytics, which enables real-time interventions to be taken within a given course [5]. However, the learning data is not sufficiently utilized to measure the level of student engagement and progress because of lack of conceptual models for aligning such data with pedagogical intent [6].

While there are several discussions about the need to align learning analytics with learning design, few studies have suggested models for the integration of the two concepts. As [4] states, one of the challenges faced with learning analytics is how to empower teachers so that they can be able to use it and act upon analytics data. Despite the fact that learning analytics offers actionable insights into educational data, there is insufficient evidence about how learning management systems can adopt results from learning analytics to support learning and educational activities [4, 7]. We intend to develop a framework for self-organizing learning designs of online courses using learning analytics to suit the learning needs. This framework will integrate insights gained from learning analytics into learning design of online courses so as to improve the course delivery and learning outcomes of the students in online learning environments.

The rest of this paper is organized as follows. Section 2 presents literature review learning analytics, learning design and learning analytics use for learning design. Section 3 presents the research directions and the research methods that will be employed. The paper is summarized in section 4.

2. LEARNING ANALYTICS

Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [8]. Learners are normally diverse in terms of educational background, usage of course resources, motivation and reasons for studying [9]. Schools and teachers can use learning analytics to tailor the learning activities to each learner's level of need and ability, and extend its use to assess curricula, programs, and institutions.

In the study carried out by [10] to determine the factors that have impact on learner performance, it was discovered that participation in online discussions, interaction with peers and completion of exercises had a positive impact on the performance. Factors such as number of downloads, login frequency and time spent while logged in the learning management system had no impact on the performance. This indicates the need for teachers to develop engaging learning content if the learning objectives are to be achieved.

However, as [11] states, developing learning activities and content that enable the achievement of learning objectives poses a great challenge for most of the teachers. This calls for means through which learner competencies in different learning activities can be evaluated against the intended learning outcomes. A learning analytics framework that can be integrated with learning management systems to capture learning traces and use them to determine the extent to which learning outcomes are achieved was proposed [12]. However, the framework does not give guidance on how instructors can use the observed performance to assess the student progress. Therefore, there is need to build a theoretical and empirical base for matching the observed student study behavior and performance to the intended learning outcomes [6]. This suggests a need for a way in which the capabilities of students in different learning activities can be availed for instructors to assess whether the learners are making progress in relation to the set learning objectives.

Learning dashboards have been suggested as a way of enhancing the awareness and reflection on the learning activities by both teachers and learners. [13] developed an exploratory learning analytics toolkit (eLAT) with the aim of improving teacher support with graphical analytics, so that teachers can reflect, evaluate and subsequently improve on their instructional designs. Teachers can explore content usage and assessment results on individual learner basis using the toolkit. For a positive effect on the students' progress, the learning analytics dashboards must always be developed after considering the needs of the learners [14]. However, the challenge faced with the use of learning dashboards is choosing the right indicators to show the progress in a given learning activity, and the indicators that can enable the teachers make good decisions concerning their learning designs and as well provide good feedback to the learners [4].

3. LEARNING DESIGN

The field of learning design has evolved to the recognition that learners need to be actively engaged and positioned as active knowledge creators, and not just knowledge recipients [15]. This implies that teachers and facilitators need to adopt the mind-set of designers, who understand learners and create an environment to help the learners get to where you want them to be, be those tasks, resources, social configurations or tools. [15] further states that teachers should create an environment which permits learners to enquire, explore, analyze, synthesize and collaboratively construct their knowledge from the variety of technological resources available to them, given that information is dynamic, rapidly changing and needs to be contextualized. Learning design emerged from the field of instructional design, but with emphasis on the learning activity.

Instructional design is the process of improving instruction through the analysis of learning needs and the development of learning materials [16]. Several instructional design models have been suggested, but the model that forms the foundation for other instructional design models as well as learning designs is the ADDIE model [17]. It is a cyclic model, with five phases of analysis, design, development, implementation and evaluation, hence ADDIE [18]. However, the ADDIE model has been criticized for being so teacher-centered, thus not considering the needs of the learners in the process of designing instruction [19].

Learning design models which aim to enhance pedagogy have been developed including Integrative Learning Design Framework (ILDF) for Online Learning Environments [20] and Analysis of learners, Analysis of technological affordances, Course design, Learning support design, Ongoing evaluation and Constant improvement (AACLOC) model [21]. However, these models only propose changes to a learning design at the end of a course, do not provide timely, personalized feedback to the learners and do not cater for self-adaptation of learning designs to cater for learner needs. Therefore, there is need for making evidence-based decisions about learning designs, which, as the study proposes, can be provided by learning analytics.

4. LEARNING ANALYTICS FOR LEARNING DESIGN

Learning designs provide a good description of the pedagogical intent, while learning analytics results can enable teachers to evaluate the effectiveness of their learning designs and support activities offered to the students [6]. Learning analytics can be used to inform, monitor and validate learning designs with the purpose of improving online course delivery [15]. However, few studies consider using learning analytics to design learning activities that support collaboration and cooperation among students [22].

While there are several discussions about the need to align learning analytics with learning design, few studies have suggested models for the integration of the two concepts. [6] suggested two categories of analytics application, namely checkpoint analytics and process analytics. Checkpoint analytics shows whether a student has met the prerequisites for learning by accessing the relevant resources for the learning design while process analytics provides insights into how the students are engaging in the different learning activities. However, the study does not suggest how the teacher can change the learning design to suit the learner.

In [23], three areas of learning design that can be informed by learning analytics were identified: representations, approaches and tools. Representations provide the description of the pedagogical plans for a given course, which can be customized for a student or groups of students using analytics. Approaches support both novice and experienced teachers in their decision-making process about pedagogical plans. Tools support the sharing, adaptation and reuse of practitioners' pedagogical ideas, and also facilitate reflection. This

study defines what learning analytics can be used for, but does not explain how analytics can be used to inform learning design. [4] identified three key opportunities for applying learning analytics in learning design: Using on-demand indicators to support learning design decisions, making interventions during the period of course delivery and increasing student learning outcomes and satisfaction.

In [24], five dimensions of learning analytics were proposed, namely temporal analytics, comparative analytics, cohort analytics, tool specific analytics and contingency and intervention support tools, shown in figure 1. Temporal analytics includes the statistics of students' access to learning materials and is broken down into recurring events, submission events and single events. Comparative analytics enables teachers to compare student engagement in learning activities within the same period or over different time periods with the aim of identifying aspects that may need to be re-designed. Cohort dynamics involves grouping students with similar online engagement behaviors and assessing the performance of students within a given group. Tool specific analytics are tailored to specific learning management systems that are being used. Contingency and intervention support tools seek to enable teachers to identify at-risk students using a given set of parameters. However, teachers are considered to be central to using the information from analytics to manually improve on their course designs.

5. CONCLUSION

Learning design affects the level of engagement and performance of a given learner. Teachers thus need to always determine if the learning design is suitable for learners, and if not, change the design. This can be achieved through learning analytics, through which teachers can determine how well learners are progressing with their learning tasks. Therefore, this study suggests that online courses should self-organize, using the results from learning analytics to suit the learners' needs and learning styles.

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ON ADAPTIVE LEARNIG SYSTEM DESIGN USING COMPUTER GAME TECHNOLOGY

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Abstract: *The paper deals with reducing needs for instructor assistance in eLearning environment. Similarity between in-game learning and learning in life has been exploited as guiding idea to use well developed computer game technology in design of adaptive e-learning system. Learning to pilot an aircraft has been chosen as a carefully and well defined learning task to illustrate the concepts in the paper. The prototype of game technology based adaptive eLearning system has been developed and tested and results are reported in this paper.*

Keywords: *adaptive eLearning system, computer game technology, education games, flight simulation*

1. INTRODUCTION

By introducing an e-Learning system, the student received 24/h per day computer support, but that support could not evaluate student's preferences like teachers do: to answer student's questions and to provide him with additional help in mastering the material. Adaptive Learning System (ALS) is a Learning Management System (LMS) - computer system that attempts to fulfil some of the roles that teachers have in classical education (otherwise, it cannot be implemented without teacher, or the quality of the teaching is low). It has the ability to assess learner progress and account for this while creating the learning path. Modern ALS leaves the Learning Environment concept (LE-Learning Environment) with pre-programmed content and allows student to be more active, because they react depending on cognitive models and feedback - student behaviour. A modern LE design attempts to implement logical reasoning on a computer and intelligent agents [1, 2]. However, the artificial intelligence approach brings risk of complexity of the ALS structure, its verification and validation, and even the success of the ALS development project [3] [4]. Thus, the drawback of those ALS are: complexity, complicated development and uncertainty of realization success, despite level of the modern artificial intelligence, which still does not have the necessary level to support even the simplest human activities (for example, a home service robot).

On the other hand, play has an important role in a development of children and adolescents [5, 6] as a type of environment improvisation for problems solving that the individual meets in reality. Computer game designers use native property of the individual to play, they succeed to keep the attention of the participants in the game and that can be used for training. More precisely, there is a class of educational games that could be used in training and teaching, and that application is known as Game Based Learning (GBL) [7]. Hence, the application of game technology in ALS design is another alternative to AI approach, which attracts researchers. [8].

When designing the ALS, one of the most important things is to stimulate students to use that kind of system in order to have more successful learning. Computer games could be used to motivate students and this is one of the reasons for using computer game technology when designing an ALS. The use of virtual reality, 3D games, and educational simulators is a trend and also helps in the motivating and engaging of students. With these technologies we enrich the learning experience, provide a constructivist approach to learning, whereby students have free interaction with virtual objects, enabling them to explore, experiment, receive feedback and also allow greater interaction comparing to traditional teaching tools.

One of the possible approaches to the design of ALS is based on the technology of computer games. Namely, commercial games have already developed methods of motivating users for solving tasks and gradual learning and adjusting the complexity of tasks to the level at which the user may observe the way of solution. Moreover, the idea of this approach is found in the theories of internal motivation [5, 6, 12, 13], game theory [14] and problem-oriented learning [15]. The game based learning (GBL) is not the new concept, but the digital games technology development has facilitated GBL and it has been used in different areas of learning. This reduces the uncertainty regarding the feasibility of the ALS technological concept. However, applying game design methodology to the design of ALS has not yet attracted attention of the researchers, and therefore is the main goal of this paper.

The contribution of the paper is in solving the task: how to make easier learning in VLE (Virtual Learning Environments) and reduce need for instructor assistance,

without decreasing effectiveness of studies (course completion). This paper discusses the implementation of this and other similar systems and extrapolates learned lessons into general pedagogical guidelines that need to be considered when developing an ALS based on computer game technology. In the following sections we present how an adaptive learning system based on serious games and simulations planning may look like and to what should we need to pay attention in a way to make modern teaching more effective than traditional one.

A prototype of „game based ALS“ has been developed and tested in order to study advantages and drawbacks of the approach.

Learning to pilot an aircraft is well studied task supported by carefully formulated regulations and rich computer and simulation technology. It is chosen as well defined learning task, suitable to evaluate the concepts proposed in the paper. Educational games have been developed for a long time and also applied in teaching at all levels of education [16]. Simulation games that can be used in teaching and training are particularly interesting, such as, for example, flight simulators with a long tradition and application [17,18].

The plan of the paper is following. The main facts and knowledge about educational potential of computer games as well as relation between simulations, digital games and highly interactive Virtual (Learning) Environments are discussed in sections 2,3. Game design approach to motivate players (i.e. learners in the context of this paper) is reviewed in sec.4. Section 5. Describes development of the prototype of ALS and its evaluation.

2.REVIEW OF SOME RESULTS ON ALS DESIGN

The paper [9] presents the importance of simulation games and serious games when creating a learning environment system and this study has problematic limitation of teaching subjects to the learning of mathematics, computer and technical subjects. The paper is a review and concrete solution has not yet been given, but is good as the starting point for studying literature in order to develop an adaptive system based on computer games for the needs of the Belgrade Metropolitan University (BMU).

The next paper [10] presents the use of instruction programming concepts, the intelligent tutoring system concept, adaptive learning systems, and the recommendations for pedagogical system concept to help the development of adaptive learning systems based on serious games. The presented concept of work shows some extent coincides with our research as well as the direction for the studying matter, therefore it is considered as one of the important for the further developing of our research.

In the paper [11] has been shown the methodology for designing educational computer games, and those are based on what people think or create. he author proposed a model of educational game design combining elements of instructional design and system design. In essence, he did not present any instuctive theory that would be relevant to this model.

The paper [14] presents an adaptive learning system based on computer games and shows and describes the method for creating experienced systems for purposes of a serious game and ALS using the principles from the Simulation Experience Design Method. The demonstration of the use of the simulation experience design method gave the idea of how to approach the already mentioned problem of merging ALS and serious games.

3. COMPUTER GAMES AS AN INSTRUMENT OF STUDENT MOTIVATION

How games motivate players, i.e. how would this motivation help students to follow the teaching using an ALS based on a computer game methodology? Games should be "fun". The role of the game designer is, in most cases, that the game does it "fun".

Koster starts from the hypothesis that learning is the biological and sociological characteristics of people, and that games (and playing) are one aspect of that learning. [6,19,20]. Another Koster hypothesis (comes from psychology) is: people like to be successful in what they do, and they are satisfied if they are successful. So, it's attractive to be successful. [19]. Furthermore, games are one kind of thing to try, check and learn [19,20]. Let's remember, the world of the game is in some aspect similar to the real world. As an example, the ancient Greeks invented the Olympic Games as the performance to showing in the conduct of skills which were relevant for the war. Hence, Koster's "fun" in games comes from showing the performance of the player ("the fun of games comes from skill mastery"). The approach to Theory of Fun [19], therefore, the pleasure of playing games (fun) directly links with learning and improvement. More precisely, he relies on the work of Mihaly Csikszentmihalyi, who was investigating how, he said, the mental state of the "flow" (or "in the zone"). [20]. Sometimes, an activity captures our attention so completely that the rest of the world seems to disappear. We become totally engaged in what we’re doing that time becomes distorted, somehow it seems to both slow down and to fly by unnoticed. In such a state, we perform better, forget ourselves, and become one with what we’re doing. This state is known as “flow” and it perfectly captures the fundamental appeal of games. In such a state, people become highly focused, become less aware of themselves, experience an altered sense of time, and feel fully in control of their actions. *That is what is important and help in teaching - motivated and productive students - students in "flow".* Therefore, it is necessary to carefully program the game or, in this case, to design the ALS based on the computer game.

4. VR, 3D GAMES AND EDUCATION SIMULATORS

Educational game is most typical serious game, and close to academic people from application domain point of view. Let's point out the spectrum of simulation (or VR-virtual reality) technologies which are successfully applied in training and learning [9,22]. Due to a constant decline in price, they become the part of the game technology and therefore they become interesting for formal education, offering another opportunity for teaching. Serious games are not only used for fun or play

and they do not have to be games in the right meaning of this word, but basic technology has been borrowed from video games using artificial intelligence, robotics and theory of learning. That's why serious games are sometimes called light-weight simulators – simulators implemented in low cost (game) technology [22-24]. A simulation game (if not used for entertainment only) may be considered as educational game (project management simulations, vehicle simulations) and used in formal education process.

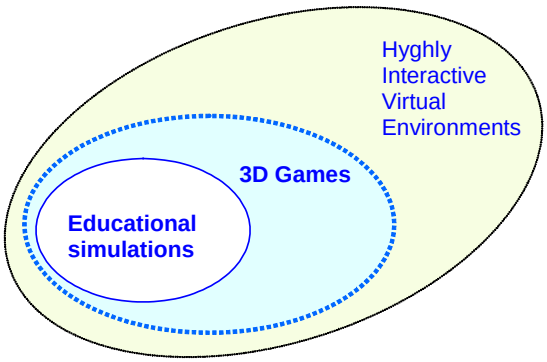

Fig 1: VR, games and SIMs

5. METHODS FOR MOTIVATING PLAYERS IN GAMES

In order to put flow in our games, we figured it out that a player achieves a certain skill level (in playing the given game), and the tasks which are played in the game could be easier or more difficult. As an example we can take a flight simulation training game where flight conditions could occur that plane may be flown without any excessive flight control. The next situation can already be such that it is very difficult to bypass some particular obstacle. Generally, in games the player's abilities are usually concentrate on the problem solving, i.e., it is necessary to be more successful (= more skilful). For games we can say those are improvisations of real-life situations in which something needs to be done, i.e. a problem to be solved. So, games are the context for solving a real-life problem. [25]

In strategy games (for example, chess), time can also be included, and those games themselves require the mental energy engagement. So, here we can also say that ability = skill. However, in the design of specific games, one has to go beyond such a simplified interpretation of the player's ability and explain it to further elements (as coaches of sports teams do). Throughout the game, the player manages how to solve the problem (player becomes more skilful). By repeating the game, players become more skilled. Skills can be like a reflex (on the basis of acquired reflexes - Pavlov [26]) or intellectual-logic skills dominated by the conscious part of the brain. The same games (even video games) can be divided into: action-dynamic (i.e. based on reflex skills) and intellectually-logical.

Energized Focus is a state of mind, where the substance of playing is one of the basic goals of game design: to grip attention of the player and bring it into full state of play. Visual and sound effects, challenges, interaction of players combine in perfect harmony for flow (high tension and concentration), to stimulate emotions of player and make them to forget that they are in non-real world.

Involvement a.k.a. Replacing Reality is further extending the previous idea in order to get the player away from reality. In the cinema, lights are dimmed, all sounds are muted to hear and see only what is on the canvas. Games have different methods, but they have the same goal and achieve similar effects, because players can feel like they are really involved in the happenings in the game world - in the case of the simulator, environment and the model of the airplanes that the player sees replace the reality, where the VR environment can be used for more reliable view.

To be successful is the basic goal for all people, and that is also the goal in games. The reason why the brain brings the organism into a state of high concentration and tension is the desire to achieve success, even that is not achievable with a common level of engagement. Success is rewarded with a sense of satisfaction and that is (by Koster), "fun" in games [19]. Something like: the games are fun because they give a chance to people to be successful. For designers: games are fun if they give a chance to players to be successful, but only with enhanced work.

5.1 Design Flow in Games

Let's look at previously exposed facts from the point of view of game designers with a better explanation. So, we know that if we want to be in the flow condition, the activity must be challenging. Game needs an attainable, balanced goal. If the activity is easy, the brain has no reason to lose the mental energy, because success has already been ensured. If it is too difficult to achieve the goal, the brain has no reason to work hard, because it knows that it will end up with failure anyway. It is therefore necessary to "level up" (set a goal) so that the player can succeed, but only if he really work hard.

In Fig 2. we can see that the tasks must be simultaneously challenging and achievable. A task that is not challenging (or that requires excessive time to accomplish) becomes boring and we lose interest. On the other hand, if the task is too hard, we become frustrated and anxious, and once again, we lose interest. Everything depends on the balance between the difficulty of the task and our skill. Further, since a person's skills will improve over time, the challenge needs to increase along with the improving skills. This is good for games, because there's a lot of fun there. Keep in mind that "flow" and "fun" are not synonyms, although they are related. You can be in a flow without playing the game. For example, a rescuer may be in the flow state while extracting people from the building affected by the fire. He can work on the edge of his ability but to overcome obstacles as efficiently as possible. After success, the rescuer will feel pleasure, but we can not talk of fun. [27] [28] If, when flying a simulator, a player feels that bypassing the obstacles is too difficult, he can stop playing the game and can lose motivation, but also if is too easily to play, the game becomes too boring. Therefore, the obstacles that the student should circumvent should be carefully selected. After the mastering flying a certain type of aircraft, it can also

change the type of aircraft in the order to master flying of aircraft with different characteristics.

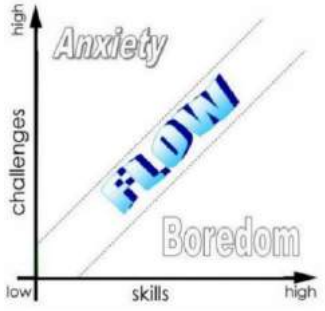

Fig 2: Flow – Balance of Difficulty vs. Time/Skill

5.2 Practicing players and saturation

When confronted with challenging tasks, you are getting better in solving. It's fun because you learn. So, most people start an activity (even a game) with a low level of skill, so if the game does not require a lot, that's acceptable. But what happens when a player achieves some level of gaming skills? If player still gets the same easy tasks, the game becomes boring. That's exactly what happens to Tic-Tac-Toe when a child begins to understand the strategy of the game. At the same level of the task, the person who performs it several times gets more and more efficient. Activity becomes less and less interesting and slowly goes into routine. A similar situation is also with the flight simulator - the longer it plays, the player routinely learns the behaviour of aircraft and alleviates the obstacles more easily - with increasing difficulty levels in order to maintain the attention of the player - the student.

5.3 How to prevent the player from getting bored of playing games?

Game designers try to solve that problem in various ways. In the next section, we'll show some of them.

- Increasing difficulty as the game progresses (this is sometimes called "pacing" games). As a player becomes better, he advances through the levels that are getting harder. This is a common video game based on level.
- By introducing a beginner, intermediate and expert level, where better players can choose a level with more difficult challenges.
- Dynamic difficulty adjustment DDA, a special type of negative feedback loop that attempts to automatically adjust a game's difficulty to match the player's skill. If the player is struggling, the challenges are made easier; if the player is dominating, the challenges are made more difficult. For instance, opponents can become less numerous or tougher; time criteria may be extended or shortened; or solutions may be made more or less obvious via graphical techniques such as highlights and particles. As an example, in Tetris, it would be possible to generate suitable blocks that can be packed more easily (but not done so in the game). When we create a flight simulator, it is necessary to overcome all difficult obstacles and, therefore, we decided to use this technique.
- Human opponents in the game. Of course, you can be better and better in the game ... but if your opponent is also getting better, the game remains challenging if it has enough depth. But, here the problem is the game, because that must be interesting also to opponent (unlike computer opponent, who is immune to psychology). In classic games, this is solved by awarding the title to players (in chess - categories, in sport leagues).
- Levels of challenge created by expert players using level creation tools (level editor). Clear goals are connected to the player's ability to have enough mental resources for cognitively processing and clustering missions, levels, quests or game sections, so that their progress in the game is always apparent.

The game flow has a built-in dynamic weight adjustment (DDA Dynamic difficulty adjustment) design. Players with different levels of skill can intuitively adjust their experiences in the flow zone and enjoy the game in their own pace and this principle is used when the simulator is created. [29]

6. ADAPTIVE LEARNING SYSTEM TO PILOT AN AIRCRAFT

A beginner, aiming to gain a pilot license issued by aviation authority for a chosen type of aircraft, should pass flight training which is typically conducted in flight school under accredited syllabus. An example of training course syllabus for a private pilot license is outlined in [30].

6.1 Learning task and syllabus

For the study described in the paper a shortened version of syllabus is created for virtual flight school for those who like to learn basics of piloting aircraft.

Namely, to prove concept of eLearning system reducing instructor assistance it is sufficient to cover most important parts of training. In our case training is restricted to VFR (visual flight rules), first solo flight and flight lessons completed on simulator of a single-engine GA airplane. This we shall refer to as virtual piloting course, whose participants are university students, receiving virtual pilot licence after successful completion of course. The course participants are also beta testers for the adaptive learning system developed to support the following syllabus.

The following learning objectives (based on AC141are adopted :

- Aviation regulations and requirements
- Airport familiarization,
- Airplane familiarization,
- VFR navigation & flight planning
- -Aviation weather
- Flight mechanics
- Basic manoeuvres of flight
- Fundamental flight training manoeuvres
    - Straight and level flight
    - Constant altitude turns

- Climbs
- Descents

- Systems and instruments

The following practical tasks (Flight lessons) are to be successfully completed

Flight lessons (Stage one)

1. Airplane familiarization,
2. Review on basic flight manoeuvres
3. Flight at minimum controllable airspeed, steep turns, and power-off stalls
4. S-turns across a road, turns around a point, power-on stalls, and elementary emergency landings
5. emergency procedures, procedures used to change airspeed and AC configuration
6. At least three take-offs and landings to a full stop
7. review, preparation for solo
8. review, continue take-off and landing practice
9. first supervised solo flight

STAGE ONECHECK: SOLO PLIGHT

6.2 Adaptive learning system design

The primary goal of the adaptive learning system design is successful course completion with minimal instructor assistance. The goal will be achieved using game technology based design, considering course participant as game player.

The base of VLE is simulator of Cessna 172 and airport used in Pilot Academy at Vrsac.

Considering learning as a game, the following correspondence may be established

a) player rank = learner skill = { beginner, intermediate, good }

b) game level = Lesson = { task_1, task_2, ..., task_n}

c) game level difficulty (= task difficulty) = { FM easy, FM intermediate, FM realistic }

Levels are to be ordered "in logical way" i.e. all the facts and concepts used as known at present lever should already have been learned at preceding levels.

Like in games, student may pass to the next level (task) only after successful completion of the actual level. By default, task difficulty is set to realistic if player is ranked as good. If, after several attempts student does not successfully complete task, task difficulty is reverted to an easier level. On the other hand, if student successfully completed several successive tasks (levels), his rank is increased in order to speed up progression through the lessons.

Lesson (Task criteria) example:

Flight lesson No 1. (dual) [141-1A]

At the completion of firs flight lesson (dual) , the student should be able to, with assistance, conduct a pre-flight, use checklists, make engine run-ups, maintain altitude in straight and level and in turns within + - 200 feet and control heading with +- 20deg, and display an understanding of ground safety.

6.3 Adaptive learning system implementation

Adaptive learning system based on computer game technology is a result of student project and was developed by students of Faculty of Information Technology (FIT) and Faculty of Digital Arts (FDA) who have already mastered game technology to some extent (i.e. Final year of bachelor, master or doctoral level studies). Afterwards, a simulation was created in Unity 3D (airport, planes, moving elements, primary scripts).

The airplane (Cessna 172) and airport modelled was originally used by the national pilot academy for civil aviation at Vršac to train the cadets. In order to simplify project and to reduce cost, project is based on easy to find public sources (e.g. Google maps, on line free flight lessons). Also, simulator fidelity is limited to introducing airplane controls and instruments, as well as airfield objects, covered in first few training lessons.

Fig 3: Cessna 172 ALS based on computer game technology

6.4 Adaptive learning system testing

For the usability test we took CS367 Game Development 1 subject. In this subject, students learn about programming applications in Unity 3D, including the study of aircraft (also include aircraft physics, which is necessary to make flight simulator). For testing we use AB principle - two groups of students (A and B groups). It is necessary to determine which group has more success in solving the test. We found 10 students who reported themselves as volunteers and divided them into two groups. Each one of the groups have students with similar profile (the total average at faculty is the same, similar years ...) Both groups were doing the same test - a simplified flight simulator. The first group use ALS based on computer game technology for learning (to master the physics and principles of airplane programming), and second group has traditional lectures on the same subject. After the lecture, students were about to solve the same test.

Testing results

Test results could be seen in the following tables. The first table shows the results of the first group, the second table shows the results of the second group.

I group

	I student	II student	III student	IV student	V student
Result	88%	70%	90%	95%	80%

II group

	I student	II student	III student	IV student	V student
Result	75%	65%	60%	75%	69%

Fig 4: Test results

With this, we can conclude that all students studied had more success if they used the ALS based on computer games technology. It was interesting to the students because the lecture was not monotonous and they devoted more time to it and were more attentive to the lecture. With this we can conclude that the introduction of new technology has helped students to learn more easily and that the created simulator has so much stimulated students to follow the lessons more closely.
This can also be considered as a new kind of adaptive learning system that will be interesting to students. It would be thus very interesting to introduce not only at university level, but also in elementary and high school.

7. CONCLUSION

Similarity between game playing and real life task solving as well as correspondence between in-game learning and learning in life has been exploited in the paper as guiding idea to attempt to apply from well-developed game design methodology to design of adaptive e-learning system.
An airplane piloting education task has been chosen as an example to implement flow based (game like) adaptation mechanism in eLearning system.
Prototype of ALS for pilot initialisation has been developed and tested using IT students who volunteered in virtual piloting course.
Prototype evaluation has shown that students progressed through flight lessons with no major difficulty and with minimal instructor support.
Thus, it has been shown (or confirmed at least) that treating learning process in higher education as a game gives useful tips in designing and developing ALS and exploiting well developed computer game technology.

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BEHAVIORAL ASPECT OF TEACHING LINEAR PROGRAMMING TECHNIQUES FOR GAMIFICATION OF THE ENGLISH LANGUAGE LEARNING

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Abstract: *Gamification and implementation of the computer games in education support knowledge and increase children's' attention during a learning process. Teachers, on the other side, usually are just passive users of the Gamification techniques in teaching. There is an evident gap between behavioural aspect of teachers and their adoption of modern technologies and the same aspect on accepting technologies inside children population. This study used quasi experimental approach and constructive qualitative methodology for the analysis of the behavioural aspect and adopting of new technologies learning linear programming techniques to students of the English languages. During the course implementation, students developed tailor modelled games in line with the curriculum for the language teaching adequate for the age, and a level of knowledge of children in the learning group.*

Keywords: *Gamification, linear programming, behavioural aspect, education*

1. INTRODUCTION

Extensive devlopment of Informational Technologies (ICT), at the end of twentieth and beginning of the twenty-first century, made foundation for implementation of these technologies in every aspect of human endeavors. The beginning of implementation of ICT was closely related with educational institutions and universities, but it was mostly in the domain of the research with limited number of people, with access to raw computational power. Development of the Personal Computers PC changed this paradigm and managed to bring computers into the houses and widen the usage of ICT, not just within the limits of highly professional usage, but also enabled sage for fun. Development of the Internet and mobile computing enabled creation of new social forms, and new and exciting ways in connecting people.

Since children spend more and more time in front of PCs for fun time and spend a huge amount of time in solving video games, the first research were introduced whether we could develop and implement gamification of education and made it closer and adapt to new generations.

This approach developed a new didactical approach to learning, where in many aspects; gamification requires a change of the traditional aspects of learning. Gamification is not a simple implementation of video or computer games as an additional learning or teaching tool. Gamification is a new approach to learning, exercising, repeating and marking. Gamification uses game mechanics, interactive games (not only computer based), presentations, role playing, game based marking based on previous achievements and adapting learning steps according already achieved scores or markings [1].

Gamification and accepting new technologies was extensively researched in the fields of engineering, mathematics and informatics education. This was rather expected since students and teachers in the specialized schools were the first adopters of new technologies [2-4].

Similar techniques were used in teaching of non-engineering lectures, and term of Computer Assisted Language Learning (CALL) was easily implemented in the curriculums of language learning. The application of new technologies showed an important improvement of learning experience and positive response was received form teachers, students and pupils [5].

Students of foreign languages in the curriculums have lessons in modern technologies and CALL, but there is a missing link and understanding of the processes involved in linear programming, since it is one of the core issues of understanding gamification and game design. Design of the game which needs to be interesting, fun, but education is of the most importance in developing successful gaming environment for teaching [6]. The lack of Mathematical knowledge creates a negative opinion within student population and creates a lack of the initiative to gamification classes. Pupils are on the opposite side, they

use modern technologies as an integrative part of their social environment. Learning of the ICTs and gamification arise as paramount for future educators.

The research we delivered was based on the delivery of the course of linear programming to students of the English Language and Literature, following behavioral aspect toward implementation of gamification of the teaching of the second language, in this instance the English language.

2. CALL IN EXISITNG CURRICULUMS FOR EDUACTION OF THE ENGLISH LANGAGE TEACERS

Analysis of the curriculum for the students showed they have two courses regarding CALL in education. These two courses cover the basic knowledge of computer based skills, like the usage of word processors, spreadsheet programs, usage of the Internet and presentation programs. The second course covered more advanced issues, like programs for management of eLearning courses (Moodle Package), and professional packages for supporting translation work.

Beside these two courses which provide basic ICT knowledge, CALL approach and implementation of advanced technologies is mentioned during methodical course during 6 classes. But, there is only vague mention of the different technologies which can be implemented during learning and preparation of the teaching material.

The detailed overview of the courses showed the courses are predominantly based on the end user experience. There is no description of the processes or logic which exists in programing. This creates an obstacle to students if they want to use gamification in the future work. There is a clear need to establish environment where these students can acquire the needed knowledge, taking in account their lack of the Mathematical knowledge.

Learning of programming languages can be cumbersome, but during development of ICT, programmers developed a wide range of specialised programing languages adaptable for different applications. The existence of object based programming languages, and especially specialised programming language, adapted to children can create an opportunity for students with the lack of Mathematical knowledge to develop more interactive teaching material. The importance of this package is recognised in Serbia and these packages are now included in curriculums in elementary schools, which create a solid basis for implementation of these packages at tertiary level education.

2. LINEAR PROGTRAMMING COURSE FOR ENGLISH TEACHERS

Understanding of the linear programming concept to students was initiated with familiarisation with management tools used in the Software engineering. The main objective for students was to develop their skills in understanding of programme languages and defining: functions of compilers, Syntax and Semantics in programme language. The second aim was to make them familiar with algorithmic approach for problem solving and testing algorithm. The third aim was to train students how to programme algorithmic steps and how to actually write the programme. And finally, to understand arrays, functions and procedures. Every objective was accomplished by development of the short educational game or animation.

We used Scratch programming language as the implementation tool. This is a visual programming language for creating interactive stories, games and animations. It is developed by MIT media lab and its target group are children. In this way, we could teach teachers to prepare Mathematical games for children, but also, at the same time, they can support interest in children population toward information technologies.

The course was delivered with following objectives and received outputs:

Understanding the concept of programme languages, definitions of functions and compilers, definition of Syntax and Semantics in programme language.

- Graphic representation of algorithm
- Stages for solving algorithm
- Structure of algorithm
- Testing algorithm

Algorithmic approach for problem solving and testing of algorithm

- Graphic representation of algorithm
- Stages for solving algorithm
- Structure of algorithm
- Testing algorithm

Understanding definition of arrays, functions and procedures

- Basic cycle
- Organization of cycle
- Leaving cycle
- Arrays
- Functions
- Recursive function

Image 1: The interactive game prepared during the course

3. BEHAVIORAL ACOECT OF THE IMPLEMENTATION OF LINEAR PROGRAMMING IN ENGLEASH TEACHING CURRICULUM

The aim of the study was to track changes in students' attitudes towards engineering approach in learning and methodical preparation of material and whether this approach actually induced the change of attitude at the behavioural level.

The study population comprised of students (N = 80) who were in the final year of their Bachelor Studies and at Master Course. Linear programming was implemented during 8 week course, as an addition to the regular classes.

To properly measure this, we used constructive qualitative methodology [7]. This model can be used to measure the attitude of an individual towards a particular object, as a combination of three components: cognitive, affective and behavioural. The cognitive component represents the rational arguments towards the object; the affective component reflects the feelings towards the object; and the behavioural component represents the individual's overall behaviour towards the object. This model is used as the theoretical foundation in many educational studies examining attitudes [8-9]. Our case covered only the behavioural aspect.

The method is based in anonymous questionnaires at the beginning of the first and at the beginning of the final teaching session. In order to supplement information obtained by the questionnaires, semi-structured interviews were held with students before the last course session, the observations focused at the behavioural aspect of students' attitudes towards Constructive Approach in teaching. After completion of interviews and questionnaires, the received answers were within the content were analysed and categorized. The information obtained from at least three different participants, for a single research tool, was included in the analysis as the relevant one.

Since the aim of the research is to establish student's attitude towards linear programming in language learning course,

Students at the beginning of the first session were asked:

'What is your opinion regarding learning programming techniques?'

"What is your opinion on classical, lecture based approach?"

These two questions were defined with two possible outcomes of positive attitude and negative attitude. Positive refers to positive response, while negative represents negative response or lack of response.

The analysis of the findings showed most of the students 67% had positive opinion on lecture based classical approach, while 100% had negative opinion on learning programming skills. Table 1.

Learning	**Attitude**	
	Classical %	Programming %
Positive	60	0
Non positive	40	100

Table 1: The opinion of students before the course

In the additional questionnaire, they elaborated the main problem was in behavioural level, since the overall opinion was that programming in preparation of teaching material is something which should be within the domain of engineering.

In the final questionnaire, filled out at the beginning of the last session, the students were again asked regarding their attitudes towards different teaching approaches. This time, 90% of students stated positive stance towards learning programming language skills, Table 2.

Learning programming skills	**Attitude**
	Laboratory %
Positive	90
Non positive	10

Table 2: The opinion of students after the course

In order to provide a deeper insight and find out behavioural change of opinion before and after implementation of the additional course, we needed to repeat these questions in the forms of semi- structured interviews.

Since students had an extensive experience in traditional teaching, the main disadvantages of this approach were evident at the behavioural level. The reasons why traditional teaching does not feel attractive and challenging are based on a rather passive student role in traditional teaching, where students feel more like notifications of results then active teaching subjects. After completing this additional course, the opinion on behavioural level drastically changed, student praised the active role in learning and preparing material. The material developed was also planned as the interactive tool rather than non-active presentation.

Passive participation	90	I do not spend too much time for preparation of class. All needed actions and procedures are prepared in handbooks, books or material presented at classes	Classical approach does not activate students to participate in development of methodical tools.
Active participation	100	During the course, not only I need to create something new, I also needed the support from other students and teachers in order to complete this task.	Learning programming skills improves interest for the course expressed through more active participation.

Table 3: The additional opinion explanation at the behavioural level

5. CONCLUSION

The implementation of ICT in all aspects of learning should not be based on simplification, and education of educators to be just mere end users. Fulfilment of the meaningful technology development in a learning cycle is possible only if we use proper tools and adapt them to teachers, in all fields of education. Technology must not be

just extensive used to engineering and informatics courses, we need to incorporate them at all level of curriculum and lesson preparing. We showed this endeavour increased active participation of students and a better opinion of the future implementation of newly developed ICT at the behavioural level.

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M-LEARNING, MYTH OR REALITY - EDUCATIONAL APPLICATIONS

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Abstract: *Technological development and increasing use of mobile phones have opened up a new market in the field of production and sales, as well the development of applications for mobile devices. The data indicate that by 2018 developed over 7.1 million applications for mobile phones. Apps made for mobile devices are available to all users who can download them for free or with a minimum fee. Applications can be downloaded from "stores", of which is most popular Google Play Store and the Apple App Store. The paper presents an overview of the research with the aim of recording the current state and representation of m-Learning, as well as the use of applications intended for the education of mobile users. One of the goals of the work is to examine users about the use of educational applications in order to acquire knowledge.*

Keywords: *M-Learning, e-Learning, Educational application*

1. INTRODUCTION

Developing mobile and information technologies created the conditions for the development of distance learning (e-Learning), and later learning by using mobile devices (m-Learning). M-learning provides high availability to users (anytime and anywhere) and thus represents one of the modern ways of education. According to a survey [1], in 2015, 30 percent of mobile users used a mobile phone in teaching or accessed educational content. The survey showed that 82% of adults own a laptop, 65% own a smartphone, 48% own a tablet, while 26% of users have all three devices. According to [2] mobile learning strategy can actually achieve the goal, that is, learning at anytime and anywhere.

The paper presents an overview of the research related to the representation of mobile learning, the trend of publishing educational applications and the overview of applications that are most common among respondents.

2. RELATED WORK

The authors [3] give an overview of the application of mobile applications in education. In addition to the stated advantages of defined mobile applications, the authors give an overview of the advantages that mobile learning has over classical electronic learning. Authors for the listed mobile apps give an overview of the ratings and description of the applications themselves.

The paper [4] provides an overview of the mobile technologies used in education, an overview of the operating systems represented in mobile devices, and a review of mobile learning applications in the context of mobile learning in the future.

The author [5] defines the concept of m-Learning and gives an overview of the basic characteristics of m-Learning in relation to e-Learning. Through the chapters of the paper, the author defines the advantages and disadvantages, similarities and differences of m-Learning and e-Learning.

In the paper [6], they deal with applications of mobile learning from the pedagogical aspect, as well as a study of the application of teaching strategies in different contexts. The authors define the potential for generating innovation in schools, offering new and different ones opportunities in the process of teaching and learning, and helping students to better understand the content and information using m-learning

This paper [7] describes the basic elements and characteristics of mobile learning according to new trends and technology development. Defined elements of mobile learning are learner, teacher, environment, content and assesstment and basic characteristics of m-learning are ubiquitous, portable size of mobile tools, blended, private, interactive, collaborative, and instant information.

3. DEVELOPMENT OF MOBILE APPLICATIONS AND M-LEARNING

With the development of smart mobile phones in the mid-2000s, a large number of applications for mobile phones have developed. The current estimate [8] is that there are 4.57 billion mobile phone users and that the number will increase to 4.78 billion by 2020. With the advent of the Google Play Store and the App Store (in 2008), conditions

have been created for storing and downloading a large number of mobile applications. In addition to the two aforementioned stores, the most commonly used applications are BlackBerry World (earlier BlackBerry App World) released in 2009, Windows Phone Store (formerly Windows Phone Marketplace) published in 2010 and Amazon Appstore (published in 2011).

Apps that were in the distribution in the earlier period were mostly created by large corporations. With the increasing growth of highly educated in the IT field, applications developed by freelancers have become more developed.

The two mentioned and most common stores contain applications divided into categories Google Play Store (33 categories) and the App Store (25 categories). The number of available applications on the Google Play Store in June 2018 was 3.3 million, while 2.2 million applications were published on the App Store by January 2017 [8].

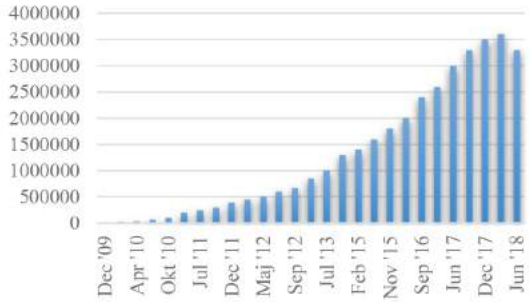

Image 1: Number of available applications in the Google Play Store from December 2009 to June 2018

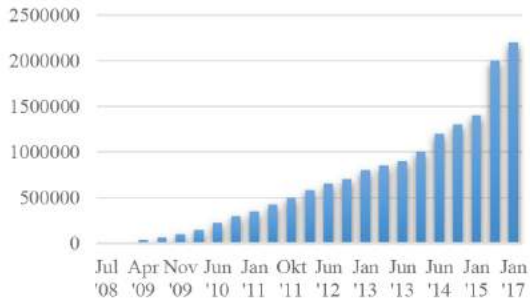

Image 2: Number of available apps in the Apple App Store from July 2008 to January 2017

The next graph shows the estimated number of downloaded applications in the current and 2022 years. According to the chart, the number of downloaded applications in 2022 will be higher by 80 million and will amount to 258.2 million applications.

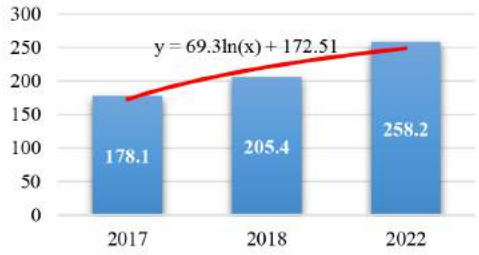

Image 3: Number of mobile application downloads worldwide, 2017, 2018 and 2022

The mathematical expressions of logarithmic functions in the function of the values of number of mobile application downloads:

$$y = 69.3\ln(x) + 172.51 \quad (1)$$

Education categories on both watched stores are one of the most common and a large number of applications are classified into this category. It's estimated that there are close to 273000 apps on the Google Play Store, while there are 200000 educational apps on the App Store.

Developing a large number of mobile applications has created one of the prerequisites for mobile learning. Mobile learning can be defined as a learning method in which the only and dominant device is mobile. Mobile learning may include the use of mobile phones, PDAs, personal digital assistants, tablets and other portable devices [9].

Many authors have recognized the benefits of m-learning, for example, Authors in the paper [10] state that this type of learning increases the flexibility of transferring knowledge and feeling of freedom of movement. In this way, they remain connected with the environment, although they do not have to be physically at all times present [11]. Also, the good sides of such support continue, they are seen in increased motivation, better coordination of team activities, faster response options, as well as in the increased level of communication between students and students. It should also be noted that mobile learning is in line with learning strategies throughout life, since everyone can be a mobile application user, i.e. there are no restrictions only on students [3].

Some of the advantages of mobile learning in relation to e-learning are the ability to quickly access educational content. According to research [1], users go through educational courses most often while on business trips (32%), at home (26%), in public transport (24%), at work (18%). The users who use the mobile device on average spend less than 45% of their time on average compared to those who use traditional computer-based online learning.

The benefit of mobile learning is the fact that 65% of digital media is viewed by users via a mobile device, and 70% of users are more motivated when learning via a mobile device compared to users who learn using a computer.

According to [7], basic elements of mobile learning are:

- Learner: Learners at the center in all teaching and learning activities according to new education approaches. All the other elements serves to the learner. Mobile learning builds on the learner's interests, experiences and needs.
- Teacher: Books and other media elements store information and teachers convey it to students in traditional learning environments. On the other hand, recently using technology for store information, support more accessiable information for students.
- Content: Issues that expected to learn by students. Content should be decided in consultation with all stakeholders such as learners, teachers, parents etc. Otherwise teachers can not get the desired results.

Learning content must enable a user to quickly zone into needed information.

- Environment: Environment must design properly to obtain positive learning experiences. Environment is that place when students reach information. Students studying entirely online must have access to all of the unit content including the learning outcomes, assignment requirements and relevant resources.
- Assessment: Assessment is a critical component of the complete m-learning. Mobile technologies can assess record and report learner performance to the instructors. So, student evaluation should make via database logs, software packages, online exams, chat room, discussion board, online quizzes, or project evaluation. Also students should evaluate themselves and others. It provides the pieces needed to accurately evaluate a learner's knowledge, skills, creativeness and etc.

However, the simple random use of a mobile device for performing isolated activity in classroom is not mobile learning. For an effective understanding as such, the trainer (teacher) should be integrated the use of technology with pedagogical planning that includes the study of content, teaching materials, implementation strategies and activities [6].

According to [12], there are several advantages inherent in mobile learning:

- helps learners to improve literacy and numeric skills
- helps learners to recognize their existing abilities
- can be used for independent and collaborative learning experiences
- helps learners to identify where they need assistance and support
- helps to overcome the digital divide
- helps to make learning informal
- helps learners to be more focused for longer periods
- helps to raise self-esteem and self-confidence

In various parts of the world mobile learning developments are taking place at three levels:

- The use of mobile devices in educational administration
- Development of a series of 5-6 screen mobile learning academic supports for students
- Development of a number of mobile learning course modules.

Covering problems of distance learner through mobile learning The common problems of distance learners can be summarized as follows:

- Lack of personal contact and immediate instructor feedback that some learners prefer
- Sense of isolation
- Requirement of pre-course orientation to help manage courses
- Requirement of the tutor support counseling sessions during course of study,
- Improved information and formative advices.

Mobile learning can provide helps in following dimensions of distance education provision:

- The provision of course content to off-campus students,
- The provision of feedback to off-campus students,
- The provision of student support services to off-campus students,
- Links to the WWW and other resources,
- Student-to-student interactivity,
- Student to tutor and institution interactivity.

4. RESEARCH METHODOLOGY

The aim of the research in this paper is to determine the representation of mobile learning among the respondents. Data collection was conducted by a month-to-month survey, where users of the Internet polished the survey, or provided answers to questions regarding the use of mobile devices for educational purposes. The survey questionnaire was distributed online, using social networks. The poll is anonymous.

Methods of research used in the paper are methods of analysis, inductive-deductive method and comparative method.

Koliko imate godina?

_____

Stečeno obrazovanje?

○ Osnovno obrazovanje ○ Srednje obrazovanje ○ Visoko obrazovanje

Vaš trenutni status?

□ Učenik □ Student □ Zaposlen

Koju marku mobilnog telefona (i/ili tableta) koristite?

○ Acer	○ Coolpad	○ Meizu	○ Samsung	○ ZTE
○ Alcatel	○ Gigabyte	○ Micromax	○ Sharp	○ nepoznat proizvođač
○ Apple	○ Google	○ Microsoft	○ Sony	
○ Asus	○ HTC	○ Motorola	○ Tesla	
○ BlackBerry	○ Huawei	○ Nokia	○ Vernee	
○ Blu	○ Lenovo	○ OnePlus	○ Vivo	
○ Chuwi	○ LG	○ Prestigio	○ Xiaomi	

Koliko dnevno provedete vremena koristeći mobilni telefon/tablet (razgovaranje, dopisivanje, upotreba interneta/aplikacija)?

○ <1h ○ 1-3h ○ 3-5h ○ >5h

Da li ste do sada na mobilnom telefonu (tabletu) imali/imate instaliranu neku edukativnu aplikaciju?

○ Da ○ Ne

Koju edukativnu aplikaciju imate instaliranu (ako je odgovor na prethodno pitanje Da).

_____

Da li smatrate da su edukativne aplikacije na mobilnom telefonu/tabletu uspele da podignu nivo vašeg obrazovanja?

○ Da ○ Ne

Da li ste tokom dosadašnjeg školovanja koristili neki sistem za elektronsko učenje na mobilnom telefonu/tabletu?

○ Da ○ Ne

Da li nakon ovog upitnika planirate da posetite Google play store / App Store ili neku drugu prodavnicu i istražite/instalirate neku edukativnu aplikaciju?

○ Da ○ Ne

5. RESULTS AND DISCUSSION

The number of respondents in the survey was 231, of different ages, from 13 to 51 years. The percentage that was most prevalent was from 19 to 24 years of age.

According to the education structure, the respondents were: 4 respondents (1.7%) completed elementary school, 129 respondents (55.8%) enrolled secondary school, and 98 respondents (42.4%) were highly educated. The structure of respondents can be applied to students (3 respondents or 1.3%), students (161 respondents or 69.7%), employed (76 respondents or 32.9%) and unemployed (13 respondents or 5.6%).

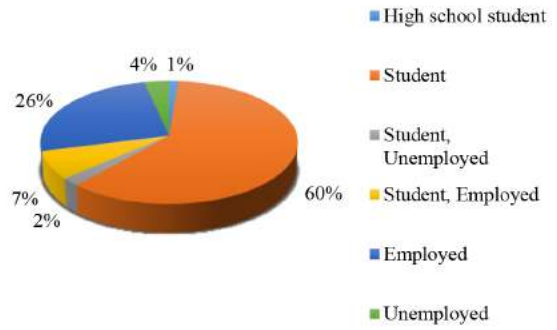

Image 4: Structure of respondents

By indicating the mobile phone brand, it was possible to conclude which operating system users are using. According to the results obtained, the Android operating system is represented by 84.4%, while the iOS operating system is represented by 15.6%.

The time use of the mobile device during one day with the respondent is extremely high. The answers given by the locals are shown in the following table.

Table 1: Using a mobile device for one day

Time period	Number of respondents	
less than 1 hour	11	4,8%
from 1 to 3 hours	77	33,3%
from 3 to 5 hours	67	29,0%
more than 5 hours	76	32,9%

To the question "Have you ever had or have an educational application installed on your mobile phone (tablet)?", 100 respondents or 43.3% said they had an educational application installed in the past, while 131 or 56.7 % stated that it was not.

Respondents who have said that they used educational applications in the past, to the question "What educational application have you installed" gave one or more answers. By looking at the above answers, it can be noticed that the largest number of applications are free of language learning (applications: Duolingo, English Learning, Quizlet, Memrise, etc.). In the second place are IT applications (applications: SoloLearn, CppDroid, DataCamp, Programming Hub etc.).

The other applications mentioned are the areas of mechanical engineering, mathematics, statistics. In addition to the above applications, there are applications that support a wide range of courses from different fields, vocabularies, encyclopedias, professional papers, etc.

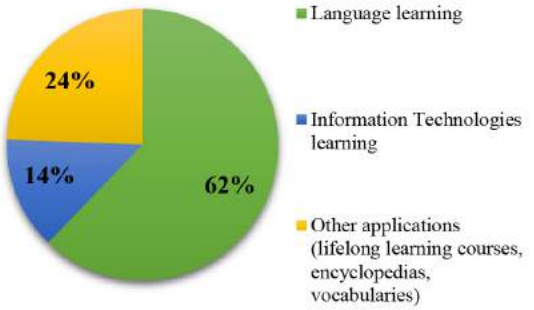

Image 5: Most used applications

The five applications most common among respondents are:

- Duolingo - is an application for language learning. The application works as a support to the same web portal. The application provides the ability to learn 34 languages. The current app's rating is 4.7.
- Quizlet - a language learning application. The application provides the ability to learn 44 different languages and complete grammar support for the selected languages. The application was rated at 4.6.
- SoloLearn - represents one of the most widely used applications in the field of information technology. The application has multiple variants customized to a specific field (programming, database, algorithms). The current app rating on the Google Play Store is 4.8.
- Coursera - this application provides access to over 2000 courses from various disciplines (mathematics, music, medicine, etc.). The application is supported by a large number of video lessons. the current app's rating is 4.4.
- Programming Hub - application for learning programming languages (Python, R Programming, C #). The application is one of the more represented in terms of mobile learning. The current app rating on the Google Play Store is 4.3.

The survey found that 88% of respondents (203 in total) believe that educational applications on the mobile phone / tablet can raise the level of education, while on the question "Do you plan to visit Google Play Store / App Store or some other store after this questionnaire? explore / install an educational application? ", only 49% of the respondents replied affirmatively.

Answers to the question "Have you used the application of a mobile phone / tablet e-learning system during your previous education?" 44% of respondents gave a confirmed answer.

6. CONCLUSION

This paper presents basic characteristics of m-Learning as well as a review of trends in mobile app publishing trends

in Google Play Store and Apple App Store stores. The aim of the research in this paper is to examine the representation of educational mobile applications.

The results obtained by the research are related to a large number of respondents who actively use educational applications in order to master knowledge in the field of language, information technology, parenting, protection at work, etc. A large number of respondents aged 20-25 years actively use mobile learning applications in the field of learning foreign languages and information technologies.

The paper presents the five most common applications that users listed, description of application and current rating on Google Play Store.

One of the aims of the work was to draw the attention of the respondents to the benefits of m-Learning, and when the questionnaire was completed, almost half of the respondents said that in the coming period they would visit mobile application stores and explore educational applications for mobile devices.

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GDPR AND LEARNING MANAGEMENT SYSTEMS

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ABSTRACT: *GDPR came into force on 25th May 2018. It applies to all citizens, residents and companies of the European Union, regardless of the company's location. It is designed to protect individuals' personal data and give people in the European Union more control over how their personal information is used. Organizations must get explicit permission to collect and use an individual's data, and it must be just as easy to withdraw consent as it is to give it. Developing LMS to become compliant with the GDPR is not only about developing the tools. Schools/faculties/universities have to customize their LMS in order to use the tools properly and make sure their own practices are in line with the regulation. The purpose of this paper is to provide basic guidelines for administrators and show recommended practiced on some learning management systems that have become fully GDPR compliant.*
Keywords: *GDPR, personal data, consent, LMS, Moodle*

1. INTRODUCTION

As of May 25, 2018, all companies collecting or storing personal information about anyone who lives in the European Union, must be compliant with the GDPR. The GDPR the acronym[1] for the General Data Protection Regulation[2] - a document that was finally approved by the EU Parliament on 14 April 2016 and enforced on 25 May 2018. The EU GDPR replaces the Data Protection Directive 95/46/EC and is designed to protect individuals' personal data and give people in the European Union more control over how their personal information is used. Organizations must get explicit permission to collect and use an individual's data, and it must be just as easy to withdraw consent as it is to give it. The regulation applies to companies everywhere around the world—not just in the EU. It is also important to realize that universities offering online courses, especially on learning management systems, have to become GDPR compliant.

The aim of this paper is to help course administrators and course creators on learning management systems become GDPR compliant by providing them with the basic information about GDPR, what personal data are, how to collect, store and what they are allowed to do with users' personal data[3]. There are many definitions of learning management systems; however, this would be the most comprehensive one: it is a software application that automates the administration, tracking, and reporting of training events. Furthermore, it should:

- centralize and automate administration
- use self-service and self-guided services
- assemble and deliver learning content rapidly
- consolidate training initiatives on a scalable web-based platform
- support portability and standards
- personalize content and enable knowledge reuse [1].

Since users on such systems leave their personal data in order to complete the course they enrolled in, GDPR is fully applicable and must be observed.

2. GENERAL PROVISIONS AND DEFINITIONS WITH REGARD TO LMS SETTINGS

Generally speaking, GDPR is about personal data and how to protect EU citizens from both misusing and abusing their personal data from the third parties. The subject-matter of GDPR is with regard **to the processing of personal data and rules relating to the free movement of personal data** (GDRP, Art. 1).

The GDPR defines personal data as any information about a person that can be used to identify them—either directly or indirectly: a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person (GDRP, Art. 4). When we talk about sites and LMS, this definition refers to a name, an email address, account information, a photo, an IP address, and more. It even includes pseudonymous information, if it can be easily deciphered to discover a person's identity. For example, in order to enrol to an online course on Moodle, users usually have to submit the following data (required fields): username, first name, surname, and email address. The administrators can choose "email display" - this setting controls who can see

[1] Acronym is a word formed from the first letters of the words that make up the name of something.
[2] The official pdf of the Regulation can be found at https://gdpr-info.eu/ as a neatly arranged website.
[3] The information contained within this paper is for informational purposes only and does in no way constitute legal advice. Any person who intends to rely upon or use the information contained herein in any way is solely responsible for independently verifying the information and obtaining independent expert advice if required.

the user's email address: whether the submitted email address will be hidden from everyone, allowed to be seen by everyone or allowed only to other course members to be seen. Additional information that can be submitted by a user is city/town, country, time zone, description (some text about the user him/herself which will then be displayed on the user's profile page for others to view), user picture, additional names, interests and many more (Web page, ICQ number, Skype ID, AIM ID, Yahoo ID, MSN ID, ID number, Institution, Department, Phone, Mobile phone, Address). As we can see from this list of both required and optional fields, they are all subject to GDPR because on the basis of which a person can be identified.

Material scope of this Regulation applies to **the processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which form part of a filing system or are intended to form part of a filing system**. Processing of personal data includes collecting, recording, organising, structuring, storing, adapting or altering, retrieving, consulting, using, disclosing by transmission, dissemination or otherwise making available, aligning or combining, restricting, erasing or destructing. A filing system is defined as any structured set of personal data which are accessible according to specific criteria, whether centralised, decentralised or dispersed on a functional or geographical basis (GDRP, Art. 2). If we take the example of any LMS, personal data is collected, recorded, organized etc. for the purposes of keeping track of user's progression and in formal education it is a must that the activity is connected to the learner.

Territorial scope of GDPR refers **to the processing of personal data in the context of the activities of an establishment of a controller (**the natural or legal person, public authority, agency or other body which, alone or jointly with others, determines the purposes and means of the processing of personal data**) or a processor (**a natural or legal person, public authority, agency or other body which processes personal data on behalf of the controller) **in the Union, regardless of whether the processing takes place in the Union or not** (GDRP, Art. 3). Any school/faculty/university (the controller) that conducts data processing that offer service such as online courses, whether by payment or for free to EU citizens must comply with the requirements outlined in GDPR. Although Serbia is not yet a member state, if there is a single one user on LMS from the European Union, that LMS has to become GDPR compliant.

4. IMPLICATIONS

Eventhough GDPR has become one of the most controversial regulatives in the last couple of years, there are many reasons for laying down stricter rules relating to collection, sharing and processing of user personal data. There have been recently cases of misuse of users personal data, such as „The Facebook and Cambridge Analytica Scandal[4]". It all contributed to the stricter implementation of GDPR. What does GDPR imply? On one hand, the most important change is for the organizations offering services. They have to become aware of the concept „personal data", what it means, what it refers to and how the data must and must not be used. Furthermore, they must inform users in succinct, clear, plain and simple language what they neeed the data for and ask for consent about it. On the other hand, users themselves must be informed about the use of their data, who has their data, why they have it, where it's stored and who is accessing it, and provide consent for all this: „Consent under the GDPR must be a freely given, specific, informed and unambiguous indication of the individual's wishes. There must be some form of clear affirmative action – or in other words, a positive opt-in – consent cannot be inferred from silence, pre-ticked boxes or inactivity" [2]. Moreover, a user has the right to withdraw his or her consent at any time and can request for hir os her data to be removed or deleted when there is no compelling reason for a course to continue processing that information. A site policy can be used to collect consent for the purposes of GDPR compliance. The site policy document for any LMS should be reviewed carefully to make sure it covers all the information required by GDPR in clear and simple language.

If schools or universities collect and process personal information on minors (Under 18 in Serbia, under 16 in most member states, but some states may reduce this as low as 13 years of age), they must ensure that the consent is obtained from their legal guardian.

If schools or universities collect personal information for the purposes of marketing, they must obtain a separate consent from each user to use this data for this purpose. Consent to use the data for marketing must be separately withdrawable by the user.

If schools or universities collect personal information for the purposes of research, they must either obtain a specific consent from each user to use the data for this purpose, or completely anonymise the data before using it for research. [3] For example, when backing up the course in Moodle, there is an option to anonymize user information which "protects user identities" by making each user anonymous.

4. RECOMMENDED PRACTICE

Some LMS are already fully compliant with GDPR, some require plug-ins. Just simply installing the plugin doesn't make LMS GDPR-compliant. The administrators still need to set them up properly and make sure practices and policies of the university/faculty/school are in line with the regulation. In simple language, the administrators have to provide information to users about:

- What information is collected.
- The purpose of all processing to be performed on the user's data. Marketing must be listed separately with a separate revocable "consent".
- The identity of the data controller and contact information
- List of rights

[4] The data analytics firm used personal information harvested from more than 50 million Facebook profiles without permission to build a system that could target US voters with personalised political advertisements based on their psychological profile.

- The period the data is stored
- The mechanism for withdrawing consent
- The mechanism for requesting corrections, or erasures of personal data
- The mechanism for requesting a record of all personal data
- List of third parties that data will be shared with (This includes integrations such as LTI, portfolios, plagiarism, repositories, authentication etc.)
- The contact details of the data protection officer for each
- The privacy policy for each
- Whether the personal data will be used for any automated decision-making process, including the significance and details of the process (e.g. analytics) [3].

5. CONCLUSION

GDPR came into force on 25th May 2018. It applies to all citizens, residents and companies of the European Union, regardless of the company's location. Developing LMS to become compliant with the GDPR is not only about developing the tools. Schools/faculties/universities have to customize their LMS in order to use the tools properly and make sure you're their own practices are in line with the regulation.

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USE OF MIND MAPS IN ADAPTIVE E-LEARNING PROCESSES

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Abstract: *This paper presents an implementation of one of the concepts of adaptive learning processes that use mind maps to allow students to arbitrary choose any part of the learning material modelled with fine-grained learning objects. Use of mind maps provide students navigational direct access to any learning objects linked to a node of a mind map. This is especially useful for students when they have to review and explore quickly a learning material of an online lesson before a validation activity (such as tests or Q&A) and before doing their assignments. A lesson may have one or more mind maps. It is recommended to use them the before every validation activity and at the end of the lesson, providing all learning objects for their assignments.*

Keywords: *E-Learning, Learning objects, Learning process, Mind map, Personalized learning*

1. INTRODUCTION

Adaptive learning process is supposed to enable teaching materials adapted to the level of students` knowledge during the learning of a certain teaching topic, as well as the freedom to choose the direction within the learning process itself. This type of learning process should direct a student towards teaching materials according to his/her current knowledge. The use of mind maps is going to be shown in this paper, as a supplement to the adaptive learning process. Mind maps allow students to access the certain part of learning process via simple navigation and thus revise the acquired knowledge. If necessary, a student may develop his/her own mind map for the chosen learning process.

We present the results of the research on the application of mind maps in the adaptive learning processes in this paper, as well as the comparative analysis with the approach presented on our previous eLearning-2017 International Conference [1]. [1]

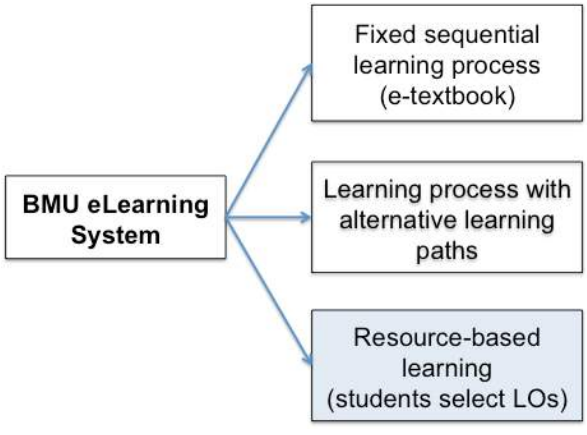
2. FREE SELECTION OF LEARNING OBJECTS

A e-learning process consist of learning activities and LAMS activities [T1]. Learning activities provide simple (atomic) or complex (containing other learning objects) learning objects (LOs). A learning object (LO) provides a chunk of new knowledge that students have to learn. LAMS provides many different activities used for

- evaluation and validation of acquired new knowledge of students, such as Assessment, Q&A, Multiple Choice;
- branching of a learning process (Branching Activity) or selection of one of offered activities (Optional Activity);
- students' collaboration and communication with lecturer (Chat, Forum, Voting, Submitting Files, Shared Resources, Web Converence) ect.

Belgrade Metropolitan University (BMU) has been developing its LAMS-based e-learning system to provide three basic types of e-learning models (Figure 1):

a. *sequential learning process*, with sequential learning activities
b. *alternative (parallel) learning paths* for different categories of students (supported by LAMS Branching Activity) and
c. *resources-based learning*, allowing students to select learning objects needed to solve specific problems (supported by LAMS Optional Activity).



[1] This paper provides some results obtained by the project with code III44006 financed by the Ministry of Education, Science and Technological Development of Republic of Serbia

Figure 1: Three types of e-learning process models

In [1] we demonstrated how we can create these three models of a e-learning process. As explained in [1,2], in order to uses personalized and adaptive e-learning processes, they have to use fine-grained learning objects (LOs). Using them analogous as Lego elements, we can configure and easily modify a learning process of an online lesson and modify the content of the prepared learning material for the lesson.

Here we will demonstrate how we can use mind maps to develop a resource-based e-learning process. It is very useful especially in cases when a student has to quickly review previously learnt LOs and explore some details needed in a verification activity. If an e-learning process does not provide this feature (Figure 2.a) a student will loose more time to find needed LO. If LAMS Optional Activity is posted before a validation activity (such as Q&A or Assessment), the student will be able to directly choose the needed LO (Figure 2.b) from the provided list o optional LOs.

Instead of using LAMS Optional Activity, in this paper we explore the use of mind maps to realise a resource-based learning (Figure 2.c). All activities of e-learning process (usually created for a online lesson) represent nodes in a mind maps. We can link a file containing a LO with any of nodes. This allows us to navigate through the structure of a lesson presented as a mind map, quickly find the node that is linked to a multimedia document representing a (simple or complex) LO, and by using a mouse double click, we can access and open the needed LO.

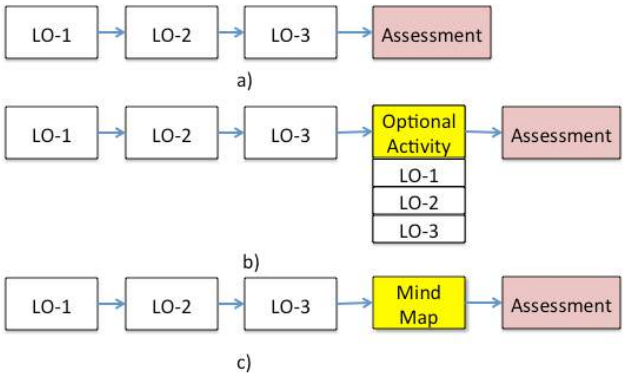


Figure 2: Review of previously learnt LOs before an assessment of acquired new knowledge

A lesson designer has to decide how many mind maps to use in a lesson and where to locate them in e-learning process. Figure 3 shows few options:

1. There is only one mind map and an assessment activity (Figure 3.a). A student has total control of access to any LO and can choose them in any order.
2. All LOs are sequentially ordered before a mind map and an assessment activity. A student has to access all LOs before he/she can use a mind map for review and explore any LOs before starting the assessment activity (Figure 3.b).
3. LOs are grouped (in this example there are three groups). After each group of LOs, there is a mind map with all LOs of the group, and an Assessment Activity (Figure 3.c). In our example, there three groups of LOs, three mind maps and three assessment activities. A student uses first LOs of the first group, and then can review them using tem mind maps with LOs of the group 1 and then preform the assessment activities related with the group 1. The seam procedure is repeated for the groups 2 and 3 of LOs.

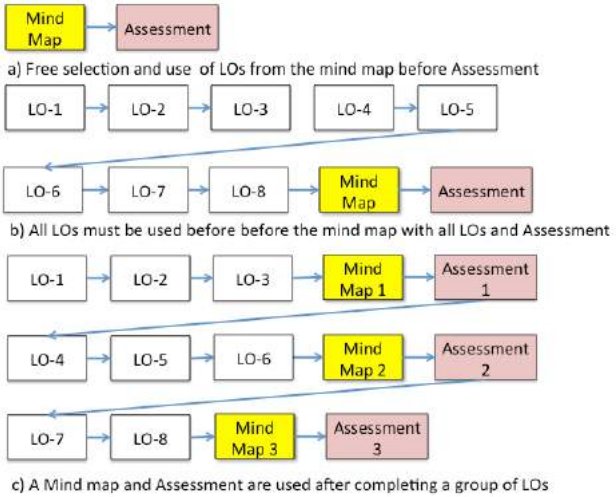


Figure 3: Three cases of use of mind maps in e-learning processes

The case 1 (Figure 3.a) is not usually appropriate for students of Year 1 and Year 2 as they have difficulties to choose appropriate order of LOs. It can be used for master courses and in Year 3 and Year 4 bachelor courses.

The case 2 (Figure 3.b) allow students to use the only one mind map ate the end of lesson. In principles, it is better to test students understanding several times during a lesson, so that can clarify issues that they did not understand after first reading or watching few LOs. So, we think that the case 3 (Figure 3.c) is the most appropriate implementation of mind maps in e-learning processes.

3. AN EXAMPLE OF MIND MAP APPLICATION IN ADAPTIVE LEARNING PROCESSES

Use of mind maps in learning processes allows students to access all learning materials they need at that moment.

We will use the same online lesson used as an example in our previous paper [1], when we were exploring a use of some of LAMS activities to allow a student to choose next learning object (LO) from a set of offered LOs.. This is the Lesson 7 “Software Design” of SE201 Introduction to Software Engineering course. Figure 4 illustrates the learning process of the online lesson, with three mind maps at certain locations in the learning process. Within the mentioned learning process, a mind map may be found at the following locations:

- after the learning objects which include a thematic unit "*Creational Patterns*"

- after the learning objects which include a thematic unit "*Structural Patterns*"
- after the learning objects which include a thematic unit "*Behavioural Patterns*"

The mind maps are located before knowledge verification activities (such as Assessment or Q&A)

In this way, a student has the possibility to use mind maps to find, select and use needed learning objects to prepare answers to given questions. In Figure 4, the positions of mind maps are marked with red rectangles. Green rectangles represent these verification activities.

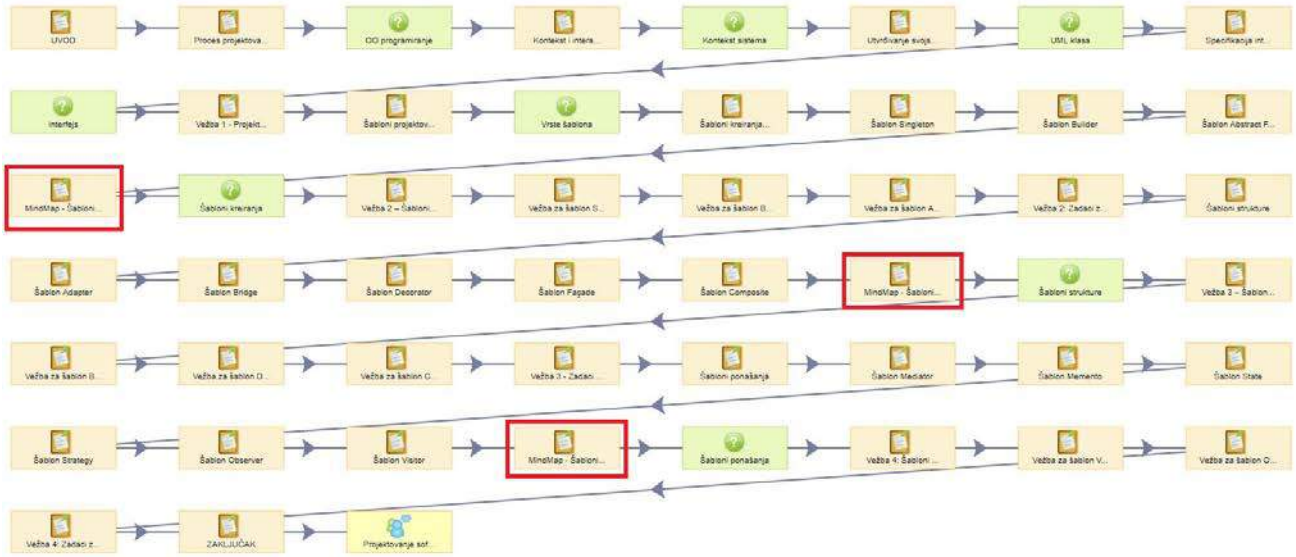


Figure 4: The example of the learning process with the mind maps at the end of certain thematic unit

The first mind map in Figure 4 in the lesson includes the learning objects of the thematic unit "Creational `Patterns". The content of the mind map "Creational Patterns" is shown in Figure 5.

When a student uses the given mind map, he/she obtains introductory learning objects from the lesson, as well as the learning objects belonging to the Creational Patterns thematic unit.

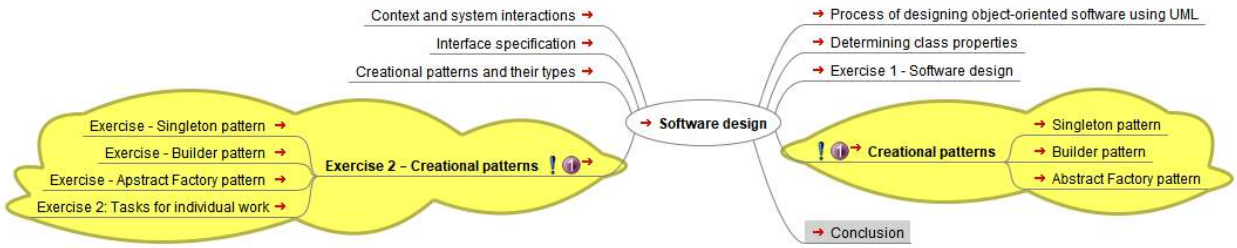


Figure 5: The Mind map for Creational Patterns thematic unit

The next mind map within the learning process illustrated in Figure 6 includes the thematic unit "Structural Patterns".

Figure 6 shows the structure of this mind map and LOs linked to its nodes.

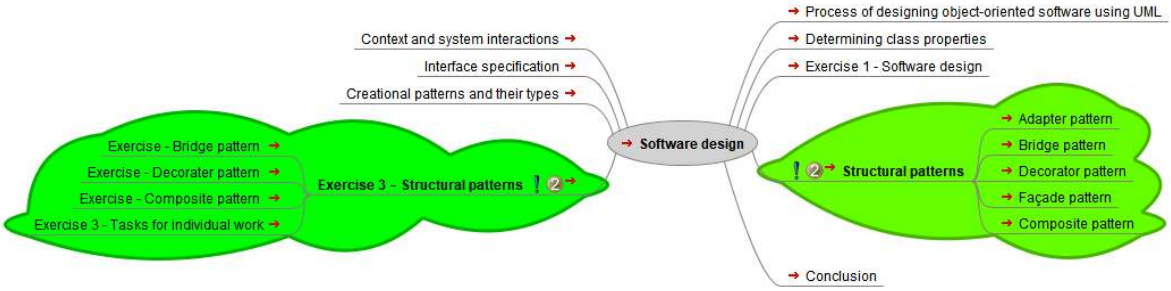


Figure 6: The mind map for Structural Patterns

The final mind map in the lesson includes the learning objects of the thematic unit "Behavioural Patterns"

Figure 7 shows the structure of this mind map and LOs linked to its nodes.

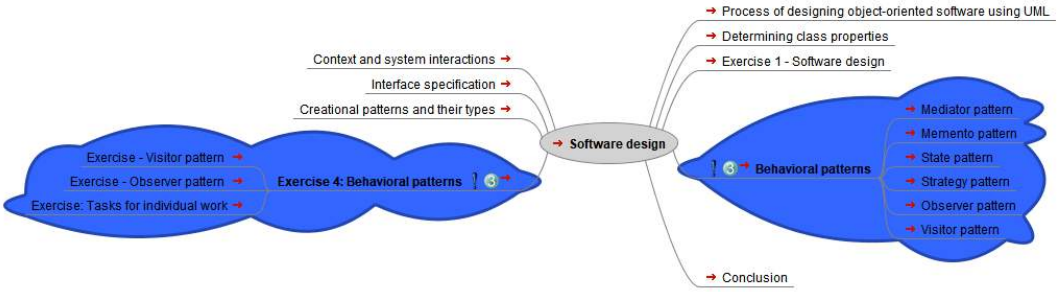


Figure 7: Mind map for the Behavioural Patterns

As students get work assignment for each lesson, and a project for each course, they often need to search again specific LOs and get needed information. Course designer may add a final mind map at the end of lesson that allows a student to search and get any LO of the lesson. Figure 8 shows the structure of this mind map and LOs linked to its nodes. It contains LOs of Creational Patterns, Structural Patterns and Behavioural Patterns.

Figure 9 shows the main map with all LOs of the lesson, as the mind map in Figure 8, but with exercise LOs linked to related lecture LOs They are not linked directly with the core node " Softvare Design" as in Figure 8.

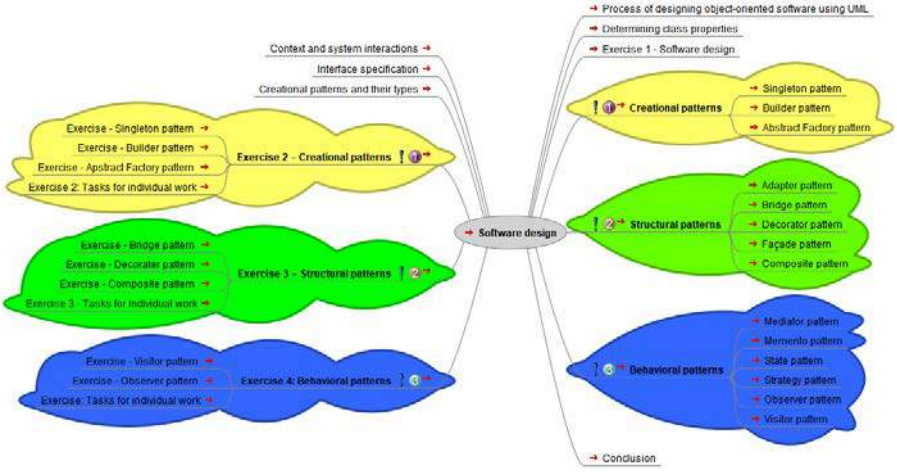


Figure 8: The complete mind map of the lesson "Software Design"

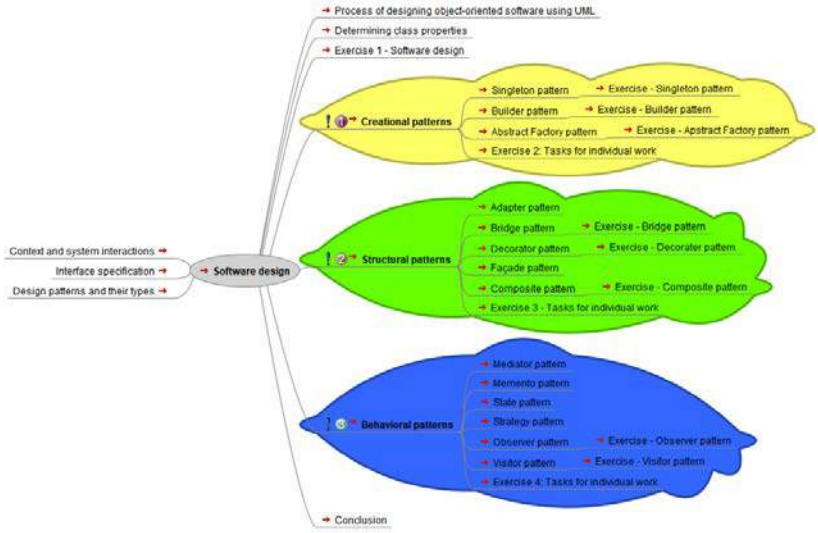


Figure 9: The complete mind map of the lesson "Software Design" exercise LOs linked directly to the nodes of related lecture LOs

Mind maps for the described learning process may be presented in two different ways:

1. *Nodes with attached LOs of lectures and exercises for each thematic unit are presented separately and they are all directly linked to the core node of the lesson "Software Design"* In this case, they are both marked with the same colour, different for each thematic unit, as shown in Figure 8.
2. *Nodes with attached LOs of exercises are linked to nodes with attached LOs of related lectures.* Only LOs of lectures are directly linked to the core node of the lesson "Software Design", as shown in Figure 9. In this case, a student, after choosing LOs of a lecture, may proceed to LOs of related exercises for the chosen thematic unit.

Lesson designer make decisions related to the structures of mind maps, and determine the best number of mind maps and location in a e-learning process. related to the number and content of mind maps in a lesson.

4. CONCLUSION

The paper presents the actual R&D work of BMU in area of personalized e-learning, supported by mind maps inserted in certain location of an adaptive e-learning processes. A e-learning system should allow students to search and use any learning object of a lesson, or part of a lesson. Mind maps can be used in such e-learning systems to empower students to control their access to any learning object of an on-line lesson.

Use of mind maps in an adaptive e-learning process allow students to easily retrieve, find and use learning objects that they need when they work on their assignments or prepare themselves for validation activities (such as tests).

Use of mind maps in e-learning process give students more control of their e-learning process. Learning maps may also provide additional LOs for students interested to learn more. It is recommended to lecturers to use this opportunity, as they have to think about the interests of all students, including those who want to use additional, more advanced learning objects and other references. Implementation of mind maps in e-learning may provide them access to optional and additional LOs to satisfy needs of more advanced students.

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[T3] FreeMind - free mind mapping software, http://freemind.sourceforge.net/wiki/index.php/Main_Page

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THE USE OF TECHNOLOGIES AND TOOLS TO SUPPORT LEARNING DESIGN AND DELIVERY

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Abstract: *This paper gives an overview of technologies and some of the tools developed to support learning design and delivery. An important technical basis for the development of these tools was formed by the standard IMS Learning Design. Teachers need support from digital technology to help them with their all the more demanding and complicated working environment. The goal of the paper is to provide insight into research and development projects focusing on digital support for teachers, that is, digital design tools, resulting in recommendations and guidelines for using them. Therefore, examples and specifications of tools such as Learning Activity Management System (LAMS), the Learning Designer tool, iCoper, Cloudworks as well as other web-based planning tools are given.*

Keywords: *teachers, support, learning design, tools, technology*

INTRODUCTION

In general, the field of Learning Design refers to ways of helping educators to describe, design and share teaching ideas (Dalziel et al., 2016). The creation of learning tasks that are technologically enhanced is surrounded by descriptive frameworks, learning and teaching concepts and educator practices within the learning design. Learning design mostly focuses on the design of learning tasks and less on the bringing of learning activities. The relatively new field of Learning Design places more attention upon collaborative and student-centred learning, in contrast to the older field of Instructional Design that was more oriented to the science of cognitively efficient information delivery (Mor et al., 2015). Learning Design mostly refers to how the designs are described and shared. The process of learning design can be defined as "the creative and deliberate act of devising new practices, plans or activity, resources and tools aimed at achieving particular educational aims in a given context" (Mor & Craft, 2012). There have been a wide range of initiatives within the Learning Design field to develop languages and tools for supporting the description and design of learning. In this paper several approaches together with an example of each one are shortly described. The approaches include the use of technical standards (*IMS-LD*), visualization approaches (*AUTC LDVS*), visualization tools (*CompendiumLD*), pedagogical planner tools (the *Learning Designer*), *Learning Activity Management System* (*LAMS*), *ICOPER* and the *Cloudworks*. They can also be used to show the wide range of possible approaches in conceptualizing, describing, creating and sharing learning designs.

LITERATURE REVIEW

Starting points in the field of Learning Design directed towards creating technical standards in order to support the description and sharing of learning designs. The rationale of these technical standards is in fact that learning designs could be more easily shared between people, platforms and contexts if they could be described using a common technical framework. There have been significant attempts to standardize the technical description of digital learning objects to make them more accessible, reusable and interoperable. The most evolved and widespread set of technical standards for education is *IMS Learning Design* (*IMS-LD*). The Learning activities can be described using the specifications of the *IMS Learning Design*. *IMS Learning Design* is a specification that proposes a metalanguage to describe all the elements in relation to the learning process. The approach of this specification can be explained as follows: people act in different roles, roles work towards certain objectives by executing learning activities which are performed within an environment structured of learning objects and services (Specht and Burgos, 2007). The objective of *IMS Learning Design* (*IMS LD*) is to provide a containment framework of elements that can describe any design of a teaching and learning process in a formal way (Koper and Olivier, 2003). Basis of *IMS LD* is an Educational Modelling Language (EML) which is a meta-language that allows codifying the pedagogical values of learning objects as elements of the study and to associate each element of content (like texts, assignments, tests, tasks) with information describing its instructional strategy (roles, relations, interactions and activities of students and teachers). The outcome of these specifications is providing a framework for supporting a numerous of pedagogical approaches by taking into account their commonalities. Generally, every learning design is based on a set of prescribed activities for the stakeholders involved, teacher and learner, which should be performed in a certain order. *IMS-LD* provides conditions towards the reusability of adaptive content. This is shown in the study of Specht and Burgos (2007) that provides a proof of concept that the most widely used adaptive methods in educational systems can be represented and made reusable in *IMS-LD*. *IMS-LD* has not become as widely used standard as was initially

seemed willing be, although the initial idea that technical standards could promote standardization, interoperation and sharing of learning designs was promising.

One of the products of the AUTC (Australian Universities Teaching Committee) project on ICT based learning designs is a graphical representation named the *Learning Design Visual Sequence (LDVS)* which was developed to facilitate descriptions of designs. It describes learning designs with the resources, tasks and supports necessary for their implementation. Educators consider designs very useful for sourcing design ideas as well as to benchmark good practice (Agostinho et al., 2013). Supporting use and reuse of designs was enabled by very important contextual descriptions that accompanied the *LDVS* visualizations.

There is also another software tool for designing learning activities by using a flexible visual interface, named *CompendiumLD*. Its development aimed to support lecturers, teachers and other participants in education in order to help them express their idea and map out the design or learning sequence. *CompendiumLD* contains predefined sets of icons, some generic and some specific to learning design. It provides a set of icons to represent the components of learning activities and stands for a user friendly tool which means the icons may be dragged and dropped, then connected to form a map representing a learning activity. It enables users to show connections between learner and teacher tasks and resources in a diagrammatic manner. The designs can be exported in different formats, including HTML and JPG. *Compendium* LD provided users in the study to visualize design structure and to identify gaps and flaws while textual descriptions lack a way of doing it (Conole, 2013). On the other hand, some users found the tool too rigid to show all types of designs and assume the tool frustrating and time consuming to learn and use. Benefits of the tool were considered in articulating key steps and interdependencies within a learning design, planning logistic and sharing practice.

In contrast to visualization tools that enable ways for describing learning design, more structured guidance on the design process, involving types of elements need to be taken into account for successful design, is provided by pedagogical planner tools. One of those tools for teachers and creating lesson plans is the *Learning Designer*. The *Learning Designer* includes an interactive modelling environment for representing the pedagogically relevant components of teachers learning design. It also ensures analytic feedback that can help teachers to better understand the implications of their designs, especially with regard to their use of technology enhanced learning (TEL) (Bower et al, 2011).

In order to create lesson plans teachers can also use the *LAMS* software. *LAMS* or *Learning Activity Management System* is a tool for designing, managing and delivering online collaborative learning activities which can include individual tasks, small group work or whole class group activities based on both content and collaboration (Dalziel, 2013). This software provides very intuitive visual authoring environment which is simple to use and easy to learn thus can be used to create sequences of learning activities. The results of research conducted by Campbell and Cameron (2009) showed that using *LAMS* to plan lessons has many advantages in regards to writing a traditional lesson plan. Some of them refer to helping plan all aspects of the lesson by using software, providing a visual overview of the lesson that allows to identify the learning styles by designing activities as well as producing lessons in a standardized template that can be easily modified for future re-use (Campbell and Cameron, 2009). Furthermore, *LAMS* has a distinctive property as it allows each activity for integration with the actual content which allows educators to actually run their designs with real classes.
Concerning interoperability between the *Learning Designer* and two common learning platforms *LAMS* and *Moodle*, the interoperation is bidirectional. This means that learning designs created in the *Learning Designer* can be exported to *LAMS* and *Moodle* as well as *LAMS* and *Moodle* designs can be exported to the *Learning Designer*. The benefits and implications of the proposed functionality can be seen in a fact that a *Learning Designer* layer within learning platforms *LAMS* and *Moodle* can stimulate educators to think about pedagogically relevant features of the activities they are designed as well as to provide a more precise mapping into the *Learning Designer* for analytic purposes and possible exporting to a third system (Bower et al, 2011).

Contribution to a more effective and efficient implementation of technology-enhanced learning in higher education with special attention on outcome oriented teaching and operability based on standards and specifications was the goal of the eContent+ Best Practice Network (*ICOPER*). Thus a technological roadmap and a reference model (IRM) for standards development in the domain of Learning, Education and Training is developed by the *ICOPER* Best Practice Network (Olivier and Kamtsiou, 2012). *ICOPER* worked on models by roadmapping activities and explaining how community demands are put into the specification design process and valorised in the standards consensus process. The project provided *ICOPER* Roadmapping technology in terms of utilizing publicly available conceptual modelling techniques to ensure various groups to map emerging trends, opportunities and threats as well as to provide a European system of finding an insight for stakeholders (Olivier and Kamtsiou, 2012). In general, the *ICOPER* Reference Model provides a common frame of reference for stakeholders who wish to contribute to the design and development of outcome oriented teaching and content for reuse. Thus the design of the IRM aims to improve interoperability of educational systems and applications at the processes and the technical level.

Cloudworks is a web 2.0 tool, that is a social networking site that combines the practices of socialisation, sharing and creating common in social networking sites, wikis and social media, with different forms of dialogue, debate and peer commenting (Alevizou et al., 2010). In fact, this site combines a mix of web 2.0 functionality and enables new forms of communication and collaboration as well as cross boundary interactions between different communities of

users. The main objects in *Cloudworks* are Clouds that can be anything to do with learning and teaching (a description of a learning or teaching practice, a review of a particular tool or resource) and it can be grouped into Cloudscapes. Alevizou et al. (2010) evaluated the ways in which *Cloudworks* can support evidence informed practices connected to learning and teaching. So they have examined and evaluated the use of the site by individuals and communities involved in producing and researching the development, delivery and use of Open Educational Resources (OER). The interface of *Cloudworks* as a public, resourceful space has important implications for sustainability as it provides participants and discussions to go through thematic and temporal dimensions of involvement or objectivity (Alevizou et al., 2010). One of the key features of *Cloudworks* is the way in which there is a mixture of different types of activities showing in the same space like events, reading groups flash debates, online consultations and online research reviews. The work of Galley et al. (2010) aimed to encourage greater dissemination of Learning Design ideas by providing for web 2.0 style discussion and debate of exemplar LAMS sequences within *Cloudworks*, formed around live experiences of real, running sequences. Success factor in this context is related to the development of an easy to use and flexible embed function as well as a clear framework for discussion around the pedagogical and pragmatic features of the design (Galley et al., 2010). Successful results would include dynamic discussions around the designs with participant from a range of sectors and with a range of technical knowledge and experience.

DISCUSSION

There are many ways in which learning designs can be represented, constructed and shared. Every approach reflects some of the requirements of the field and practitioners as well as limitations. The *IMS-LD* technical standards constitute machine representations to facilitate standardized description for interoperability, although have not been utilized widely by practitioners because of the extra technical effort required to use them (Goddard et al., 2015). Manual visualization systems such as AUTC *LDVS* help to explain the key components of a design and the way they are sequenced, and there is some evidence to propose that it can help improve learning design thinking (Agostinho et al., 2013). Furthermore, using the tools to represent learning designs has also had limited impact. While visualization tool *CompendiumLD* help educators to map out their designs in a flexible and to some extent transferable way, users report time demanding to learn the system and suspicion about the advantages as compared to the time commitment demanded (Conole, 2013). Additional value is provided by pedagogical planner tools like the *Learning Designer* in a way of helping educators to analyse the efficacy of their designs. Another contributing factor of *Learning Designer* is that it integrates with an online repository an intelligent database to promote sharing. In spite of it, the *Learning Designer* has not yet implemented in general educational practice. The learning design tool that has made the most influence on teaching practice is *LAMS*. Within the *LAMS* users can plan their designs and then expand on the content in a way they can run them with their classes. In contrast to the use of some learning object repositories using the *LAMS* Community is modest (Dalziel, 2013). Benefit of *Cloudworks* is its interface as a public, resourceful space that seems to allow both participants and discussions to crossover across thematic and temporal dimensions of engagement or purposefulness and has significant implications for sustainability (Alevizou et al., 2010).

CONCLUSION

One of the main goals of learning design is to promote the transfer of good teaching ideas (Dalziel et al., 2016). Research suggests that educators prefer working with specific designs rather than abstract design even if the specific ones are from unrelated context (Agostinho et al., 2013; Masterman, 2013). There is possibility for educators to make their own abstractions about learning design instead of being provided with them. When educators take the time to use learning design tools and representations they mostly implicate it develops their design understanding (Agostinho et al., 2013; Masterman & Manton, 2011). Educators often lack time for pedagogical reflection and thinking explicitly about design due to the overall busyness of teaching work (Laurillard et al., 2013). Every learning design representation approach outlined in the paper can be used to advance practitioner thinking and have made a valuable conceptual contribution to the field of Learning Design.

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ANALYSIS OF THE EXISTING E-LEARNING SYSTEMS FOR TEACHING SQL AND A DRAFT OF AN E-LEARNING SYSTEM FOR DATABASE COURSE AT METROPOLITAN UNIVERSITY

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Abstract: *The purpose of this paper is to analyse new approaches to the e-learning systems for teaching SQL (Structured Query Language), domain-specific language that is used for working with relational databases. Recent years have seen a rise of numerous e-learning systems for learning programming languages based upon a direct program code entry into a web browser and evaluation and display of corresponding output. Given the fact that very few systems deal with SQL, the paper gives an overview and a description of the existing systems and their characteristics. Based upon the previous analysis we will recommend a system adequate for the Database course at the Metropolitan University. Compared to the existing systems, the new one should enable the addition of new databases, as well as the option of subsequent addition of new problems by the professors so that each student can practice a different task. Also, the system can easily be adapted for operation with several RDBMS. This system is based on automatic check of problem solutions produced by students.*

Keywords: *E-Learning, SQL, MySQL, RDBMS, Codecademy, DataCamp*

1. INTRODUCTION

SQL (Structured Query Language) is a domain-specific language used in programming and designed for managing data held in a relational database management system (RDBMS), or for stream processing in a relational data stream management system (RDSMS). It is particularly useful in handling structured data where there are relations between different entities/variables of the data.

During last several years, a new science discipline emerged - Data Science where SQL is used for further data processing and various algorithms are implemented.

Data science is an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from data in various forms, both structured and unstructured.

Students who learn programming, are familiar with standard programming languages and the basic elements of programming languages such as: variables, types, logical and conditional problems, loops, arrays, methods, classes and objects. In a previous paper - [1] , we analyzed obstacles and possible solutions needed during learning the basic elements of programming languages.

SQL as domain-specific language used in programming represents a different concept compared with standard programming languages. SQL originally based upon relational algebra and tuple relational calculus, SQL consists of many types of statements, which may be informally classed as sublanguages, commonly: a data query language (DQL), a data definition language (DDL), a data control language (DCL), and a data manipulation language (DML). The scope of SQL includes data query, data manipulation (insert, update and delete), data definition (schema creation and modification), and data access control.

So, it is important to conclude that a majority of concepts within SQL are unknown to students who used standard programming languages.

Therefore, this paper presents and analyzes the existing e-learning systems for teaching basic elements of SQL (Structured Query Language), domain-specific language that is used for working with relational databases. Recent years have seen a rise of numerous e-learning systems for learning programming languages based upon a direct program code entry into a web browser and evaluation and display of corresponding output. Given the fact that very few systems deal with SQL, the paper gives an overview and a description of the existing systems and their characteristics.

Based upon the previous analysis we will recommend a system adequate for the Database course at the Metropolitan University. These solutions enable an interactive monitoring and checking of the problems that a

student is working on, with the student himself being able to get feedback on his results in a significantly faster way.

2. ANALYSIS OF EXISTING E-LEARNING SYSTEMS FOR LEARNING SQL

E-learning system Codecademy, enables learning of the basic elements of programming languages. The supported programming languages include: JavaScript, Python, Ruby, and Java. Apart from that Codecademy enables learning of SQL [2].

In the beginning, Codecademy was offering a completely free access, however, during the last year, they introduced commercial memberships: PRO Membership [3] and PRO Intensive Membership [4].

The learning path of SQL covers the following subjects, which are showed in the following table:

Table 1: Codecademy SQL

Part 1 - Manipulation		
Manipulation	Interactive Lesson	Free
Create a Table	Freeform Project	Commercial – only for Pro users
Manipulation	Multiple Choice Quiz	Commercial – only for Pro users
Part 2 - Queries		
Queries	Interactive Lesson	Free
New York Restaurants	Freeform Project	Commercial – only for Pro users
Queries	Multiple Choice Quiz	Commercial – only for Pro users
Part 3 - Aggregate Functions		
Aggregate Functions	Interactive Lesson	Free
Trends in Startups	Freeform Project	Commercial – only for Pro users
Aggregate Functions	Multiple Choice Quiz	Commercial – only for Pro users
Part 4 - Multiple Tables		
Multiple Tables	Interactive Lesson	Free
Multiple Tables with REBU	Freeform Project	Commercial – only for Pro users
Multiple Tables	Multiple Choice Quiz	Commercial – only for Pro users

Codecademy secures a rich GUI for every theme that consists of the following parts:

- Learn - a theoretical part that covers each specific subject

- Instructions - defining of the problems that the user needs to solve

- Stuck? Get a hint - user support

- Community forums - a forum for users to discuss specific subjects

- Report a bug - which reports errors to the administrators

- Editor - an integrated editing tool that enables the user to input, change, and correct the existing code. By clicking the Run button, the entered code is being interpreted

- Query Results - displays the result of the interpreted code entered by the user or an error message

- Database schema – displays current database schema

The following image shows the described GUI:

Image 1: Codecademy GUI for SQL course

Another solution which we discuss here, DataCamp e-learning system, is primarily oriented for teaching of programmers who would be working on the following positions:

- Python Programmer
- Data Scientist with Python
- Data Analyst with Python
- R Programmer
- Data Scientist with R
- Data Analyst with R
- Quantitative Analyst with R

So, the primary orientation is in the following areas:

- Python Programming, Importing and Cleaning Data with Python, Data Manipulation with Python, Machine Learning with Python, R Programming

- Importing and Cleaning Data with R, Data Manipulation with R, Intro to Statistics with R, Data Visualization with R, Time Series with R, Applied Finance with R, Finance Basics with R, Machine Learning with R, Text Mining with R, Spatial Data with R, Shiny Fundamentals with R, Big Data with R, Tidyverse Fundamentals

As we already mentioned in the introduction, for the work in in the area of Data Science, it is required to know SQL, and DataCamp offers a free course: Intro to SQL for Data Science [5] The learning path of SQL covers the following subjects, which are listed in the following table:

Table 2: DataCamp SQL

Selecting columns	
Welcome to the course!	Video
Onboarding | Tables	Multiple Choice Quiz
Onboarding | Query Result	Multiple Choice Quiz
Onboarding | Errors	Interactive Lesson
Onboarding | Bullet Exercises	Interactive Lesson
Beginning your SQL journey	Multiple Choice Quiz
SELECTing single columns	Interactive Lesson
SELECTing multiple columns	Interactive Lesson
SELECT DISTINCT	Interactive Lesson
Learning to COUNT	Multiple Choice Quiz
Practice with COUNT	Interactive Lesson
Filtering rows	
Filtering results	Multiple Choice Quiz
Simple filtering of numeric values	Interactive Lesson
Simple filtering of text	Interactive Lesson
WHERE AND	Interactive Lesson
WHERE AND OR	Multiple Choice Quiz
WHERE AND OR (2)	Interactive Lesson
BETWEEN	Multiple Choice Quiz
BETWEEN (2)	Interactive Lesson
WHERE IN	Interactive Lesson
Introduction to NULL and IS NULL	Multiple Choice Quiz
NULL and IS NULL	Interactive Lesson
LIKE and NOT LIKE	Interactive Lesson
Aggregate Functions	
Aggregate functions	Interactive Lesson
Aggregate functions practice	Interactive Lesson
Combining aggregate functions with WHERE	Interactive Lesson
A note on arithmetic	Multiple Choice Quiz
It's AS simple AS aliasing	Interactive Lesson
Even more aliasing	Interactive Lesson
Sorting, grouping and joins	
ORDER BY	Multiple Choice Quiz
Sorting single columns	Interactive Lesson
Sorting single columns (2)	Interactive Lesson
Sorting single columns (DESC)	Interactive Lesson
Sorting multiple columns	Interactive Lesson
GROUP BY	Multiple Choice Quiz
GROUP BY practice	Interactive Lesson
GROUP BY practice (2)	Interactive Lesson
HAVING a great time	Multiple Choice Quiz
All together now	Interactive Lesson
All together now (2)	Interactive Lesson
A taste of things to come	Interactive Lesson

The following image shows DataCamp GUI:

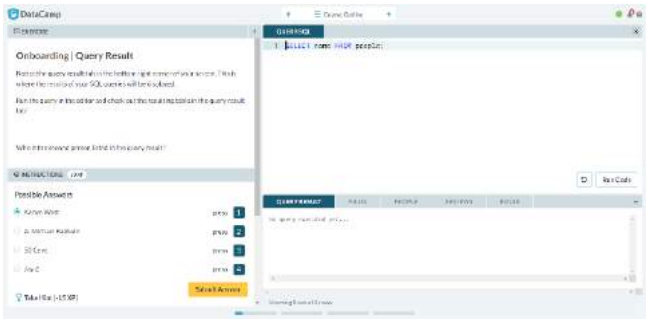

Image 2: DataCamp GUI for SQL course

We can conclude that both systems have the following important constraints:

- Small number of problems for learning SQL
- Missing problems dealing with advanced SQL
- E-learning systems are becoming totally commercial
- Existence of identical problems for all students
- Existence of identical database schema for all students
- Inability of adding new problems
- Inability of translating them to a different language
- Missing support for operation with several RDBMS

3. DESCRIPTION OF THE DEVELOPED E-LEARNING SYSTEM – AN ONLINE EDITOR FOR SQL

Based on the analysis of the existing solutions, described above, a comprehensive and flexible system being developed at the Metropolitan University, intended to enable efficient e-learning of SQL, titled: SQL Online Editor (SOE).

The system enables learning of the basic and advanced elements of SQL, starting from scratch, and also including the input of the entire code into an integrated editor, as well as modifying/extending the already existing code and correcting the mistakes in the existing code.

The system was developed from the scratch using Spring 5 and Bootstrap 4 framework, where problems are given in HTML format, and tests for problems in JavaScript language, resulting in fast and easy extending of the system and adding solved examples and learning tests. Also, the system can be easily integrated with the system described in [1]. Primary relational database management system (RDBMS) is MySQL (because, it is frequently used at the University Metropolitan), but the system can also be easily adapted for other RDBMS.

The following picture shows the database scheme which we used in this development phase, but we can point out that it is easy to add various other database schemes.

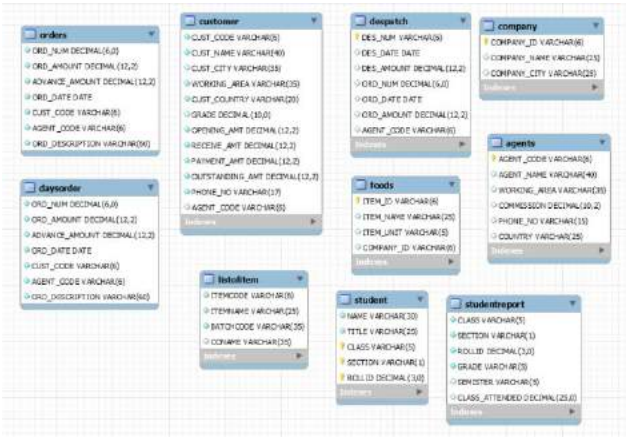

Image 3: Database scheme for SOE SQL course

The developed sistem (SOE), combines good characteristics of existing systems, and introduces some new options, and its properties and its advantages can be described/summarized in the following way:

- The SOE system enables entering SQL code in an integrated editor, including syntax highlighting
- Creating/adding any number of new problems and also theorethical tests for a given section (area of learning)
- Easy to add adequate learning tests for problems
- Creating/adding problems which enable modifying of existing problem solutions and correcting errors
- Adding new sections with problems and theoretical tests (new learning areas), e.g. advanced SQL topics (not available neither in other systems)
- Using videos
- Sending detailed messages to the user informing about his/her performance and syntax errors (more comprehensive compared to the existing systems), depending of tests written for a specific problem
- Easy producing several versions of the same course or similar courses, in any language (e.g. Serbian), which is not available in the existing systems
- SOE supports MySQL RDBMS, but it can easily be adapted for operation with other RDBMS (which is an important difference compared with existing systems)
- Enables easy addition of other database schemes, so the system can be extended to enable each student group to do different problems under different database schemes (which is an important advantage compared to existing systems)
- Easy integration with the existing system JOE, described in [1]

Images 4 illustrate the GUI of the proposed system, where the following example problem is demonstrated:

The following table is given to students:

customer(CUST_CODE, CUST_NAME, CUST_CITY, WORKING_AREA, CUST_COUNTRY, GRADE, OPENING_AMT, RECEIVE_AMT, PAYMENT_AMT, OUTSTANDING_AMT, PHONE_NO, AGENT_CODE)

and it is required to write SELECT query, which results in selection values from the column CUST_NAME, with alias name: 'Name'.

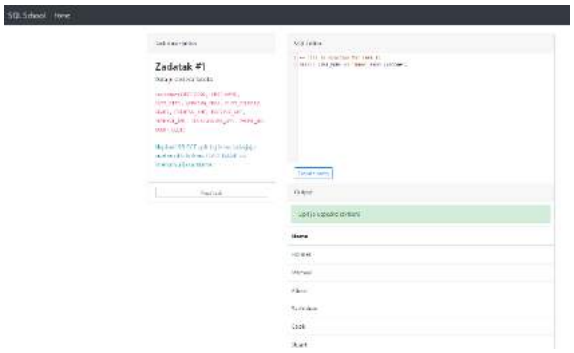

Image 4: SOE GUI – problem 1

Image 5 shows a test for the problem mentioned above, written in JavaScript.

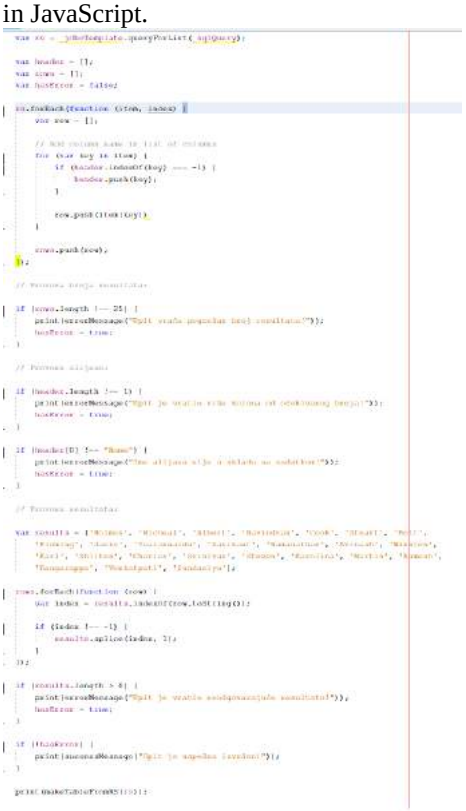

Image 5: SOE GUI – test for problem 1

So, the developed SOE system combines good characteristics of the existing systems, and offers more flexibility and more learning comprehension compared with the Codecademy and the DataCamp e-learning systems.

4. CONCLUSION

This paper analysed the existing e-learning systems for learning SQL. A comprehensive and flexible system has been recently developed at the Metropolitan University for learning of SQL, titled SQL Online Editor - SOE. This paper describes this SOE system and compares it with the existing systems. The developed SOE system offers a list of combined and new options compared to other systems, more flexibility and more comprehensive learning of SQL compared to other existing systems.

ACKNOWLEDGMENT

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[2] https://www.codecademy.com/learn/learn-sql

[3] https://www.codecademy.com/pro/membership

[4] https://pro.codecademy.com/offerings/

[5] https://www.datacamp.com/courses/intro-to-sql-for-data-science

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ICT ENHANCED CONSTRUCTIVE TEACHING FOR IMPROVED MATHEMATIC UNDERSTANDING AND DELIVERING SAME LEVEL OF SKILLS TO ALL CHILDREN IN LEARNING GROUP

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Abstract: *One of the main goals of teaching in mathematics is to provide same level of the skills to the teaching subjects. Unfortunately during education different children acquire different level of knowledge. In this study we used constructive approach and ICT to create equal teaching environment. We used constructive approach to develop teaching tools to address those issues. Effects of the application of those tools will be analysed by using quantitative methods on control groups. Group was engaged in traditional method without support of the ICT and after that we will used ICT on individual level. Results showed that proper application of ICT give better results than tradition learning methods.*

Keywords:

1. INTRODUCTION

Mathematics as complex and constantly developing science, put serious challenge in front of the teachers and persons involved in preparation and delivery of mathematical education. Even when we have same educational outputs, curriculums and approach to mathematical education is vastly different from country to country. When we compare mathematical curriculum in Serbia and other EU countries we will see that mathematical curriculum consists from wider number of lectures then other countries. Approach to teaching is rather classical, based on lectures, solving mathematical problems and homework's. Application of modern approach to education in European countries is based on teaching throught game and manipulation, rich and variable didactical material, creativity in education, differentiation and individualization. Efficiency of this approach showed in Netherlands whose students always achieve excellent scores on PISA testing.

Innovative and modern teaching must set student in the center of the teaching process, this provide unique filling and personal need for further development. This approach establish teacher and student are partners in education process [1-2].

To achieve this we set two important aspects to achieve during this research. First was introduction of the concept of the gamification of education to the students of the master studies on State University of Novi Pazar, and second was developing educational games for specific curriculum lessons of mathematics. Then we concluded research within children population to discover did this approach increased children motivation for mathematics and are the final results of implementing this approach gender balanced. Since research showed that gender difference showed higher interest in male student population for mathematics, while females as main aspect of the less interest stated misunderstanding of the classical lectures [3].

2. CONCEPT OF THE GAMIFICATION OF EDUCATION ON THE MASTER COURSE OF METHODIC IN MATHEMATICS

During first lessons important difference between games and gamification is introduced to students. Usually students think that this two aspects are identical. While games are computer programs for providing some type of amusement (regardless are they educational or not), those game are just one of the aspects in the wider concept of gamification of the teaching process. Gamification is learning and teaching approach which use elements like game mechanics, interactive games and computer based games, role playing, game based thinking with one single aim. That aim is to grab and hold learners attention and to manipulate them to learn even in the environment and

topics they do not find attractive [4]. Since gamification uses different elements of games, during course on master studies we presented students with curriculum of the mathematics for elementary schools. Students then choose one school year and developed gamification elements which could be included in the official mathematic teaching. Final aim of the course was to encourage students to develop educational games, not as standalone element, which will be in meaningful way incorporated in the wider educational strategy. They would develop games for repeating and exercise solving mathematical problems. On this way we will cover explanation of the wider context of gamification

3. DESIGN AND DEVELOPMENT OF THE MATHEMATICAL GAME AS PART OF GAMIFICATION OF MATHEMATICS TEACHING

Today on the market we have number of the development tools and languages, adapted for easier teaching of learning programming languages especially for design and development of the video games. Most of them like Scratch or Snap! are tools adapted for kids, and introduction in this packages to students is easy [5-6]. Since students on the course had extensive programming lessons included in their curriculum we decided to introduce programming language and packet Unity. Most important asset of this environment is that it support development of the packages for Android and iOS mobile platforms.

Students must have knowledge in the programing in JavaScript or C#, since Unity support those two ways of programming and additional scripting language Unity Script Image 1.

Image 1: Unity Script Image

During course students developed game World of Math, first step in development was decision to offer gender of the character for the playing. After that pupil can choose working area, class and finally one specific topic of mathematics. This can support especially female pupils to avoid problems with understanding teacher and provide flexible and unique approach to learning through playing Images 2, 3 and 4.

Achievement of student in the game was measured by number of books collected, every collection game consisted from the series of the mathematical problems for solving with proper time limit for submitting answer. More books acquired delivered students more complex tasks and shorter period of time for solving. In order to engage learners in gaming score acquired in game consisted part of the final mark which could be acquired through standard testing if that is something student prefers.

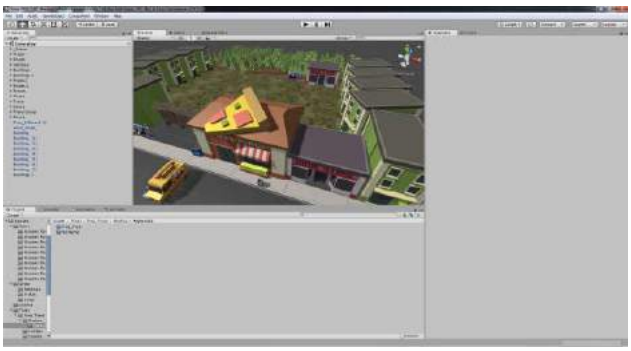

Image 2: Development of the game environment

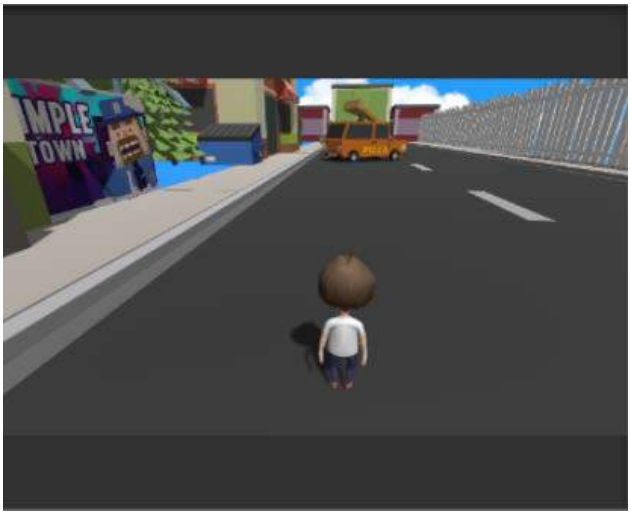

Image 3: Game screenshot

Image 4: Unsuccessful attempt to solve level

All implemented steps in the developing of the games are in line with constructive learning approach. This approach is based on the active student implementation and development of original ideas and solutions. Three main steps of constructive teaching are planning, implementation and learning [7]. Planning phase was covered during design of the game phase were students needed to develop game based on the official curriculum of the mathematic for elementary schools. All tasks and learning material need to be properly adapted for digital

media. Also they needed to make decision which part of the curriculum is adaptable for this approach and which must be teacher on more traditional way.
Implementation phase consisted on the programming game and actual delivery of completed product, in this case educational game.
To achieve actual learning we needed to demonstrate that development and implementation of the gamification concepts will actually deliver planed results. So we took students and their completed product put on real life test in the selected schools, were we also completed research in order to test our hypothesis.

4. METHODOLOGY OF RESEARCH

After completion of the game we wanted to see do the pupils in children population endorse this approach of teaching and can we receive data which support gender balanced teaching of mathematics. In order to properly receive data we needed to establish starting position before implementation of gamification elements and after those implementation. This approach required following tasks for research:

Defining target group (age, gender and achievements).

Development of the research tools (questionnaires).

Analysis of the pupil opinion on innovation in teaching of mathematics.

Analysis of experience with innovations in teaching before and after implementation of gamification.

Analysis of the overall achievement and gender balanced achievement.

Analysis of achieved data is completed using analysis and synthesis methodology.

Fulfilling aims of this approach is achieved by using following techniques: document analysis, observation and interviews.

Researched group was established in two elementary schools in Novi Pazar, total 148 pupils. For the research two equal groups were formed consisting pupils of both schools were established, 74 pupils each. Since we wanted to track gender based issues in learning group consisted from 77 girls and 71 boys. This was used as parameter of same relative frequency of gender in the wider area of Raski district (male 51,1%, and female 47.9%). Testing group was also divided by the age and grade (fifth grade RF 26.35%, sixth grade 24.32%, seventh grade 23.64% and eight grade 25.69%). Before implementation of the gamification processes initial test was concluded and pupils achieved following results (grade 1 RF: 3.37%; grade 2 RF 10.13%; grade 3 RF 17.56; grade 4 RF 29.73%; grade 5 RF 39.29%). Also important result that male students were dominant on higher grade 4 and 5 over female students 65% contrary 35%.

Three important aspects were covered during initial interviewing. First was do pupils use computer as integral part of the educational proceeds. Majority of the give negative answer (95%), Second question was do they use computer as supporting tool for learning outside of the classroom like at the home. Again majority of 78% stated that they do not use computer as tool for teaching.

Final question was related to playing video games, not targeted as educational tool but rather any form of virtual and computer entertainment. Majority of 80% confirmed that they regularsy play video games.

Since we wanted to tracks success and opinion of the students on the video games as part of gamification of teaching, we used binary distributed questionnaire which showed as relevant in researching this type of opinion monitoring [8]. Most of the students 73% had positive opinion and considered worth of trying video games in the education process. Also they stated rather low opinion on the mathematics and motivation to learn and especially to engage in homework and exercising and solving mathematical process. Only 45% had positive opinion on this aspect of mathematic teaching.

After implementation of the games on the experimental class and delivering test similar like tests used before implementation we received more gender balanced results regarding higher scores. This time male pupils achieved 53% of the highest scores. This showed that results of previous research which established link between lower scores of the female students on the misunderstanding of teacher rather lack of cognitive capabilities Application of gamification and games removed teacher as element between cognitive understanding of the delivered material, and on this way delete edge which male pupils had on the classes.

As the final part of the research we concluded interview with teachers and students to give impression about this aspect of the gamification of the teaching, and we received result that pupils think that this approach could be of the value in teaching not only mathematics but natural sciences in all. This will be in the focus of the future research, especially how to methodically present this approach to the teachers of the subjects which are not connected with algorithm based thinking like mathematics is.

5. CONCLUSION

Research showed that gamification and implementation of video games increased activity of the pupils and improved understanding of the teaching material. Most important aspect was removing issues of understanding of teaching and lack of the interest for exercise and solving of the problems presented to pupils. Since this issue is often stated as crucial in the gender based learning research we managed to remove this obstacle and achieve gender balanced results and outcomes of the learning.

Implementation of the games also required additional; input and effort from future teachers, since they were responsible for development of the proper game and problems presented to children.

Future research will be based on development and implementation of the similar concepts in the wider learning topic themes.

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E-TEST

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Abstract: *Through this paper, electronic checking of students' knowledge is described. We are given the definition of the E-test and the type of tasks from which we can form the test. Two e-tests from the Technical and Informatics education are briefly described, and several examples of tasks have been given. This paper is the result of a five-year practice of testing students via e-tests. Students were interviewed and the aim of the survey was to determine the advantages and disadvantages of e-testing, and to give students the ability to choose between classical and e-testing. The reason for writing this paper is to introduce to numerous teachers a way of assessing where the results are presented instantly; none of the students complain about the marks, and there is the possibility of getting detailed statistical reports and analysis.*

Keywords: *E-test*

1. INTRODUCTION

E-testing is a rapidly growing area of e-assessment involving the delivery of examinations and assessment on screen, either using local systems or web-based systems. An e-test is any that replicates or replaces paper-based test with a computer screen, also referred to as on-screen test.

- **A good e-test has the following characteristics:**

- Contains a variety of tasks;

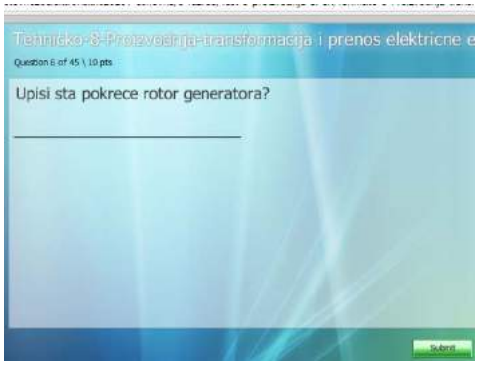

Image 1: Open type question

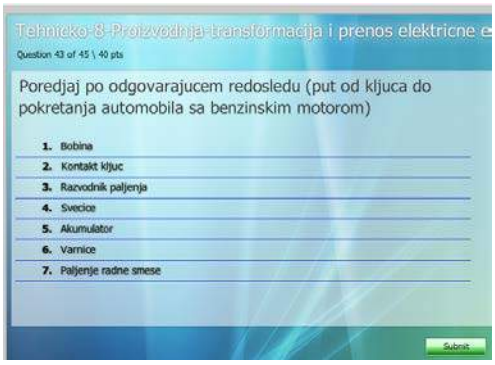

Image 2: The question of determining the exact order

- Contains tasks that are balanced by level of difficulty;

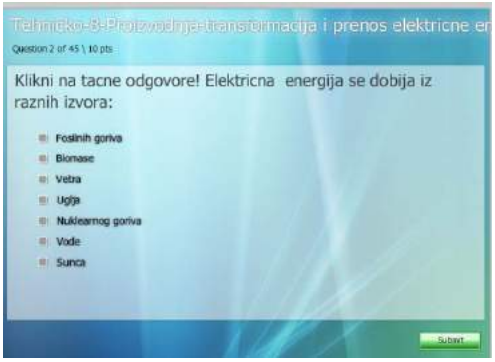

Image 3: A question with more correct answers

- Has beforehand defined exact answers and takes into account all possible answers i.e. how to write a response;

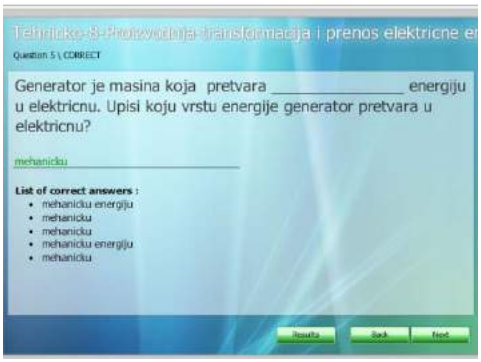

Image 4: An open type question with more accepted exact answers

- Has clearly defined scoring and translation of points into grades, beforehand;

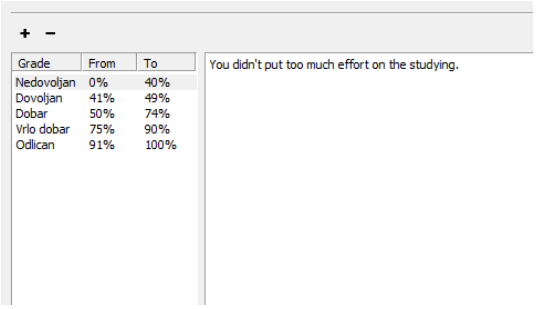

Image 5: Translating points into grades

- Criteria are already known to pupils before tests

Each task has to be:

- Simple (explained in a simple way);

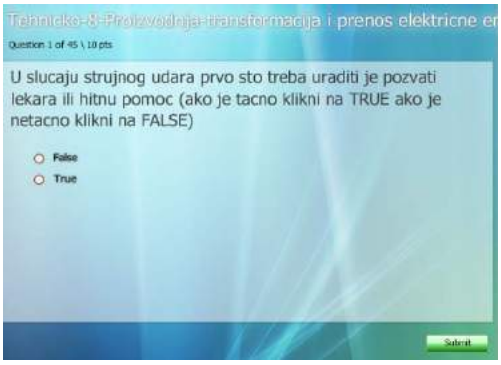

Image 6: A simple basic-level question

- Focused (focused on the essence);

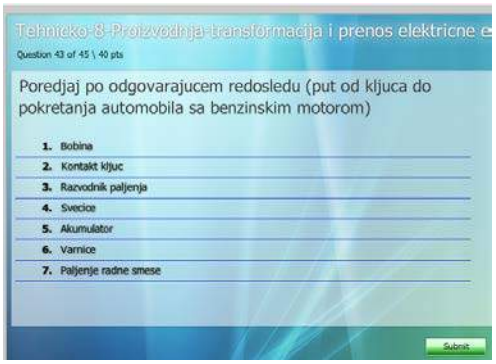

Image 7: Middle-level essential questions

- Precise (said clearly without the possibility of different understanding and implication);
- Reliable (to check exactly the knowledge and skill that is the goal of testing);
- Valid (well presenting a phenomenon, event, and the like);
- Discriminatory (determines differences between students and ranks them).

2. SOLVING THE TEST

When the test starts, a log window appears and only when students enter their name and surname they can start solving the test.

The timing of the test can be limited according to questions, but it does not have to be so (it is a teacher's judgment and decision).

Image 8: Students' logging in

At the end of the test, students receive feedback on their score in the form of the number of points and the appropriate grades. Then, they can return to the test and analyze their work. They are immediately offered to see which answers are correct and which are incorrect.

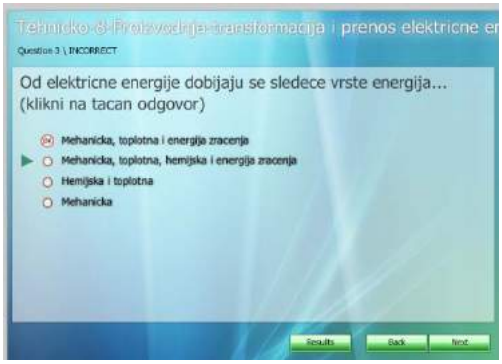

Image 9: Review of the done test

3. ADVANTAGES AND DISADVANTAGES OF E-TEST

The test program I used did not allow moving through questions back and forth. They could only move forward, and only after they answered the question.

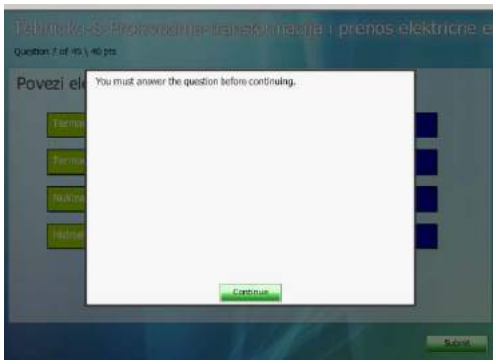

Image 10: Switch to the next question only after the given answer

This kind of testing has its own good and bad sides. The good thing is that the student will not skip the question and leave it unanswered. The bad thing is that they can not choose the order of solving the questions, but have to comply with the offered one.

In the first encounter with the e-test, students easily understand this type of testing and quickly solve the test. When they complete the test and see the result, which is always bad in the first attempt, then they realize that they need to pay more attention to reading the questions and answers and, of course, to think more about the solutions. For this very reason, I had a habit of putting a trick question in a test where words could or could not be terribly confused if students do not read the question carefully.

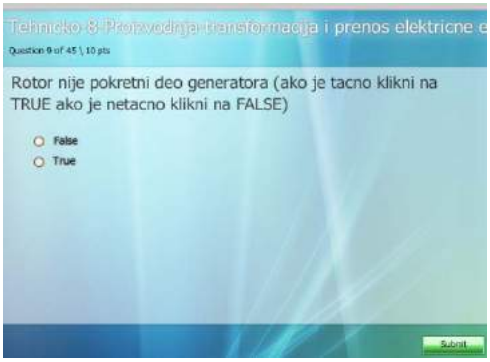

Image 11: Trick question

But despite the poor first results, no student was ever revolted and discouraged. Everyone examined the test immediately and asked when they could correct the score.

And not only were the following grades much better, but they had the habit of coming in and after the classes to ask to run the test a couple of times. Even if it was free time, it was interesting and fun for them to spend time on re-solving the tests.

And, of course, they do not have any jitters or fear before and during test solving.

3. SURVEY

An e-test survey was conducted in one class of grade 7. To the first question about whether they like the e-test, all the students answered affirmatively. The second question was to explain why they like the e-test and here are some answers:

- It's fun;
- We can recall what we learned;
- It is more interesting, and better, and more practical than a paper test;
- Because it looks like a quiz;
- It is interesting and not so hard.

When asked if it was easy to do an e-test, only one answer was "whatsoever" and all the other students replied affirmatively.

Then there was a question about the benefits of the e-test and the answers were as follows:

- Easier to operate;
- Through one click we give answers;
- We do not have to write answers;
- We work on a computer and when we do the test we get an automatic assessment;

- More practical, faster, easier.

When asked "Would you change something on an e-test, most students responded *nothing* and only one answer suggested a change to the rating system.

The next question was about the e-test disadvantages and the students answered:

- There are no disadvantages;
- Asks for many points;
- It did not bother me;
- It can be easily hacked;
- It was not easy and some questions were unclear.

The last question in the survey was as follows: "Would you rather do an e-test or a paper test? All students gave the same answer: e-test.

4. CONCLUSION

A modern information age requires a new, contemporary and informatics-oriented approach to teaching and learning, and of course, assessing students.

Today, at a time when students spend a large portion of their free time on a computer, we need to get them a testing closer to their interests. The e-test is interesting because it's done on a computer and the answers are made by simply clicking a mouse. It all reminds you of playing games or solving quizzes and that’s why it is fun for students.

The e-test will put teachers in trouble while creating it, but a quality e-test will save a lot of time later for evaluation and a variety of test analyses.

And of course, the most important thing is that the teacher can easily create from the simplest tests to the tests for complete curriculum systematization.

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ON THE USE OF VIDEO GAME DEVELOPMENT TECHNIQUES IN ADAPTIVE E-LEARNING SYSTEMS

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Abstract: *In this paper, we present an analysis of main published result in the field of application of video game development techniques in design of adaptive e-learning systems. An overview of the application of the main video games techniques that are used to support adaptability and personalization of learning systems is presented in the following stages: first is given a review of the design of adaptive learning systems, then the analysis of game learning based papers is given and finally the review of using video game techniques in e-learning systems.*

Keywords: *Video Game, Learning systems, E-Learning, Adaptive E-Learning systems, Game Based Learning*

1. INTRODUCTION

Applying video game technology in education has attracted a lot of attention lately, especially regarding emotional and cognitive development, problem solving and motivation. Namely, commercial video games have elaborated ways of motivating users for task solving, gradualness of learning how to solve presented tasks, as well as adjusting the difficulty according to player skill level. After deeper research we see authors battling prejudices about video games – that games can be used for education and not only for fun. Every decade brings a new way of using video game technology in education, and this research strived to encompass newer papers with high number of citations in influential magazines on this subject. Video game technology offers powerful visualization methods, tactile and audio communication between man and machine, and intelligent virtual worlds that enable total immersion of users. Serious games offer functionality of simulation technology at several times lower cost than of commercial simulators and is widely used in practice. Commercial video game designers have mastered techniques of grabbing the attention of users and keep it throughout their interaction with the game, balancing the difficulty of tasks users have to solve successfully. Designers of adaptive educational systems don't always manage to accomplish such goals. Therefore, this research goes both into the area of video game development, as well as applying of video game development technology.

This paper consists of three parts. In the first part, we take a look at papers which are concerned with designing adaptive learning systems. Later, we give an overview of papers which are concerned with learning based on computer games and in the end we give an overview of papers which are concerned with applying video game technology in adaptive education systems.

This paper presents applications of technology of video games in development of an adaptive learning system (ALS), so as to identify potential benefits, synthesize empirical evidence about efficiency of that approach with ALS design and identify areas for further research. Adaptive learning systems represent hard and soft technologies that adapt teaching materials presented to student depending on cognitive models and feedback (student behavior), and so they represent adaptive learning environments [1]. Basic goal is to provide students with support that is as close as to support provided by a human teacher. Learning in context of digital games is scrutinized by Kraford 1982, in book [2], which is the first book dedicated to the design of video games, while Koster in [3] uses human desire to be successful in what they are doing as an inherent human trait as a basis upon which he builds principles of video games design.

2. ADAPTIVE LEARNING SYSTEMS BASED ON COMPUTER GAME TECHNOLOGY

As Computer Based Learning Environment (CBLE) appertains to a broad spectrum of technologies used, and since we can take adaptive learning systems as supportive to computer based learning, we can say that simulation games are very well connected with usage of technologies that support learning. Adaptive learning, also known as adaptive education, represents educational method that uses a computer algorithm that manages and creates interaction with students and gives them adapted resources and learning activities so as to satisfy unique needs of every

student. Serious, simulation, educational games themselves can be a sort of adaptive system for education based on video game technology (we're introducing a new abbreviation: ASEBVGT). Adaptive learning model used for creating adaptive learning system includes components of video game design, as well as elements of learning strategy, adaptive learning, and is also required to provide guidelines for creation of adaptive learning games to educators and game creators.

Adaptive personalized systems based on agent technology represent software that has the capability for the student to autonomously perform a task and which can generate report on the student regarding the completion of a task or occurrence of an expected event without any intervention by the educator. Agents themselves can be defined as computer system which cooperates with the learning environment and has the capability to react in a flexible and independent way according to the goals set.

3. A REVIEW OF ADAPTIVE LEARNING SYSTEM DESIGN

Unlike a traditional learning management systems (LMS), which acts as a repository of information and a tool for the training administrator to assign modules and track progress, an ALS assigns modules based on learner needs/styles/competence level/etc. And there's more. It has the ability to assess learner progress and account for this while creating the learning path. Those system can be referred to as Intelligent Tutoring Systems which are applied in education and corporate training.

In paper [4], adaptive learning systems are defined as hard and soft technologies which adapt content presented to students using technologies such as cognitive modelling and/or sensory input. Currently existing adaptive systems cover a broad spectrum of adaptability: they go from simple systems for support of certain aspects of adaptation, with basic knowledge about a student, all the way to systems that are capable of learning themselves – intelligent tutoring systems. If we take into consideration all of the existing definitions, we arrive at a conclusion that a computer game itself can be adaptive learning system.

The most popular papers on this theme are from Peter Bruslovsky. Bruslovsky has given several proposals for adaptive learning system design. In this paper [5] he discusses the problems of integrated intelligent learning environments (ILE) for programming and reviews existing research that forms the background for future research in this area. In particular, he would review their work on a student model-centered architecture for ILE. In this paper[6] Bruslovsky presents KnowledgeTree, an architecture for adaptive E-Learning based on distributed reusable intelligent learning activities and the goal of that KnowledgeTree is to bridge the gap between the currently popular approach to Web-based education, which is centered on learning management systems vs. the powerful but underused technologies in intelligent tutoring and adaptive hypermedia. In *„Adaptive and Intelligent Web-based Educational Systems*"[7] Bruslovsky gives a review of adaptive and intelligent Web/based educational systems. In that paper he presents that first pioneer intelligent and adaptive Web-based educational systems were developed in 1995-1996, and the one of first article was his.[8] In paper *"Layered evaluation of adaptive learning systems"* [9] Bruslovsky et al. give an alternative to the traditional 'as a whole' approach of evaluating adaptive learning systems (ALS), and adaptive systems, in general. We argue that the commonly recognized models of adaptive systems can be used as a basis for a layered evaluation that offers certain benefits to the developers of ALS. They proposed the layered evaluation framework, where the success of adaptation is addressed at two distinct layers: user modelling and adaptation decision making.

The next paper [10] presents the use of instruction programming concepts, the intelligent tutoring system concept, adaptive learning systems, and the recommendations for pedagogical system concept to help the development of adaptive learning systems based on serious games. Furthermore, it has been found that concepts which are already given are not enough, and therefore teaching and learning require human understanding and thus human communication is necessary to foster learning. It is assumed that within these restrictions reasonable concepts can be developed and this was used in the development of an adaptive learning system based on serious games. During the work on the paper [10], the restrictions presented assumed that within those restrictions reasonable concepts can be developed. One suggested approach is to refer to the pedagogical theory of play and the understanding of pedagogical actions as an art. Based on this approach, it is understood that the design of an automated educational reasoning system for learning is like creation of tools for artists. With these tools, teachers from the University of Vienna who tested the created system, had created playground equipment that is played with by students. The presented concept of work coincides to some extent with our research as well as the direction for the studying matter, therefore it is considered as important for further developing of our research. During the implementation of the learning environment, there were a number of complex operational problems. These problems required a large scale of innovative solutions and procedures for effective problem solving.

In paper [11], Persico et al. describe an experience where the Technology Acceptance Model (TAM) has been adapted for use in the evaluation of methodological and technological innovations determined by the introduction of a new e-learning system in an Italian online university. That paper shows how e-learning evaluation can rely, today, on several sources of data that can be mapped to one another to obtain a detailed picture of acceptance, usage and effectiveness of a system and also confirms the importance of formative evaluation of e-learning systems in innovation processes in higher education and provides important elements concerning how these processes can be activated, supported and sustained.

In "Development of an adaptive learning system with two sources of personalization information" [12], Tshenga et al. propose an adaptive learning approach based upon two main sources of personalization information that is, learning behavior and personal learning style. They give questionnaire to students to determine their initial learning styles. To more precisely reflect the learning behaviors of each student, interactions and learning results of each

student are analyzed when adjusting the subject materials. Based on the innovative approach, an adaptive learning system has been developed; moreover, an experiment was conducted to evaluate the performance of their approach. By analyzing the results from three groups of students using different adaptive learning approaches, it can be found that this innovative approach is helpful in improving both the learning achievement and learning efficiency of individual students. They give the architecture of adaptive system which is used in Chung-Hua University in Taiwan. In paper [13], authors describe a concept for combining ITS and AH into Adaptive Intelligent Tutoring System (AITS) for e-learning systems that allows knowledge to be stored in such a way that is not only independent of the knowledge domain, but also supports the storage of transfer knowledge relationships and prerequisite knowledge relationships. The concept results show that this innovative approach is helpful to the learners in improving their learning achievements.
Article [14] proposes a personalized e-learning system based on Item Response Theory (PEL-IRT) which considers both course material difficulty and learner ability to provide individual learning paths for learners. To obtain more precise estimation of learner ability, the maximum likelihood estimation (MLE) is applied to estimate learner ability based on explicit learner feedback. Moreover, to determine an appropriate level of difficulty parameter for the course materials, the study also proposes a collaborative voting approach for adjusting course material difficulty. Experiment results show that applying Item Response Theory (IRT) to Web-based learning can achieve personalized learning and help learners to learn more effectively and efficiently.

The next papers are the most recent research (from 2016-2018). This article [15] aims to give the foundation of a framework for an ALS that gives extensive attention at each stage of the design process to the end-user: learners. The system proposed is based on balanced combination of Agile Learning Design (Agile LD) and Learner-Centered Design. The paper gives general view of how to support de design and the implementation of an ALS respecting the Agile LD method and integrating the learner-centered approach. In next paper [16] Hammami present a development of an adaptive e-learning system to measure deaf student progress and interaction, and to enhance them. Enhancements are based on several recent technologies, including Bilingual/Bicultural methodologies, and adaptive learning, multi-agent, and mobile technologies. Presented system is based on a specific set of defined skills. To evaluate the Deaf Students Learning Outcomes results, they define an Academic Advisor Agent. The objective of the Academic Advisor is to monitor the students' achievements of the learning program and to provide them with advices to better achieve the program Student Outcomes. In next paper [17] they investigated learning outcomes and user perceptions from interactions with a hybrid intelligent tutoring system created by combining the AutoTutor conversational tutoring system with the Assessment and Learning in Knowledge Spaces (ALEKS) adaptive learning system for mathematics. This hybrid intelligent tutoring system (ITS) uses a service-oriented architecture to combine these two web-based systems. Self-explanation tutoring dialogs were used to talk students through step-by-step worked examples to algebra problems. These worked examples presented an isomorphic problem to the preceding algebra problem that the student could not solve in the adaptive learning system. Results: Due to crossover issues between conditions, experimental versus control condition assignment did not show significant differences in learning gains. In paper [18] authors investigate what behavior patterns learners with different characteristics demonstrate when they interact with an adaptive learning environment. Incoming 1st-year students in a pharmacy professional degree program engaged in an adaptive learning intervention that aimed to provide remedial instruction to better prepare these professional students before they began their formal degree program. Authors analyzed the participants' behavior patterns through the usage data to understand how they used the adaptive system based upon their needs and interests. This study found: (1) apart from learners' cognitive ability, it is important to consider affective factors such as motivation in adaptive learning, (2) lack of alignment among various components in an adaptive system can impact how learners accessed the system and, more importantly, their performance, and (3) visualizations can reveal interesting findings that can be missed otherwise. That evidence-based research is given to understand how data such as user behavior patterns can be used to design effective adaptive learning systems. In next paper [19] by reviewing 51 studies, they delve deeply into different parts of the integration process for learning styles in e-learning. It captures a variety of aspects from learning styles theories selection in e-learning environment, online learning styles predictors, automatic learning styles classification to numerous learning styles applications. The results offer insights into different developments, achievements and open problems in the field.

4. A REVIEW OF GAME BASED LEARNING

Game based learning has been capturing scientific community for the last three decades, but the number of conclusive studies with empirical background has not been significant. More so since it shows that in the context of learning, games can have negative effect if not adequately designed. In order to realize the potential of games, and when games can be efficient, a serious research is needed, that will show why educational systems based on video game technology can be effective and under what circumstances. Implementation strategies presented in the papers show: using games for motivating students, creating games for learning computer science, using games as learning environments or using video games as environment for learning or applying subjects from computer science.
In this paper [20] authors presented the mixed methods design was used to identify factors associated with motivational engagement in video gaming. Self-report instruments were administered to 189 video game players to assess goal orientations, affect, need for cognition, and perceptions of engagement and flow. Simultaneously, a sub-set of 25 participants were interviewed and results analyzed to identify patterns that influenced their propensity for gaming. Regression results revealed

motivational engagement for gaming was related to gender, hours of play, task orientation, and socialization. Players indicated that gaming was socially captivating, fun, challenging but relaxing, and precipitated positive affect and cognition even when unsuccessful results were achieved. The negative consequences normally associated with task failure were not reported by participants to take place during gaming. They concluded transfer of motivational engagement in gaming for entertainment to educational contexts was unlikely to occur.

"Game-based learning" article [21] reviews a rapidly growing body of empirical evidence on the effectiveness of using video and computer games to provide instruction. Evidence of their effectiveness is drawn from existing results and data. The topics covered there are transfer from computer games to external tasks, enhancing cognitive processes, guidance and animated agents, playing time and integration with curricular objectives, effects on game players, attitudes toward games, cost-effectiveness, and, finally, the use of games for evaluation. Areas where the evidence base is particularly weak are identified in the discussion section. Findings and recommendations for the design of games used in instruction are summarized in a table. The chapter concludes with a call for development of tools and technology for integrating the motivating aspects of games with good instructional design. People do learn from games. Missing are generally effective design processes that ensure that learners will acquire the specific knowledge and skills the games are intended to impart.

Next presented references are from 2016 - 2018.

The goal of paper [22] was to assess how metacognitive monitoring and scientific reasoning impacted the efficiency of game completion during learning with Crystal Island, a game-based learning environment that fosters self-regulated learning and scientific reasoning by having participants solve the mystery of what illness impacted inhabitants of the island. They conducted sequential pattern mining and differential sequence mining on 64 undergraduate participants' hypothesis testing behavior. Patterns were coded based on the relevancy of what items were being tested for, and the items themselves. Results revealed that participants who were more efficient at solving the mystery tested significantly fewer partially-relevant and irrelevant items than less efficient participants.

Objective of paper [23] was to evaluate the effectiveness of a game-based learning (GBL) intervention, Tapamole, in improving recognition of the features of melanoma (MM) compared to a written education intervention. Tapamole, an online education intervention, was developed using GBL. Tapamole, in improving recognition of the features of melanoma (MM) compared to a written education intervention.Results: Sixty participants were recruited. The article illustrates the application of GBL in medicine.

The paper "Evaluation of Game-Based Learning in Cybersecurity Education for High School Students" [24] describes evaluation results of game based learning for high school cybersecurity education. Four cybersecurity computer games were developed to educate social engineering, secure online behaviors, and 10 cybersecurity first principles. The use of game based learning in the PNW GenCyber camp was an excellent platform to teach cybersecurity principles and secure online behaviors for high school students. This approach is beneficial to the future cybersecurity workforce by exposing more high school students to the cybersecurity education pathway at a time when they are making decisions regarding higher education. The game based learning method was well received by the students, support staff, instructors, and site visit team.

Paper [25] presents teachers' perceptions of the usefulness of digital games might be a reason for the limited application of digital games in education. This study examined the practice-based perceptions of teachers who do teach with digital games - either playing or creating games - in their classroom. Semi-structured interviews were conducted with 43 secondary education teachers. Their findings showed that most teachers who actually use games in class perceived student engagement with a game and cognitive learning outcomes as effects of the use of games in formal teaching settings. Fewer teachers mentioned motivational effects of learning with digital games.

In next paper, "A Pilot study to assess the impacts of game-based construction learning, using scratch, on students' multi-step equation-solving performance"[26] authors examined the effects of students' construction of computer-based educational games, using Scratch, on their mathematical equation-solving performance and their attitudes towards learning mathematics with the assistance of technology. The results indicated significant improvements in students' equation-solving performance and in their attitudes towards learning mathematics with the assistance of technology.

In paper [27], Hamari investigates the impact of flow (operationalized as heightened challenge and skill), engagement, and immersion on learning in game-based learning environments. . Challenge of the game had a positive effect on learning both directly and via the increased engagement. Being skilled in the game did not affect learning directly but by increasing engagement in the game. Both the challenge of the game and being skilled in the game had a positive effect on both being engaged and immersed in the game. The challenge in the game was an especially strong predictor of learning outcomes. For the design of educational games, the results suggest that the challenge of the game should be able to keep up with the learners growing abilities and learning in order to endorse continued learning in game-based learning environments

5. A REVIEW OF VIDEO GAME DEVELOPMENT TECHNIQUES IN ALS

By reading the works, we paid attention to the fact that scientific works are newer. The number of papers was limited, so the task was more demanding.

One of the most important paper is PhD dissertation - "A study of adaptive Learning for educational game design"[28] by Edward D. Lavieri Jr. Author developed and validated the ALGAE (Adaptive Learning Game Design) model, a comprehensive adaptive learning model based on game design theories and practices, instructional strategies, and adaptive models. This dissertation extends

previous research in game design, instructional strategies, and adaptive learning, combining these three components into a single complex model. The results of this study include the validation and applicability of the ALGAE model, benefits and challenges of using the model, and insights regarding the focused and unfocused implementation approaches. The study also reveals the cross-industry applicability of the model to include government agencies, military units, game industry, and academia.

The paper [29] presents an adaptive learning system based on computer games and shows and describes the method for creating experienced systems for purposes of a serious game and ALS using the principles from the Simulation Experience Design Method. The purpose of the work is the application of the mentioned principle and the emphasis is on HCI. Also, the game uses adaptive thinking and critical thinking. Specific for paper is the use of after action review capability, which is not typical for all serious games, is also specific. An after-action review (AAR) typically allows instructors and students to critically review the decisions made and actions taken during game play. A serious game leveraging the Internet-based multiplayer game called America's Army and designed using the simulation experience design method has already been used by the United States Department. The demonstration of the use of the simulation experience design method gave the idea of how to approach the already mentioned problem of merging ALS and serious games.

The purpose of the next paper [30] is to briefly introduce adaptive training systems, and describe the Simulation Experience Design Method. Adaptive training systems are serious games whose goal it is to engender communication opportunities for players to learn about their strengths and weaknesses, receive real-time in-game performance feedback, and share diverse solutions and strategies during, between, and after game play in order to update, or adapt, player understanding. The Simulation Experience Design Method extends HCI approaches to create engaging multiplayer learning experiences by focusing on how dynamic game content, roles, scenarios, and assessment feedback contribute to emergent culture. The contribution of the present paper lies in describing how designers create rich systems of experiences for serious games and adaptive training systems by employing HCI principles and the Simulation Experience Design Method.

In paper [31], a personalized game-based learning approach is proposed based on the sequential/global dimension of the learning style proposed by Felder and Silverman [32]. To evaluate the effectiveness of the proposed approach, a role-playing game has been implemented based on the approach; moreover, an experiment has been conducted on an elementary school natural science course. From the experimental results, it is found that the personalized educational computer game not only promotes learning motivation, but also improves the learning achievements of the students.

The purpose of next paper [33] was to examine the effects of using game mechanics and a student-generated questions strategy to promote algorithmic thinking skills in an online puzzle-based game learning system. An online puzzle-based game learning system, TGTS (Turtle Graphics Tutorial System), was developed to help students learn algorithmic thinking skills by allowing them to solve puzzles. A quasi-experiment was conducted to examine the effectiveness of using game mechanics alone and using game mechanics plus a student-generated questions strategy. Nine fourth-grade elementary classes ($n = 242$) were used to form three treatment groups, including one without game mechanics, one using game mechanics, and one using game mechanics plus a student-generated questions strategy. The results indicate that TGTS with game mechanics significantly enhanced algorithmic thinking skills and puzzle-solving performance.

Next paper [34] describes the concept of Narrative Game-Based Learning Objects (NGLOB), providing a model of how to combine these different axes (narration, gaming, and learning) and how to apply it within personalized, adaptive Digital Educational Games (DEG). From a research perspective, this results in one of the main technical challenges of Serious Games (SG): personalization and adaptation. Next Article [35] is from same authors and describes the concept and use of Narrative Game-based Learning Objects (NGLOB) for the personalization and adaptation of Story-based Digital Educational Games (DEG). Authors describe their concept of NGLOBs combining learner modeling, player modeling and storytelling and a prototypical realization of the concept implemented in the context of the Bat Cave. Finally, the main results are summarized and further research activities such as additional evaluation studies are outlined.

Paper [36] provides a way of conceptualizing them as possibility spaces for learning. It provides an overview of two research programs: 1) an after school program using commercial games to develop deep expertise in game play and game creation, and 2) an in school program using game techniques to teach science literacy.

6. CONCLUSION

In this paper, results of initial paper analysis were presented in order to summarize current state of science regarding applications of video game technology in adaptive learning systems. Overview itself has identified potential benefits in implementation of video games in context of education, by reviewing papers from 1996 to 2018. Most significant benefit was identified in articles that promote motivating students for taking part in learning process. Many papers regarding Game Based Learning are available, but not that many that merge video game technology with adaptive learning systems. Strategies applied in adaptive learning systems based on video games, and described in scientific papers are: using games for motivating students, using games for studying subjects from computer technologies, using games as learning environment, and using games as examples for studying computer science subjects. Some of the papers are concerned with games as a tool for learning. Although current empirical research show positive side of using video games as education tools, they also show some conflicting results about educational efficiency of video games. Most of the studies used games to increase interest for learning certain materials, and results shown are mostly positive (90%). Going further, comparative studies that concern with methodological weaknesses are needed, as well as comparing influence of applying video games in

education with other forms of education in order to establish hard evidence which would better support findings of these studies. Results show that although GBL has broad applications, it must be used very carefully when preparing lecture presentations based on it.

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AUTHORING TOOL FOR ONTOLOGY DEVELOPMENT FOR ONLINE LEARNING

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Abstract: *This work presents design and functionalities of authoring tool used for ontology creation, as a part of previously developed software ontology-based system for learning objects retrieval (OBSLO). Main goal of OBSLO is to dynamically generate multi-dimensional concept maps (MCMs) for a particular domain given the defined ontology of its concepts. OBSLO provides flexibility to define multiple dimensions needed for the concepts maps, by allowing definition of ontology attributes as a relation between topics and subtopics. Main contribution to improving OBSLO is in providing environment for ontology creation and modification. In the first phase, instructor has a role of the ontology creator. As ontology development can be a lengthy and complex task, OBSLO from its system usage, provides feedback to the instructor as to what learning material is used and to what degree, allowing the instructor to modify already defined ontology in the second phase. Scenario of ontology creation and its representation using multidimensional concept maps is explored for the Database course in this work.*

Keywords: *E-Learning, distance learning, learning object ontology*

1. INTRODUCTION

The new e-learning systems are being more enriched with rich educational hypermedia [1]. The challenge with growing systems and diverse data formats are introducing new challenges when needing to extract learning material that is necessary for each learner. In the personalized e-learning, the tendency is to customize learning styles and learning paths for each student [2]. In this paper we show how ontology can be used to create relations between learning materials [3].

Imagine the following scenario: Instructor is currently creating learning material for a specific knowledge domain or a particular course. The instructor is trying to create flexible and modularized learning material, so that learning material can be differently used and structure for each particular student, based on his/her needs [4]. This material is created in forms of learning objects (LOs), so that each LO represents modularized and independent learning material with its content, activities and knowledge evaluations [5, 6]. Given a large number of topics and subtopics of a domain knowledge, there are probably hundreds of LOs that could be used to describe it. There are several challenges that are occurring in this scenario [7, 8, 9]:

1. Creation of ontology for large number of LOs can be complex, time consuming and expensive,
2. Connection of ontology relations between LOs to their learning content is a must in order to achieve flexible system that reduces user effort,
3. Representation of different learning paths considering large domain knowledge represents more challenges, considering that learner should not be overloaded with too much information at once.

In this work we improve previously designed Ontology-based system for learning object retrieval (OBSLO) [10]. OBSLO represents a system for storing and visualizing learning material, using multi-dimensional concept maps (MCMs) techniques. OBSLO uses instructor defined ontology and based on it OBSLO dynamically generates MCM of knowledge domain as an output. Knowledge domain is represented in the form of trees and its subtrees, where the learner is allowed to select what will be presented to him/her, while being able to see what are related, basic and advanced topics in the given domain knowledge.

In this paper we present improved element of OBSLO which only deals with Ontology Authoring tool, which provides functionalities to the instructor to create different relations between topics and subtopics within knowledge domain, as well as to create multiple dimensions within concepts. Each dimension is defined using ontology attributes between topics and subtopics.

The goal is to achieve flexible system that will allow for minimized user effort, while enhancing usability of the system. The basic functionality of the Ontology Authoring tool is to provide instructor-friendly environment for the initial ontology creation. In addition, this Ontology Authoring tool provides functionalities that provides learner feedback to the instructor, so that instructor can make decision about ontology modification. Based on the level of usage, OBSLO recommends to instructors new relations that should be added, or the ones that should be modified. Scenario of ontology creation and its representation using multidimensional concept maps is explored for the Database course.

This paper is organized as follows. Section 2 describes technical details of OBSLO and its newly developed Ontology Authoring tool, Section 3 describes the process of creation and modification of ontology for the Database course. Section 4 concludes the paper.

2. OBSLO ARCHITECTURE AND FUNCTIONALITIES

2.1. OBSLO

OBSLO represents environment for both instructors and students. OBSLO provides environment where the instructor can structure and prepare learning materials, while students have their own view of the system, which is tailored for learning and navigation through the learning material.

In OBSLO personalized learning paths are achieved by comprising learning path of learning objects (LOs) that are stored, handled, combined, and administrated by using institutional learning management system (ILS). In order to improve LOs retrieval from ILS and enable LOs content to be reused in different teaching scenarios and different learning paths, LOs are enriched with complementary knowledge represented in the form of ontologies. To overcome the issue of large domain ontology visualization, OBSLO uses the multi-dimensional concept map approach, where complex or difficult concepts are arranged into multiple dimensions. Student is presented with a MCM of domain knowledge and can browse through all topics and its related subtopics. Students is presented only with learning paths suitable to their interest and knowledge to allow for progressive learning at his/her pace. Progressive and effective mastering of small and independent concept allow learners to enhance their learning achievements.

OBSLO architecture is represented in Figure 1.

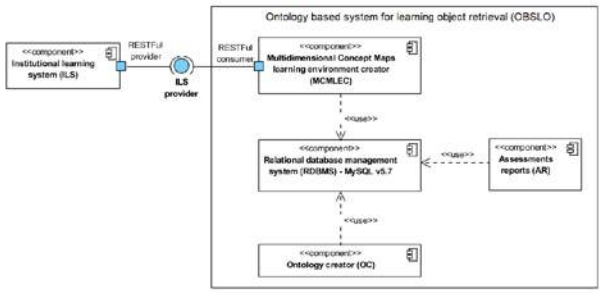

Figure 1: OBSLO architecture

Software architecture of OBSLO system is composed of four components:

1. Ontology Authoring tool (OAT)
2. MCM learning environment creator (MCMLEC)
3. Assessment reporter (AR)
4. Relational database management system (RDBMS)

The main functionality of the OAT component is to create and modify domain ontology while providing to instructor friendly environment where all ontology elements are accessible (concepts with appropriate properties, different relations between concepts, LOs and relations between concept and LOs). All ontology elements are stored in RDBMS. OAT represents the component with the intuitive graphical user interface for: (i) domain ontology creation and (ii) ontology modification based on student activities and completed learning paths.

ILS provider represented software interface that allows for communication between ILS and OBSLO. This interface allows for LOs to be assigned with different relations and assigned to certain topics, which is all stored in RDBMS.

On the other hand, the main functionality of the MCMLEC component is to provide environment for the problem based learning. MCMLEC enables instructor to post the task/problem that should be solved by learners and check the accuracy of student solutions. Also, by using MCMLEC component students review the assigned task/ problem, navigate through MCM while creating personalized learning paths. All of student activities and their answers are stored in RDBMS for later analyze by AR component. RDBMS can be considered as a component which role is to integrate three other components OAT, AR and MCMLEC.

2.2. OAT

Initial ontology creation activity assumes that the teacher defines ontology structure by specifying all concepts of the domain ontology from the highest to the lowest level and establishes different types of relations between them. Each concept at the lowest level is assumed to be decomposed into LOs that represent the only elements in ontology that contain learning content. Therefore, OAT as a software component fulfills the following functional requirements:

R1: Definition of ontology hierarchy.

Assuming that the domain ontology creation is guided by institutionally accepted curriculum, concepts for ontology model are defined according to the curriculum structure (Figure 2).

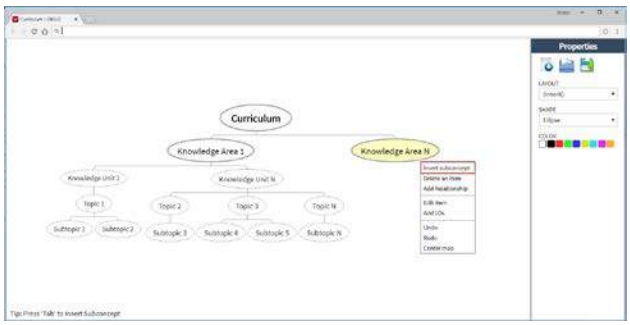

Figure 2: Definition of ontology hierarchy on several levels

The most general concept, a curriculum for entire academic major, is followed by lower levels concepts: knowledge areas, knowledge units, topics and subtopics. Initial usage of OAT will provide the instructor viewing of the curriculum.

Each time a concept is created, its name and properties (attributes) with attaching facets (properties' value type, allowed values, the number of allowed values etc.) can be defined. Definition and modification of name and attributes are possible at any point by simply selecting the concept and option *Edit item* from the drop-down menu as shown on Figure 2 or Figure 3.
Any other concept at the lower level for a specific concept (initially the curriculum) can be added by selecting option *Insert subconcept* from the drop-down menu as shown on Figure 2. Each time a subconcept is defined, OAT automatically relates the selected concept with particular subconcept by establishing *"part of"* (PO) relation between them. For example, *Subtopic 1* and *Subtopic 2* are parts of *Topic 1*. Also, *Topic 1* is a part of the *Knowledge Unit 1* (Figure 2).

The attribute that defines dimension *difficulty level* has two values: *basic and advanced.* This attribute indicates that one concept may be on the lower knowledge level than the other. Number of attribute values for the concept indicates the number of dimensions in MCM representation. Once the concept is marked as *basic* and other as *advanced*, OAT automatically creates *BA* relation between them as shown in Figure 3. For example, in Figure 3 *Topic 1* is in *BA* relation with *Topic 2*, indicating that *Topic 2* is an advanced concept to *Topic 1*. For specifying BA relation there are some guidelines that should be followed*:*

a. When the value of attribute *difficulty level* is specified for a topic on the higher level, OAT will automatically generate the same attribute value for all their lower levels subtopics.
b. When a topic has subtopics with different values for the *difficulty level* attribute (for example one subtopic is declared as *basic* and another as *advanced*), OAT will automatically generate multivalued difficulty level attribute (*basic* and *advanced*) for this topic. For example, if *Subtopic4* is declared as basic and *Subtopic 5* as advanced, OAT will automatically generate multivalued (*basic* and *advanced*) attribute on higher level concepts, in this case *Topic 3* and *Knowledge Unit N* (Figure 4).

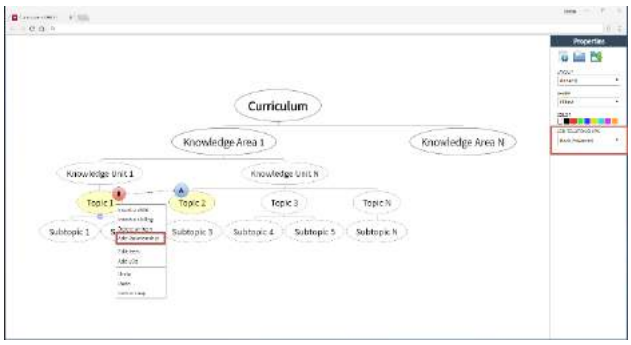

Figure 3: Basic/advanced property definition

R2: Establishing relations between concepts at the lowest level and LOs.
When the ontology hierarchy is created, instructor should add LOs for each lowest level concept. A LO can be added by selecting a specific concept and option *Add LOs* from the drop-down menu as shown in Figure 4. Each time LO is added, OAT will automatically relate the selected lowest level concept with the particular LO by establishing *"has content"* (HC) relation between them. For example *Subtopic 1* is explained by *LO1 and L02* content (Figure 4). Each LO must be named by simply selecting the option *Edit item* from the drop-down menu as shown on Figure 1.

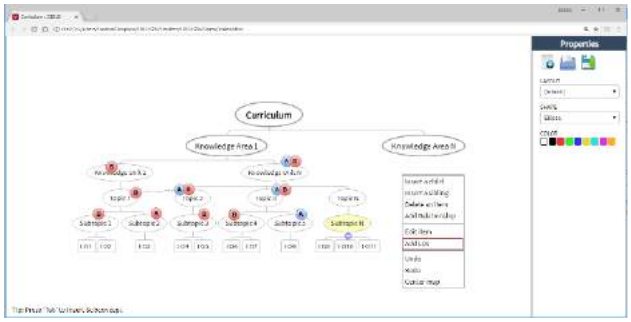

Figure 3: Attaching LOs to concept

In order to indicate prerequisite knowledge for the particular LO, *"order relation"* (OR) between LOs can be established. Each time LO is added and named, instructor has a possibility to select two LOs and from right-side menu add OR relation between them. Instructor can choose two different types of OR: (i) mandatory relation (red dashed line in Figure 5), which indicates that certain LO should be learned before accessing that specific LO and (ii) optional relation (purple dashed line in Figure 5) used only as a recommendation which LOs may be learned in order to provide deeper knowledge. For example, *LO3* is mandatory for learning *LO4*, which means that learning of *LO4* can start once *LO3* is learned. Similarly, *LO1* is optional for learning *LO2* which indicates that learning of *LO1* will deepen the current knowledge for *LO1* (Figure 5).

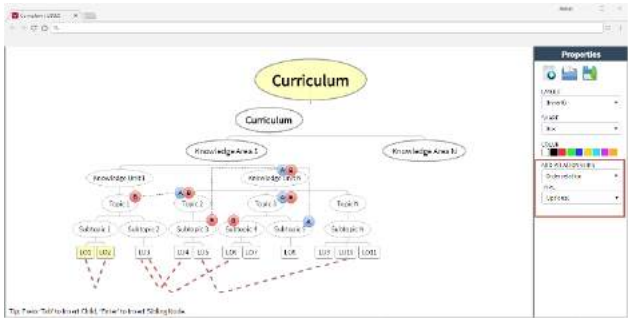

Figure 4: Creation of OR relation

R3: *Modification of previously defined ontology.*
Based on data provided by AR component (Figure 6), after the usage of learning materials in the problem-based learning setting, instructor is able to change the ontology definition by creating a new concept, delete an existing concept, edit names, assign properties to concepts, or create new relations between concepts). Also, relations can be defined, modified or deleted. By using OAT instructor has a possibility to review different kind of reports generated by AR. For example, as shown on Figure 6 the number of students who successfully or unsuccessfully solve assigned problem while using different LOs in their learning paths or time spent on each LO.

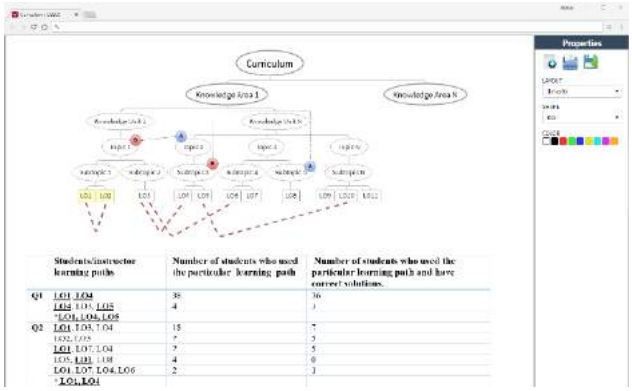

Figure 5: OAT domain ontology modification

3. CREATION AND MODIFICATION OF ONTOLOGY FOR DATABASE COURSE

IEEE Computer Society's Information Technology 2008 Curriculum Guidelines for Undergraduate Degree Programs was used as the institutionally accepted curriculum for the base of this case study and development of the domain ontology for the Database course. This curriculum proposes six key concepts that should be part of the Database course: (i) *Information Management Concepts and Fundamentals (IMCF)*, (ii) *Database Query Language (DQL)*, (iii) *Data Organization Architecture (DOAR)*, (iv) *Data Modeling (DMOD)*, (v) *Managing the Database Environment (MDBE)*, and (vi) *Special Purpose Databases (SPDB)*. For the need of this paper we present the implementation of *DQL* concept developed in OAT as shown in Figure 7.

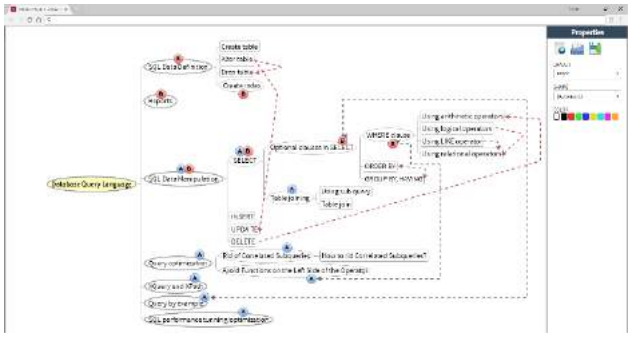

Figure 7: DQL concept creation in OAT

For the selected *DQL* concept, OAT provides the ability to easily create all other subconcepts, relation between them, and define concept attributes. As shown in Figure 7 *DQL* concept is composed of the following topics: (i) *SQL data manipulation (SQDM*), (ii) *SQL Data Definition (SQDD)*, (iii) *SQL performance tuning/optimization (SQPT)*, (iv) *XQuery and XPath (XQU*E), (v) *Reports (REPO)*, (vi) *Query by example*, and (vi) *Query optimization (QOPT)*. Further, three of created topics: (i) *SQL Data Manipulation (SQDM*), (ii) *SQL Data Definition (SQDD)*, and (iii) *Query optimization (QOPT)* are decomposed by using OAT. *SQL Data Manipulation* topic consists of subtopic *SELECT* statement and three LOs: *INSERT*, *UPDATE* and *DELETE*. Subtopic *SELECT* contains LOs *ORDER BY* and *GROUP BY HAVING*. Also *SELECT* is a complex topic which is further subdivided into more specific subtopics: (i) *Table join*, and (ii) *Optional clauses in SELECT* which includes *WHERE clause* subtopic. *WHERE clause* consists of its LOs: *Using arithmetic operators*, *Using logical operators*, *Using LIKE operator* and *Using relational operators*. Such a complex ontology structure is created in OAT by establishing *PO* and *HC* relations between concepts and LO (Figure 7).
The attribute values for knowledge level are also specified as shown in Figure 7. For example, subtopic *Optional clauses in SELECT* represents *basic difficulty level* concept for *advanced difficulty level* topic *Avoid functions on the left side of operator* knowledge. Based on specified values for *difficulty level* attribute for *SQL Data Definition*, OAT automatically generates the same attribute value for *Create index* subtopic. However, because topic *SELECT* contains subtopic *Optional clauses in SELECT* specified with *basic* difficulty level and *Table join* with *advanced* difficulty level, OAT automatically generates multivalued difficulty level attribute (*basic* and *advanced*) for the *SELECT* topic. MCMLEC uses all attribute values to create different dimensions in MCM for ontology visualization. All concepts with the same difficulty level are grouped together and presented as one MCM dimension. For example, *DQL* concept presented in Figure 7 contains concepts with: (i) *basic difficulty level* (*SQL data definition* and *Reports*), (ii) *advanced difficulty level* (Query optimization, *XQuery and XPath*, *Query by Example* and *SQL performance tuning/optimization*), and (iii) concepts with multivalued *basic* and *advanced difficulty levels* (*SQL data manipulation*). MCMLEC presents DQL concept so that:

a. *Basic difficulty level* concepts and concepts with multivalued difficulty level attribute will be

presented as one dimension like basic difficulty level subtree (Figure 8)

b. *Advanced* concepts with concepts with multivalued difficulty level attribute in *advanced* difficulty level subtree presented as other dimension (Figure 9).

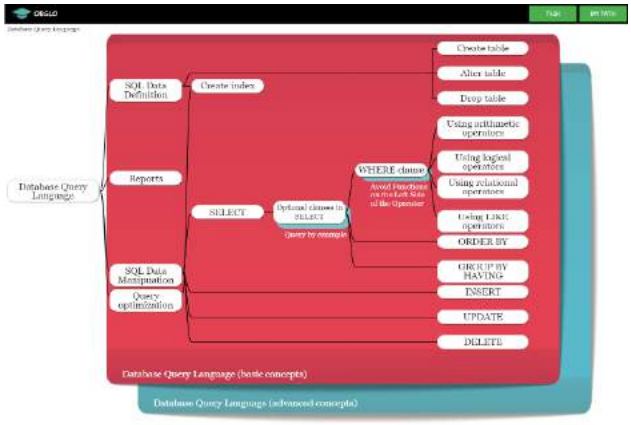

Figure 6: Basic level Data Query Language in MCMLEC

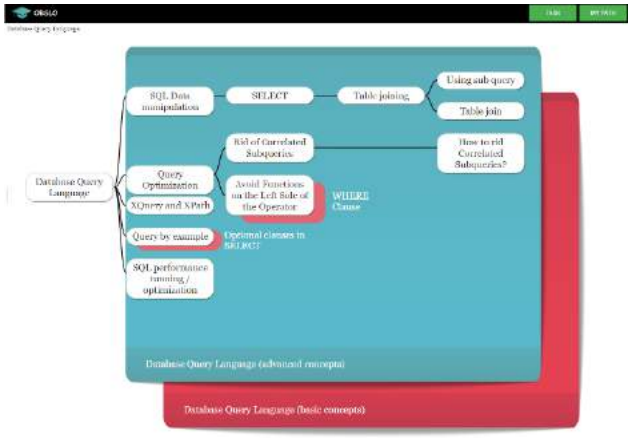

Figure 7: Advanced level Data Query Language in MCMLEC

In the initial evaluation of OBSLO system, 42 students of Database course were included. Students were given 6 problems to solve related to *DQL*. The goal was to analyze how much students and with what success will solve posed problems while using learning material in OBSLO. By retrieving *basic* and/or *advanced difficulty level* concepts, students could move through topics in the ontology structure and see only parts of the concept map they required. For example, when *Optional clauses in SELECT* topic was chosen, only this topic and its lower levels subtopics where presented. The content of a particular LO was presented to a student, only when he/she selects that particular LO.

During the process of solving problems, students were asked to save used LOs, while system was logging their activity such as learning path, time spent on LO etc. Based on collected data, the analysis of created student learning paths was done by AR component in OBSLO.

Instructor can review different reports generated by AR component by selecting particular one from the menu on the left side as shown in Figure 10.

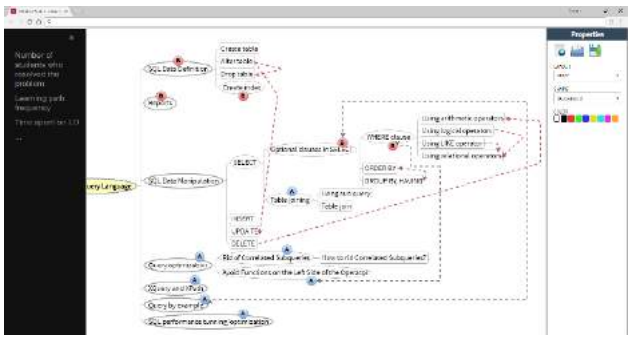

Figure 10: Reports generated by AR

For example, it is known that relational operations are often used as an alternative solution when table joining, and that it is reasonable that the ontology should be modified so that a relation between *Using relational operators* and LO *Table join* must exist. This relation can be specified as *BA* relation where LO's *Table Join* content can be treated as advanced content for LO using relational operation.

4. CONCLUSIONS

This paper addressed the creation and modification of ontology of knowledge domain concepts and its related learning materials for the usage in the online course. This work presented Ontology-based system for the learning objects retrieval, which can be used as both teaching and learning environments. OBSLO represents a system for storing and visualizing learning material, using MCMs. Based on the defined ontology OBSLO automatically generates MCM for a specific knowledge domain. In this work we presented an improved component of OBSLO used for ontology creation and modification. OBSLO from its system usage, provides feedback to the instructor as to what learning material is used and to what degree, allowing the instructor to modify already defined ontology. Future work should further developed module that based on the usage of learning materials, automatically generates and modifies existing relations between concepts.

ACKNOWLEDGMENT

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A CYCLE OF COMPUTATIONAL THINKING

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Abstract: *In dealing with e-learning materials learners often have to solve problems supported by digital technology. To this end, they need to use computational thinking (CT) as well. In this contribution we will first clarify the notion of CT. Then we propose a CT learning cycle and finally illustrate its application in solving a simple spreadsheet modelling task. Suggestions for practice are included.*

Keywords: *Computational thinking, Learning cycle, Spreadsheet modelling*

1. INTRODUCTION

Use computational thinking
to forge ideas.–S. Papert

E-learning usually comprises diverse learner-centered materials created with a range of digital technologies [1]. Through working with these materials, learners often solve problems by making use of such technology (i.e. various software tools and environments). In doing that, they must use a distinctive way of reasoning called computational thinking (CT). In the rest of this contribution we will first clarify the notion of CT. Then we describe a learning cycle whose stages capture core CT activities, and finally illustrate the application of this cycle in solving a simple spreadsheet modelling task. The contribution ends with suggestions for practice.

2. CT CLARIFICATION

Stated briefly, CT denotes problem solving thinking processes applied in the formulation of solutions by using representations that could be efficiently processed by computers. The notion of CT, introduced and exemplified by Papert [2, 3], was elaborated in detail by Wing [4, 5], who viewed CT as a fundamental personal ability like reading, writing, and arithmetic, especially in the life and work context of the 21st century, which is highly influenced by technology use. This ability enables a person to recognize aspects of computations in various problem situations, and to deal with those aspects by applying tools and techniques from computer science [6]. Of course, contrary to scientists, engineers and other professionals, most persons would just do this at introductory levels. Note that the assessment for ICILS 2018 (the International Computer and Information Literacy Study conducted in 2018) includes a dimension of CT (https://www.iea.nl/icils).

CT basically requires a person to skillfully use the computer as a tool to think with, which is an activity of high complexity [7]. Clearly, this complexity can be modelled in different ways, possibly reflecting various disciplines to cover. As a result, a widely accepted definition of CT is lacking [8]. To illustrate this state, we summarize below five CT standpoints. While the first three deal with general frameworks, the remaining two are related to subject-specific frameworks.

- Main components of CT are algorithmic thinking, critical thinking, problem solving, cooperativity [9].
- Core CT facets are abstraction (data collection and analysis, pattern recognition, modelling), decomposition, algorithms (algorithm design, parallelism, efficiency, automation), iteration, debugging, and generalization [10].
- Main CT concepts are problem decomposition, abstraction, algorithm and procedures, automation, data collection, data analysis, data representation, parallelization, and simulation [11].
- For (Scratch) programming, a CT framework with three dimensions may be applied [12]. These dimensions are *CT concepts* (e.g. data, operators, loops), *CT practice* (e.g. abstracting, modularizing, debugging), and *CT perspectives* (e.g. questioning, connecting).
- In the context of a high school STEM (Science, Technology, Engineering, Mathematics) education, CT may comprise four categories of practices [13]. These four categories are: *data practices* (e.g. collecting, visualizing), *modeling and simulation practices* (e.g. building and using computational models), *computational problem-solving practices* (e.g. programming, troubleshooting), and *system-thinking practices* (e.g. defining systems, managing complexity).

Despite the fact that a standard definition of CT is lacking, to find and apply a useful general framework to cultivate CT, it is valuable to search for key CT activities that could be used as components of a CT learning cycle. Attaining this goal may be particularly relevant to the learning of mathematics or statistics, because CT, often examined within computer science topics, has rarely been studied in relation to this learning (e.g. [14]).

3. CT CYCLE

Mathematical modelling or statistical investigation is often examined within a cycle of practice (e.g. [15, 16]). Computational thinking has not, on the other hand, been treated in this way, to the author's knowledge. It is true that, bearing in mind four cornerstones of CT (Figure 1), it has been assumed that CT uses four steps to solve problems: 1) decomposition, 2) patterns, 3) abstraction, 4) algorithms (examine https://studio.code.org/unplugged/unplug2.pdf for these steps). However, the use of technology to automate solutions is not captured by this four-step framework. Furthermore, as pattern recognition may be viewed as abstraction and generalization [17], it is clear that steps 2) and 3) overlap. Finally, patterns (i.e. pattern recognition) may be an overall goal of CT, like data visualizing, troubleshooting or managing system complexity, and, as such, may not be suitable for a CT step.

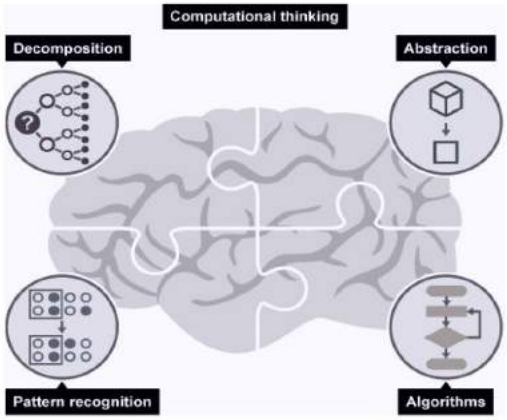

Figure 1. Four cornerstones of CT (source: https://www.bbc.com/bitesize/guides/zp92mp3/revision/1)

That said above, it is better to model CT using another framework, whose steps (or stages) are decomposition, abstraction, algorithmization, and automation (Figure 2). It is important to underline that these stages are usually advanced in a complex, nonlinear way, meaning that when we practice CT, we often go back and forth between (not only neighboring) stages. The relevance of this framework (cycle) may, for example, be supported by the second above-mentioned standpoint, which assumes the following core CT facets: abstraction (data collection and analysis, pattern recognition, modelling), decomposition, algorithms (algorithm design, parallelism, efficiency, automation), iteration, debugging, and generalization [10]. This is because many of these facets (e.g. efficiency, iteration, debugging) are put into practice to a full extent primarily in the last stage of automation, which makes problem solving alive using technology.

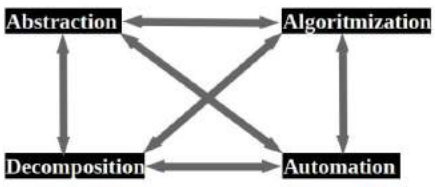

Figure 2. CT cycle

To illustrate the application of this CT cycle, let us consider the calculation of the expected/attained profit of a business venture (Figure 3). To calculate this, we need to find out revenues and costs (decomposition) and combine these. For each of them, we need to make a distinction between its fixed and variable parts (through abstraction). When suitable input and output variables are realized and chosen (through passing from concrete data values to abstract variables that can take on these values), it is a time for algorithmization to take place, which, in this example, may only make use of a linear algorithmic structure comprising simple steps that use formulas such as PROFIT = REVENUES – COSTS, and COSTS = FIXED COSTS + VARIABLE COSTS. To bring the developed algorithm to life, we finally apply automation, usually in form of a spreadsheet as done in business analyses. Of course, the consideration of revenues and costs may be done in an iterative fashion, which would require the repetition (i.e. refinement) of some or all CT stages. Although this example of spreadsheet modelling may be considered as a simple one, many (most) students may lack skills of decomposing and abstracting, which may limit their achievements considerably [18].

	A	B	C
1	**Taxi service** (first model, daily basis)		
2	without tax reduction, fixed revenue?, minibus loan		
3	payment, minibus maintenance and insurance costs, …		
4			
5	**Input data**		
6	Tours per day	4	
7	Number of passengers per tour	5	
8	Cost of ticket	€ 10.00	
9	Gasoline cost per tour	€ 15.00	
10	Driver wage	€ 20.00	
11			
12	**Costs**		
13	Variable part – gasoline cost	€ 60.00	
14	Fixed part – wage	€ 20.00	
15	**Total**	**€ 80.00**	
16			
17	**Revenue**	**€ 200.00**	
18			
19	**Profit**	**€ 120.00**	

Figure 3. Calculating profit

4. CLOSING REMARKS

To solve problems with technology successfully, we need, among other things, to apply CT skillfully. CT is not only a critical component of computer science or informatics education [19], but also a critical component of problem solving supported by technology in any discipline [10]. To master this component, we may practice it with a suitable learning cycle. This contribution described and exemplified a learning cycle that may be used to cultivate CT within different disciplines or school subjects. In doing so, students learning difficulties with decomposition and abstraction, which would limit their algorithmizations and automations, should be addressed carefully. Furthermore, apart from algorithmization, automation may also be a challenging stage. This is because the use of technology

depends on a complex process of instrumental genesis (composed of twin processes instrumentation–user's thinking is molded by technology accordances, and instrumentalization–these accordances may be improved by user's actions), which calls for a skillful pedagogical support [20]. Note that limited CT may particularly occur for students who view technology as their master [21], wrongly assuming that technology would itself complete the job (they have addressed partially!) because masters do not need everything to be specified.

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DEVELOPING ACADEMIC WRITING SKILLS IN ENGLISH AS L2 BY MEANS OF COLLABORATIVE E-LEARNING TOOLS

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Abstract: *Collaborative work has become increasingly important; however, many teachers do not include it in teaching writing since they regard writing process as an individual act. The aim of this research is to show a new approach in teaching academic writing. It is based on the sociocultural theory, constructivism and the developed process writing model. The idea is that students go through the process of collaboration by using wiki, forum and glossary, and in the end participate in peer editing and peer assessment activities (through workshops). The research question was whether the students who participated in various collaborative activities performed better in the final exam when compared to the students who did not participate or took small part in them. The research took place in 2012 at the Faculty of Political Sciences in Belgrade. It was confirmed that the students who participated in collaborative activities showed continuous development in writing. Furthermore, they performed better in the final test when they had to write an argumentative essay. The students particularly showed good results in compositional organization, mainly in using the funnel introduction, formulating the thesis statement and controlling idea, providing good supporting details. After ten weeks of collaborative practice, the shape and internal pattern of their essays became clearer, and organisational skills were more adequately controlled. The research also showed that blogs and glossaries were not as useful as it is generally thought. The best results were by using wiki, forum and workshop.*

Keywords: *English, academic writing, writing skill, collaborative learning, collaborative assessment, distance learning*

INTRODUCTION

"It's not about the tool, it's using the tools to facilitate learning"

(Churches, 2009)

Writing is one of the most important basic skills that belongs to the three Rs (reading, writing and arithmetic). Developing writing skills is a very demanding and difficult task both for teachers and students. It becomes even more difficult when it comes to developing writing skills in a foreign language. Traditional classroom setting and paper based tasks make this process complicated. Moreover, it needs time to go through the whole process of writing, revising, evaluating and re-writing. On the other hand, if eLearning tools are implemented when teaching writing, this process becomes simpler and shorter in time. The results are better in the end, too. The aim of this paper is to show a new approach in teaching academic writing where online tools for peer assessment are used. This approach is based on the research that took place in 2013 with students at the Faculty of Political Sciences in Belgrade. The theoretical background can be found in the theory of socioculturalism and constructivism. The model for developing writing skills is the model for process writing (The Hayes-Flower writing model 1981), but revised and adapted for this approach.

Rapid technological developments have enabled evolution of technologies used for learning. Expansion of numerous tools has diversified educators' options towards the implementation of the technology-supported learning, including a heterogeneous set of tools, such as Learning Management Systems (LMS), virtual classrooms, massive open online courses, and serious games. These tools (usually called Web 2.0 tools) can offer a lot to educators because they allow for socialization, cooperation, creativity, authenticity and sharing (Peachey, 2009). One of the most important aspect of using them is that they provide interaction between students, which leads to better socialization and cooperation online.

The role of interaction in online learning is crucial for effective learning because it is not only student-student interaction that matters. Six different forms of interaction that account for learning can be recognized in distance learning education: student-student, student-teacher, student-content, teacher-teacher, teacher-content and content-content (Zornić & Hasanović, 2011). Some authors believe that this kind of learning is called e-learning 2.0, because students learn to interact with each other within the electronic tools:

In this concept, students are active participants who share ideas, solve outstanding problems, using different sources of information together to create new knowledge. This approach to the collection of "small pieces of content, loosely connected" in the ad hoc formed learning communities is called e-learning 2.0. (Kljakić, 2007)

Theories that support such new vision of the learning process are based on the assumption that students are active participants who seek and construct knowledge within a

context that has meaning to them. In addition to emphasizing the interaction and active learning process, which originate from the socio-cultural theory and the theory of constructivism, there are elements of behaviorism and cognitive approach, which should not be ignored when designing courses. Communication and collaborative learning can be realized by means of collaborative tools (which are generally an integral part of the learning management system, or can be applied as an application on the network). For our research we used Moodle with its modules wiki, forum, blog, glossary and workshop, meticuously designed to support scaffolding and peer learning.

THEORETICAL FRAMEWORK

Sociocultural theory and constructivism are rich soil for explaining collaborative learning, the importance of social interaction in online learning environments and using collaborative tools in learning. A Russian psychologist Lev Vygotsky developed his theory of collaborative learning through the construct of "the zone of proximal development"; Jerome Bruner, an American psychologist, introduced the ideas of "scaffolding", "discovery learning" and "mutual learning cultures", while Eric Mazur, an American physicist, proposed "peer instruction". All these authors believe that a learner needs interaction and collaboration with other learners in order for learning processes to occur.

Vygotsky, a pioneer in this field, argued that children learn best in a social environment, and construct meaning through interaction with others. He stated that "with collaboration, direction, or some kind of help the child is always able to do more and solve more difficult tasks that he can independently" (Vigotski, 1996/1934). He also explained that there is the zone of actual development and the zone of proximal development which is defined as "the distance between the actual developmental level as determined by the independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vigotski, 1996/1934). In brief, there are no limits in learning as long as there is a more capable person to interact with.

When applied to second language acquisition, sociocultural theory sees learning as dialogically based, i.e., "acquisition occurs in rather than as a result of interaction" (Ellis, 2008: 526). Bruner continued in the same manner as Vygotsky and introduced the idea of "scaffolding". Scaffolding is the same concept as the zone of proximal development. It is "the dialogic process by which one speaker assists another in performing a function that he or she cannot perform alone" (Ellis, 2008: 527). This means that in peer learning children are more prone to make progress

Bruner continued in the same manner as Vygotsky and introduced the ideas of "scaffolding", "mutual learning cultures" and "discovery learning". Scaffolding is closely linked to the zone of proximal development. It is "an inter-psychological process through which learners internalize knowledge dialogically" (Ellis, 2008). It is concerned with nature of tutorial process where an expert (the one who knows the answer) helps the other (who is less expert) to solve the problem, carry out a task or achieve a goal (Wood, Bruner, & Ross, 1976). In describing the importance of mutual learning cultures, Bruner states that "[t]here is a mutual sharing of knowledge and ideas, mutual aid in mastering material, division of labor, and exchange of roles, opportunity to reflect on the group's activities [...] The teacher is the enabler, primus inter pares." (Bruner, 1996). Students can take an active part in the learning process if the classes are organized in a way that supports learning through discovery (discovery learning). This type of learning requires students to independently and inductively draw conclusions; not only to be passive listeners-receptors of the presented material; they must process the problem set before them as part of their cognitive abilities, which leads both to an increase in the quality of knowledge and its durability, and to the development of intellectual abilities. Learning must be experiential:

Most Net Gen learners prefer to learn by doing rather by being told what to do. The role having grown up with video games plays in this preference is unclear, but Net Gen students learn well through discovery—by exploring for themselves or with their peers. This exploratory style enables them to better retain information and use it in creative, meaningful ways. (Oblinger & Oblinger, 2005).

Eric Mazur's idea on peer instruction is similar to the idea of scaffolding. Mazur developed his idea at the beginning of the 90s and has so far supported it by numerous studies (Fagen, Crouch, & Mazur, 2002). Peer instruction is an interactive strategy in teaching when teachers' lecture is stopped periodically to pose a question (these questions are called ConceptTests). The procedure is as follows:

- Question posed
- Students given time to think
- Students record or report individual answers
- Neighboring students discuss their answer
- Feedback to teacher: Tally of answers
- Explanation of the correct answer (Turpen & Finkelstein, 2010)

Christudason also emphasizes the role of peer learning. She defines peer learning as "a form of cooperative learning that enhances the value of student-student interaction and results in various advantageous learning outcomes" (Christudason, 2003). In order to make the most of peer learning activities, instructors must provide 'intellectual scaffolding', i.e. "teachers prime students by selecting discussion topics that all students are likely to have some relevant knowledge of; they also raise questions/issues that prompt students towards more sophisticated levels of thinking. In addition, collaborative processes are devised to get all group members to participate meaningfully" (Christudason, 2003). She also concluded from her research that peer learning activities result in (a) team-building spirit and more supportive relationships; (b) greater psychological well-being, social competence, communication skills and self-esteem; and (c) higher achievement and greater productivity in terms of enhanced learning outcomes (Christudason, 2003).

It has been shown that interaction, cooperation, collaboration and socialization have deep theoretical background in explaining the psychology of learning

processes. When using online resources for learning, it is necessary to use those which will take all these aspects into account.

COLLABORATIVE (PEER) LEARNING

Collaborative learning, cooperative learning and peer learning are synonymous and mean learning in a group in which all members of the group take responsibility not only for their own learning, but also for the learning of their peers, "Collaborative learning is a type of cooperative learning which fosters the value of interaction between students and results in a variety of successful outcomes" (Christudason, 2003). They have a common goal, which can be problem-solving, research or upgrading skills. If we think of nowadays learners that belong to the Internet generation, they value social interaction a lot: "The Net Gen often prefers to learn and work in teams. A peer-to-peer approach is common, as well, where students help each other. In fact, Net Geners find peers more credible than teachers when it comes to determining what is worth paying attention to." (Oblinger & Oblinger, 2005)
The implications for teaching are that a learning platform needs to provide a socially rich environment in which students can explore their domain knowledge together with their peers, teachers and outside experts. Social networks and its activities, when used appropriately, can be viewed as manifestation of informal learning and a platform that allows collaboration and effective communication. Courses for distance learning should be created in such a way that will abound in tools that enable discussions, collaborative work, problem solving and support in learning.

PEER ASSESSMENT

An important aspect of peer learning is peer assessment. In this section we will give a definition of peer assessment/evaluation, emphasize the benefits and provide a model on how it should be implemented.
Peer assessment is a process of assessment in which schoolmates, colleagues from the faculty or peers evaluate each other's work. Falchikov (1995) defines peer assessment as "the process through which groups of individuals rate their peers". Topping proposed a more detailed definition, "Peer assessment is defined as an arrangement in which individuals consider the amount, level, value, worth, quality, or success of the products or outcomes of learning of peers of similar status" (Topping, 1998: 250). A similar idea is with the concept peer editing: it is a technique where students work together, review, correct and suggest changes or comment on the paper before the final version is submitted to the teacher.
It is obvious that there is a difference between traditional, deep-rooted ways of assessment only by teachers and alternative evaluation by and among the students. Traditional assessment views the student as a passive recipient of knowledge who can be assessed only by authorities such as teachers. Learning is an individual process and the evaluation is objective and neutral (Anderson, 1998, cited in Lee 2009). An alternative assessment expects from students to apply their knowledge and skills in order to read with understanding, analyze, criticize and evaluate the work of others. There is a mutual benefit in this interaction – both for the one who evaluates and for the one who is evaluated. The task assigned to the evaluator is cognitively demanding and meets the highest levels of Bloom's taxonomy. In the analysis and evaluation of the works of others, the evaluators become aware of their own work and develop critical skills.
While conducted our research, we insisted that the students from the beginning understand the importance of collaborative learning. They did not have the freedom to arbitrarily provide feedback, but the feedback was based on the peer review sheet. The questions from the sheet were used to create online peer review tool in the workshop.
Collaborative assessment, despite some shortcomings, which are largely culturally conditioned (Zhang, 1995), has many advantages and should be implemented in the current model of the writing process and the creation of distance learning courses.

RESEARCH[1]

The scope of this research was developing academic writing skills in English as L2 by means of electronic collaborative tools (wikis, forums, blogs, glossaries and workshops). The research took place in 2013 at the Faculty of Political Sciences in Belgrade. 105 students participated in the research. The 10-week course "Introduction to Academic Writing" took place online on Moodle platform called Writing Lab at globetrotter.rs. The research question was whether the students who participated in various collaborative activities performed better in the final exam when compared to the students who did not participate or took small part in them. The main hypothesis was that the students who use e-learning collaborative tools have better results in the final exam. It is because they develop critical thinking skills in the process of collaborative/peer assessment which helps them with their own writing.

METHODOLOGY

At the beginning of the course students were given the **entry test**. The entry test was writing an argumentative essay (300 to 350 words) on the topic *Should Pride Parade be Allowed in Our Country?* Students did not find out the number of points they received for this until the end of the course, because they re-examined their writing in the end (self-assessment).
During the 10-week course, the students participated in different **collaborative activities**: wiki, blog, glossary, forum and workshop[2]. The main tasks for each week were:

1. to participate in the brainstorming activity by writing ideas - at least 3 ideas
2. to read the lesson
3. to write a paragraph
4. to assess friend's paragraph

[1] The research was part of the author's doctoral dissertation defended in 2017 at the Faculty of Philology, University of Belgrade.

[2] For detailed description of the work with the workshop, please see Implementing Peer Assessment Tools for Teaching Writing (Ljubojević, 2014) .

5. to participate in the forum by both asking and answering questions
6. to add new vocabulary to glossary
7. write a blog entry- at least 200 words long one
8. comment on friend's blog entry - provide good arguments

At the end of the course, the student had their **final test** where they had to write an essay (300 to 350 words) on one of the following two topics:
1. In what ways has information technology changed work and working practices?
2. Guns don't kill people, people do. (Give your opinion.)

After the course had been completed, the statistical analysis was carried out.

RESEARCH RESULTS

105 students participated in the research divided into two groups based on their preferences to learn. One group of students did not participate in collaborative activities or participated minimally; instead, they preffered one-on-one interraction with the teacher. They were the control group. Our experimental group was made of students who participated in collaborative activities and gathered poins in them (experimental group).
The number of students from experimental group participating in the collaborative activities is shown in Table 1:

Table 1 Number of participants in collaborative activities from experimental group

Collaborative activity	Number of participating students (n = 75)	Participation in %
Glossary	68	90,67
Wiki	68	90,67
Forum	59	78,67
Peer assessment	70	93,33
Blog	16	21,33

Statistical analysis of their final marks is shown in Table 2:

Table 2 Average final marks for both groups

	Number of students	Average mark on final exam	Average no. of points on final exam
Control group	30	8,03	31,33
Experimental group	75	8,89	34,71
Total	105		

The average mark of the students in the control group wa 8,03, while for the ones in the experimental group wa 8,89. The results of t-test when comparing these two groups is **p=0,006292905**. This result shows that these two sets of data from these groups are significally different.

Progression of Students with Respect to the Initial Situation

This type of statistical testing was done with the results of students who participated in collaborative activities and those who did not. The aim was to determine the extent to which students progress from an initial state. To do this we took into consideration the following parameters: marks on the entry test, marks on the final test and the number of points obtained in the collaborative activities (to determine the experimental group).
In order to monitor the effect of the experimental treatment in the experimental group the analysis of variance for repeated measures (ANOVA) was used. In this research, the experimental treatment refers to collaborative learning environment and application of tools for collaborative learning and assessment (Figure 1).

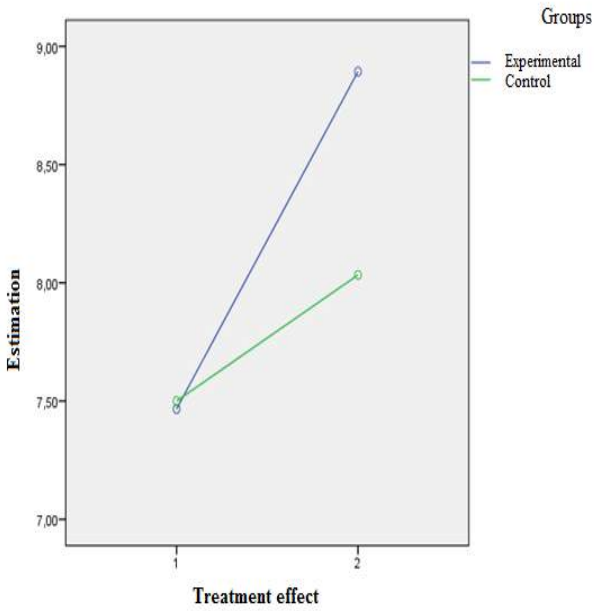

Table 3 Treatment effect for collaborative activities

	F	*df*	*p*	η2
Treatment	49,35	*1*	*,000*	,324
Treatment and groups	10,25	*1*	*,002*	,091

We can observein Table 3 on the basis of analysis of variance for repeated measures that there is a statistically significant treatment effect or the effect of collaborative activities ($F = 49.35$, $df = 1$, $p < .05$, $\eta 2 = .324$). We can say that we achieved the effect of collaborative activities and there is progress in the final test in comparison with the input test. There was a statistically significant effect of treatment groups (experimental - control) ($F = 10.25$, $df = 1$, $p < .05$, $\eta 2 = .091$).
It follows from this that progress has been made with the help of collaborative activities, while in the Figure 1 we note that progress has been made from the input to the final test. From Figure 1 we can see that there has been the effect of cooperative activities in the experimental group, i.e., there is a significant difference between the entrance test and final test, much more significant than the differences between the entrance test and final test of the control group.

We conclude that the treatment of collaborative activities has led to advances in the academic achievements of the experimental group.

CORRELATIONS

The highest correlation value is achieved compared to wikis and estimates the final test, a minimum between writing blog and the resulting number of points in the final test. Significant and noticeable height correlation is realized in the relationship workshops and assessments on the final test, and evaluation workshop on the organization of essays, forums and marks on the final test. Wikis did pointed to a good correlation with the score of the final test, but showed low i.e. negligible value in relation to the assessment of the content. The weakest correlation is shown in participating in writing a blog with the number of points in the final test.

Table 4 Correlations

Correlation	r
workshop – mark in the final exam	0,502
workshop – mark of the organization in the final exam	0,522
forum– mark in the final exam	0,476
forum – mark of the organization in the final exam	0,130
wiki – mark in the final exam	0,904
wiki – mark of the content	0,368
blog – number of points in the final exam	0, 021

CONCLUSION

Statistical analysis showed that there was correlation between participation in peer assessment activity and the grade in the final exam (r=0,502) and correlation between peer assessment activity and the grade for the essay organization in the final exam (r=0,522).

It was confirmed that the students who participated in collaborative activities showed continuous development in writing. Furthermore, they performed better in the final test when they had to write an argumentative essay. The students particularly showed good results in compositional organization, mainly in using the funnel introduction, formulating the topic sentence and controlling idea, providing good supporting details. After ten weeks of collaborative practice, the shape and internal pattern of their essays became clearer, and organizational skills were more adequately controlled.

Workshop in this research was used as the main tool for developing writing skills. Workshop is connected to the concept of collaborative learning because students can evaluate their own work and compare their scores with the scores given to them by another participant (a teacher or a student). Self-assessment is an important aspect in the development of critical thinking and fosters the autonomy of students.

Also, an important aspect of this research is shifting the focus from the traditional concept of a teacher as an instructor and evaluator to the students' new role. Student become evaluators and give each other explanations. Collaborative learning has a major role in distance education and the tools enable students to perform tasks in teams. Besides group work, tools for collaborative learning achieve continuous learning, monitoring and evaluation, which is in line with modern concepts of formative assessment, i.e. assessment for learning instead of the traditional assessment of learning. Moreover, the advantages offered by the distance learning are reflected in the fact that a teacher alone does not participate in the evaluation process, but also the students themselves develop an awareness of assessing the knowledge and achieve autonomy in learning. The teacher in this approach becomes a moderator who directs and monitors the process.

Theoretical contribution of this research is redefining the existing cognitive processes writing model. It suggests adding collaborative elements both to the prewriting phase and first draft phase. Because of the great emphasis it puts upon collaboration and peer learning, this model is called socioconstructivist writing model of cognitive processes.

Practical aspects of the research refer to organizing classes for teaching writing skills: how to implement distance learning courses and how to apply socioconstructivist writing model of cognitive processes. Moreover, the valuable part is the designed ten-week Moodle course with SCORM created lessons, as well as one of the most detailed checklists for asssessing writing (both for paragraphs and essays).

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THE APPLICATION OF EVOLUTIONARY ALGORITHMS IN E-LEARNING SYSTEMS

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Abstract: *The paper presents the analysis of evolutionary algorithms application in the process of personalized learning within the distance learning system. The application of three algorithms is being analysed in detail: genetic algorithm, particle swarm optimization algorithm and ant colony optimization algorithm. The result of the analysis show the features and abilities of mentioned algorithms within the system, as well as various approaches and methods used for the personalization of learning process and for monitoring the students` habits and their level of knowledge.*

Keywords: E-Learning, Distance learning, Personalized learning, Evolutionary algorithms, Genetic algorithm, Particle Swarm Optimization, Ant colony optimization

1. INTRODUCTION

Personalization of teaching materials ensures that every student who accesses the distance learning system gets the teaching materials according to the presented knowledge. Distance learning systems use various algorithms for recognizing the habits, motivation and the level of knowledge of a student, in order to search the available teaching materials and deliver appropriate teaching material to every student. The application of the artificial intelligence in adaptive distance learning systems enables the system itself to use certain input parameters obtained from students and to connect with teaching materials uploaded by teachers, as well as to recommend the continuation of the learning process path to every student, based on the presented knowledge. A teacher plays a very important role in the entire adaptive process, since he/she has to conceive teaching materials so that the system could carry out the search and present it to an individual student. The use of evolutionary algorithms in personalized distance learning systems shall be presented in this paper, as well as the results of students' performance in the learning process created in that way.

2. EVOLUTIONARY ALGORITHMS

In metaheuristic algorithms, meta means "beyond" or "higher level." Metaheuristics can be an effective way to use trial and error to produce acceptable solutions to a complex problem in a reasonably practical time. The main components of any metaheuristic algorithm are: intensification and diversification, or exploitation and exploration. The use of metaheuristic algorithms is a powerful method for solving many tough optimization problems, and they are particularly suitable for global optimization.[1]. There are two main types of metaheuristic algorithms: (i) single based mateheuristics, and (ii) population based metaheuristics i.e. evolutionary algorithms such as genetic algorithm, particle swarm optimization, and ant colony optimization.

Genetic algorithm (GA)

A genetic algorithm (Grefenstette, 1986; Srinivas & Patnaik, 1994) is an optimization algorithm that utilizes concepts from evolutionary biology to solve optimization problems.[2] If two individuals intermix their genes, they produce offspring. In case one offspring fits better than the other, it has a higher chance of surviving and producing offspring of its own, doing so offspring propagates its parent's genes. GA allows production of a population of P genomes. Each genome consists of N genes and each gene represents a component of the solution. Genomes from the population favouring genomes that fit better are selected in pairs (following the roulette wheel technique chance of picking a single genome is equal to its fitness divided by the sum of all genomes fitness values). A process when each pair has its genes selected and swapped between them (based on the crossover weight) is called crossover process. Conducting crossover process, two new genomes (offspring) are produced. Each offspring afterwards may change its genes to a random value (based on the mutation weight) allowing it to mutate. Mutation ensures that injection of new values into the genomes does not stagnate gene diversity. At last, mixing genomes and their offspring, depending on their fitness values, the new population is built. The functioning of the GA is controlled by three parameters and a termination condition. Three GA parameters are: mutation weight (M); population size (P); and crossover weight (C).

The mutation weight determines the probability that a gene will be mutated and ensures that particular gene

values do not persist forever. The population size controls the number of genomes in the population. The crossover weight determines the probability that any particular gene will be used for crossover. The termination condition represents the end of the GA process, it informs GA to stop processing. [2]

Particle swarm optimization (PSO)
First version of PSO was proposed by Kennedy and Eberhart (Eberhart & Kennedy, 1995). This approach is a simulation of social behaviour models. PSO keeps a swarm of particles (same as bird flocking) where is each particle represent of a potential solution to an optimization problem. Each particle in PSO keeps track of its coordinates in a N-dimensional problem space giving a optimal solution. With designed fitness function, calculated solution can provide a quantitative value of the particle's location. [3] In PSO, each particle have coordinates in the problem space, which are associated with the best solution (fitness) it has achieved so far called pbest. Best value that is tracked by the global version of the swarm with location obtained by any particle in the population is called gbest. That is location. Both pbest and gbest location can be changed at each time when step velocity of each particle flying toward.

Ant colony optimization (ACO)
This approach represents behaviour of real ants in the process of searching for a food. ACO is a class of optimization algorithms modeled on the actions of an ant colony. Artificial 'ants' locate optimal solutions by moving through a parameter space representing all possible solutions. The pheromone-based communication of biological ants is often the predominant paradigm used. Implementing this techniques in real system, an ant represents student, where each student moves freely around the learning tree, leaving pheromones as its trail.[4]

3. THE APPLICATION OF EVOLUTIONARY ALGORITHMS IN SOLVING E-LEARNING SYSTEM PROBLEMS

This section presents an analysis of the use of GA, PSO and ACO in adaptive distance learning systems. The papers are related to the process of personalization of the learning process according to the needs of students.

The use of GA in e-learning systems The purpose of the application of GA described in the paper [5] is to generate the groups within the system, which characterize the students` responses (crisp sets, based on fuzzy logic application). The groups that the algorithm creates are previously defined based on the level of difficulty: easy, moderate and hard. According to the difficulty level, the groups are created based on the qualification defined by a professor, i.e. the author of the teaching material. After a student`s response, GA takes over the answers to all questions that belong to a specific difficulty level in order to perform characterization. Sets of answers structured as <time>, <grade>, <accesses> represent the input data of the algorithm. Crisp sets represent time range, grade range and range of number of students` accesses, which together include the highest number of response patterns for a specific difficulty level. In that case, the algorithm may solve the problem by using a coded chromosome or individual [t1, t2, g1, g2, a1, a2], being t1 and t2 the lower and upper limits of a time range, g1 and g2, the lower and upper limits of a grade range, and a1 and a2, the lower and upper values of a number of accesses range.

The algorithm presented in paper [5] has solved the problem of adjustment of questions and answers to a student`s level of knowledge within the learning process. In addition to a number of ways for solving this problem, one of the ways is placing questions and answers activity in certain parts of the learning process, so that the algorithm at any time obtains feedback information from a student about his/her current level of knowledge, and in accordance with that, displays a certain questions and answers set.
The algorithm uses niching methods in order to apply variety of answers, since it is not enough just to use previously stated patterns of possible answers to the asked questions. One of the reasons for that is the students` behaviour during their work on the asked question (the motivation of students, the level of knowledge at that moment). Also, the algorithm characterizes every level of difficulty of the defined groups in the system. For every difficulty level, GA gathers input variables (range groups) which characterize the pattern of possible answers for certain level of difficulty. Fuzzy Model Generator describes the membership functions and the classification rules of the Fuzzy Model. The algorithm, based on previously conducted experiment, has defined ranges for every level of difficulty. The fuzzy set is determined for every range defined by GA. [5]
Research in paper [6] shows creation of a personalized course for distance learning by using the genetic algorithm with forcing legality (GAn). The application of GA in this system enables finding the appropriate teaching material for every student. The system enables the teaching material author to easily create a personalized learning process for every student, without the need for defining a large number of various parameters.
The application of GA and the use of forcing legality in this system enable the process of adjustment of teaching material to the needs of every student in the system. The problem that this system solves is the velocity of finding the adequate teaching material and presenting it to a student. This method of adaptive learning process creation results in increasing the quality of teaching.
The use of forcing legality operation accelerates the search process of teaching material, and reduces the search space size. During the research and testing of this system, the results have shown that by increasing the number of students, the error possibility is reduced (in the concept of learning, selection of materials, and presentation of materials), whereas the stability and the execution time proportionally increase. The data that GA obtains from students in this system includes: the level of difficulty of teaching material, time required for reading the teaching material, upper and lower limit of expected learning time for every individual student, the expected

concept for a student and the student`s level of performance.

The algorithm randomly generates binary chromosomes, where the number of chromosome genes represents the number of materials in the base of teaching material. The chromosome is encoded and represents the set of combinations of teaching materials in the teaching material base where every gene has its own binary value which is afterwards connected to the needs of a particular student within the learning process. Without using the concept of forcing legality in this part of the teaching material selection, the teaching material search would cross both lower and upper limit of expected learning time for a student. Also, there would be an overload problem for a student. [6]

The solution presented in paper [7] suggested in this paper includes four steps:

- determination of the learning concept structure;
- adjusting the difficulty level of teaching material;
- analysing the student`s capabilities and the learning objectives;
- creating personalized courses

The author of the teaching materials defines the learning levels, from the initial to the very hard one (D1 very easy, D2 easy, D3 moderate, D4 hard, D5 very hard). A student accesses the teaching material D1 initial, and then the setting of the material is done through D tuned, according to a student`s level of knowledge. Setting the material is based on the linear combination of the level defined by the instructor and the students` collaborative voting. After a student accesses the teaching materials, it is necessary to enable the testing of acquired knowledge after going through the teaching materials. The test belongs to the learning concept defined at the beginning of the learning process. Depending on the understanding of teaching materials, the system estimates (by using the algorithm) the student`s ability, which is also one of the parameters for determination of the following learning path through the learning process.

Personalization of a particular course is done according to the analysis of individual requirements of every student. When a student undergoes through one learning concept within the personalized course, the system collects information and performs the following operations:

- automatic adjustment of the level of teaching materials based on the obtained data
- updating a student`s ability and his/her objectives

The results of the use of GA in the experiment in this paper show that the developed personalized courses match students` demands. Also, the results of the research show that the efficiency of the use of PSO-based access is better than GA-based access in cases where the number of teaching units is less than 300. In case where there are over 300 teaching units within the system, the results show that it is better to use GA-based access. [7]

The process of identification of students` learning style enables sending feedback information to a student by the system about his/her abilities, advantages and disadvantages during learning a specific teaching unit.[8] Also, mentioned advantages and disadvantages may be improved by personalization of the teaching materials. The identification of the learning style may be done by using a simple questionnaire (several questions and answers) or by automatic analysis of a student`s behaviour within the distance learning system environment. The precision of the automatic approach to the identification of learning style is between 65% and 77%, showing the need for improving this approach.

Enabling the increase of precision of the automatic identification of the learning style allows the students to obtain updated information on their level of knowledge, as well as on the learning style in the distance learning environment. From the perspective of a teacher`s, who is the author of the teaching materials, the mentioned improvement enables less participation and less changing in the learning process within the distance learning system. The data obtained from 75 students was used in the analysis, and the application of the artificial neural network proved to be the best, with the average precision of 80.7%, followed by PSO with 79.1%. The application of GA in this system enables every gene to have the integer value from 1 to 100, thus representing the weight of the respective pattern. Every genome shows the solution for a candidate, presenting a set of weights. Calculated learning style for every student is obtained from adequate pattern of behaviour of adequate dimension, along with the use of the genome gene value as the described pattern weight. [8]

Approach presented in paper [9] is based on the computerized adaptive testing technique (CAT), the application of GA and the case based reasoning (CBR). The result of the combination of mentioned techniques represents the optimal learning process for every student in the system. The contribution of this paper is reflected in three essential items:

- genetic-based curriculum sequencing approach;
- case-based reasoning;
- empirical research.

Based on genetic-based curriculum sequencing approach, teaching material is shaped in a form which could be adjusted to identify needs of every student. Testing and the analysis of a student, the level of his/her knowledge, motivation and success in solving specific tasks are all done through the case-based reasoning. The last step is generating a specific course from the teaching materials adapted to the needs of a particular student.

Every curriculum in the system gets a serial number (from 1 to n) in case there are up to n numbers in the curriculum in the system, for the further generating of the learning process. Then the population accelerates the search velocity of GA, increasing the possibility of finding the highest quality solution. For the purpose of creating the high-quality learning process for an individual student, the initial population size in this paper is 50. The fitness function GA enables the assessment of quality of generated learning process for a particular student. Since the generating of the learning process is based on a student`s incorrect answers within the level of knowledge test, the assessment of the quality begins from that part. The reproduction operation takes the chromosome with higher fitness function value, which will also have a greater possibility of reproduction to the next generation (learning process). The potential issue refers to the

learning process generation and the possibility of duplication of the serial number of chromosomes i.e. the serial number of the curriculum. In order to prevent such a possibility, it is possible to use the crossover operation, which shall change the whole chromosome by probability decision. [9]
The length of the teaching material in the learning process cannot be identical for every student. [10] It is necessary to carry out the analysis of the level of knowledge, learning style and a student`s emotions, and based on that to define the learning process length. The application of the effective learning path recommendation system (LPRS) and variable length genetic algorithm (VLGA) enable the control of the learning process length. First of all, the user`s profile has been created based on the data entered by a student during the registration process (a questionnaire). The next step represents a definition of the suggestion for the personalized learning process based on the application of the genetic algorithm for every student. The final part represents a demonstration of the effectiveness of the proposed approach for every student. Based on previously obtained information, the system suggests the learning process, the same process repeats for the new course uploaded into the system as well, and based on previously obtained information, a student is presented with the adaptive learning process which suits his/her identified needs. As in previously analysed papers, the curriculum sequencing is done within this research, for the purpose of further learning process generating. [10]

In paper [11] the first iteration within the system begins with the learning objects, and then the sequence of the learning objects is created, which a student has the access to. Once the student chooses a specific learning object based on the defined ontology, the system chooses the shortest path to the next object in a set. Thus the student is allowed to move through the learning objects while the system carries out the analysis of the student. The system may independently perform the sequencing of the course according to the student`s needs and the knowledge he/she possesses. Also, it may connect various curriculums in case it is required, and thus determine the continuation of the learning path. [11]

The use of a PSO algorithm in e-learning systems
The adaptive learning system presented in paper [12] is based on the additional blog within which students, professors or course designers may upload additional teaching contents. It is also possible to modify the teaching material, to make comments and to grade it. The articles published on the blog obtain RSS feed based on which the classification of the material is done later on. A student may subscribe to a particular article and receive information related with the improvement of the mentioned article, as well as the comments given by other students or teachers. The application of PSO algorithm includes four steps:

- the first step is the initial swarm generation (the way parameters are encoded in a vector, along with the blog articles);
- the second step is the design of the fitness function;
- the third step represents the calculation of the pbest for each particle and gbest by using the design of fitness function;
- the fourth step represents updating velocities and particles position.

The system has initially been designed to provide auxiliary learning materials for students, but it may also be used for downloading additional information obtained from students during the learning process. When a student accesses the learning system, he/she may enter articles, communicate with other students, and upload additional material. The mentioned options may enable the system to receive additional information from students, and thus additionally adjust the learning process. [12]
The problem of sequencing requires the system to select a specific set of learning units and to create the adaptive learning process for a particular student, as presented in paper [13]. Sequencing is mostly done by a professor, an author of the teaching material, who creates the learning process for every student, or manually specifies the things that a student has to read or learn. The intelligent technique suggested in this paper enables the personalization of the learning process (made of learning objects) by using particle swarms. The sequencing problems transfer to the permutation problems, and with the help of various techniques (particle swarms) it is possible to find and implement the solution. Also, in the process of solving the mentioned problem, good performances are required as well. All learning objects are located in the repository of learning objects, and it is necessary to find real and adequate learning objects for every student. The suggested solution is based on:

- the best solution obtained by a particle, called pbest;
- the best solution within a set of neighbour particles, called nbest; and
- the best solution within the whole swarm, called gbest.

The results of the research show that the application of PSO successfully solved the sequencing problem on a chosen example of specific learning objects. [13]

Within the suggested system in paper [14], a student accesses the initial course interface. Every student first chooses the teaching material he/she wants to access, as well as the difficulty level of the available teaching material. The next thing a student may do in the system is to transfer to the next offered teaching material, according to his/her wishes and needs. Based on the indicated selection of teaching materials made by a student, the system chooses the following learning objects which might be presented in the continuation of the learning process, and which match the path a student has already chosen. The messages sent to the system are in the form of the teaching material topic title, date of creation of the material and the abstract of the content. Thus a professor may also check which teaching materials a student has chosen, as well as which of these a student has obtained from the system, later on, during the adaptive learning process. The second part of the user interface enables the student to independently choose all of the available teaching materials by the order they have been added into the system, and that, in case he/she has missed something,

it can be additionally included. At that moment, the system conducts the analysis, remembers the learning objects chosen by a student and records them. The student communicates with the system by entering the queries. When the system receives the query, it performs dynamic defining of the course according to the three approaches of adjustiment to the students` needs. The search and the gathering of the material by the second approach, dynamic PSO (DPSO), enables learning objects collection which precisely correspond to previously read topic of learning objects. The use of DPSO enables the control of the attention a student pays to received teaching materials. [14]

The application of the adaptive learning system reflects in identification of the weak points in the knowledge of the students. [15] The tests done within the learning system represent one of the most important approaches in gathering information on the students` knowledge, whereas asking a specific set of questions to a particular student enables improvement of the adaptive learning process path. Computerized adaptive tests (CATs) help the teachers to define a student`s performances, as well as to understand possible problems in the learning process. Every test must contain a specific set of questions from the question bank. This paper suggests a dynamic question generation system for web-based tests using the novel approach of particle swarm optimization (PSO). Dynamic generation of questions enables the student to receive several different tests with a various set of questions for different levels of knowledge. Dynamic Question Generation System adjusts the tests and questions from the large question banks. Thus, by applying PSO, the selection of questions is done, and the process of finding and presenting the questions of a certain level of knowledge is accelerated. PSO search can select near-optimal test items for students from each item bank with reasonable execution time. The time- sparing is more significant when dealing with large-scale item banks. [15]

The main problem identified in paper [16] in creating distance learning courses is that current techniques do not fully support personalized learning processes. In this paper, PSO algorithm is presented, implying digital pheromones. The application of the mentioned optimization should prevent the system from showing the identical teaching materials to all students, but to follow the input parameters and define the learning process for the selected teaching topic. [16]

In paper [17] the amount of pheromones is calculated by taking into account the results acquired in the last completed course in relation to the minimum score required and by feeding this into the learning tree in order to obtain a relative impact on the path taken by the student. Creation of the learning graph for the purpose of adaptive pedagogic model for the competence-oriented learning results in the final learning tree. Such approach and the use of the swarm intelligence enable the creation of adaptive paths that adapt to the users` needs and their habits identified within the personalized system. [17]

The use of ACO algorithm in e-learning systems

The teachers (the authors of the teaching material) apply various methods in distance learning systems, presented in paper [18] according to the previous experience in their work with students. The teachers also create learning clouds which are usually too large and unacceptable for personalized learning processes, so the students do not get teaching materials which match the level of their knowledge. Application of ACO algorithm enables an attributes-based ant colony system (AACS) which helps students to find the adaptive learning process in learning. The system is based on basic principles:

- attribute-based search mechanism;
- attributes-ant algorithm;
- adaptive learning rule;
- web based learning portal for learners.

AACS is derived from an extension of the ant colony system that updates the trails' pheromones from different knowledge levels and different styles of a group's learners to create a powerful and dynamic learning object search mechanism. It is necessary that the system identifies the students` habits and the style of learning, and then, based on the attributes defined for every learning object, to do a search and present the results to students. [18]

In paper [19] adjustment of the learning process is also based on the recommendation from the system in the form of certain teaching material. A student accesses the distance learning system. The application of ACO algorithm increases the student`s efficiency in solving certain problems for 0.9, which has been proved through the experiment in the distance learning system. The approach enables virtual learners to conduct a random search of the learning objects and to find simpler and more efficient learning path. Also, the application of the mentioned algorithm results in removing the unnecessary paths through the learning process by identifying a student`s efficiency after going through a certain path in the system.

As described in paper [20] the connection between the learning objects and students` habits and knowledge may be used to find the optimal learning path defined by the learning style. The content of the learning path depends on several attributes, pedagogical approach of a teacher, student`s motivation, student`s knowledge and the attributes which characterize the teaching material in the system. The application of ACO algorithm enables defining the permanent path with the idea of ''homogeneous'' ant for an explanation of the adaptive learning rule. This way, it is possible to connect homogeneous learners, who represent a group with the same or similar attributes, which might be used to divide the learning style or the learning objects that match their level of knowledge. After grouping, the system connects the students and their habits, and according to that, draws up the next path in the learning within the system.

Adaptivity of the learning process with the application of MapReduce-based GA is enabled through two levels. There are two steps in the first level, and those are:

- defining the relevant objective in the continuation of the learning process by using MapReduce-based algorithm;
- generating of the adaptive learning process with the help of MapReduce-based ant colony algorithm.

After this level, it is possible to apply and conduct the testing of a student`s motivation and productivity for the purpose of identifying a specific rhythm of learning for every student.[20]
Creation of the dynamic learning process along with the use of the swarm intelligence technique enables optimized sequencing and the overview of learning objects. In paper [22] each virtual learning object is given a certain level represented by a floating point value between 0 and 1. This value is normally distributed over the population of students with mean 0.5 and standard deviation 1/3. Each exercise is assigned a difficulty value, also between 0 and 1. When an ant arrives at a given node, if its level allows it to validate the node, it succeeds, otherwise, it fails.

4. CONCLUSION

Based on the conducted research, the trends in application of evolutionary algorithms are based on gathering relevant information by students for the purpose of search and display of certain teaching materials. Majority of research is based on enabling personalized learning process along with accelerating the search process and finding adequate teaching material. Also, one of the identified problems within the research is the student`s motivation, which may vary according to different actions performed by a student during the learning process. A student may leave the learning process, he/she may have problems with the connection or with the search engine, thus increasing the time spent on the particular learning object, which the systems (algorithm) identify as the time needed for solving a particular problem or for reading teaching materials. Also, by applying the algorithm, the process of personalization itself requires great engagement of teachers, who must define the set of attributes for every teaching material entered into the system (regardless of whether it is about additional, auxiliary or main teaching material). Evolutionary algorithms operate on the principle of input parameters, and those parameters must be precisely and accurately defined for teaching materials at any time, and they also must be obtained from students during the learning process. In case some of the parameters are not defined accurately, a student may receive inadequate learning object during the learning process, which may disturb the entire learning process and the possibilities of the system itself. The recommendations for the future research refer to improvement of the algorithm ability in terms of recognizing students` habits and their style of learning according to additional parameters (with the exception of the time spent on the learning object). The research has shown that a lot of short tests in certain parts of the learning process enable additional amount of information on students` habits, which might be of great help in choosing the right learning path for the learning within the system.

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GUDELINES FOR DEVELOPMENT OF ACCESSIBLE E-LEARNING PLATFORMS

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***Abstract**: Students with disability face a wide range of barriers, including access to information. Studies show that information and communication technologies provide a powerful tool in supporting education and inclusion in social and daily life of them. Unfortunately, there is a lack of available and appropriate accessible technologies. Also, developers often do not have the proper training and knowledge to make education technologies more accessible. In the paper we present most important guidelines for development of accessible web pages, like WCAG, WAI and european standards for accessibility requirements of ICT products and services in Europe. Additionally, example of the accessibility software for creating and evaluation of educational content is presented. The software enables beside creation of accessible content also management of educational process. At the end, evaluation of the software is presented, using freely available accessibility check tool.*

***Key words**: eLearning platform, students with disabilities, accessibility, supporting education, WCAG, WAI*

1. INTRODUCTION

People/Students with disability (PwD/SwD) face a wide range of barriers in education. Some of them are: lack of accessibility integration, lack of quickly and readily information on available accessible technologies, developers do not have the proper training, tools and resources to implement accessibility, lack of support of state institutions and enterprises – shortcoming in improving accessibility and violation of the rights to communication and education [1].

2. WHAT IS ACCESSIBILITY

What does accessibility mean? A very important aspect of using programs and contents used by the Internet browser is the aspect of accessibility of data and the aspect of easily exchange and re-using of data. A person who has a reduced mobility of hands, fingers, hands or one hand, or a significantly reduced functionality of the hand should have the same ability to manage such programs as other people. The same rule applies to all types of disabilities, but also to cultural, gender and other characteristics [2]. Accessibility for various types of users as well as the overcoming of technological barriers for the freedom of dissemination of educational material have to be incorporated from the beginning in the context of creating the skills for creating educational content in a digital environment. Data accessibility rules include technological and authoritative measures and procedures that allow the content to be adapted to various types of users.

Information and Communication Technologies (ICT) can be a powerful tool in supporting education and inclusion for PwD/SwD [3]. Through the learning technologies (ICT) an educational system was transformed because these technologies are available and accessible, especially for PwD/SwD.

3. ASSISTIVE TECHNOLOGY

Assistive technology (AT) is any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons/students with disabilities. We will cover assistive technologies, with a special focus on accessible e-learning systems. An organization that

specifically addresses these issues in the education process is called Global Learning Consortium, and an organization that addresses these issues when it comes to creating websites and other Internet content is called the World Wide Web Consortium, the Web Accessibility Initiative. In order to make the learning process more successful for students with disabilities, access to the Internet is necessary.

3. ATUTOR

ATutor is a software for creating educational content, as well as the overall management of the educational process , Learning management System (LMS), which the scientists at the Adaptive Technology Resource Center at the University of Toronto, Canada, created [4].

ATutor was created by making everything according to accessibility criteria for PwD/SwD. In this way, PwD/SwD can be educated by attending courses in electronic form, and courses are created according to international standards for accessibility of attending a course. The interface of the ATutor program was translated into Serbian, a detailed manual in Serbian was written. The application of such free software can significantly improve the education of PwD/SwD, especially bearing in mind that a large number of PwD/SwD are deprived of education, because they are not adapted for higher, high and often high school education. Initiatives that would allow the use of such free software in regular education as well as in adult education could have significant economic and social results because the majority of the members are adult learners.

4. ATUTOR ACCESSIBILITY EVALUATION

The Web Accessibility Initiative (WAI) of the Worldwide Web Consortium (W3C) has developed a methodology that can provide an informative evaluation framework [5] named “The Website Accessibility Conformance Evaluation Methodology (WCAG-EM) 1.0.” It breaks the evaluation procedure into five steps.
They are

- Define the Evaluation Scope,
- Explore the Target Website,
- Select a Representative Sample,
- Audit the Selected Sample, and
- Report the Evaluation Findings.

The first three steps in this methodology involve preparing for the evaluation. Defining the scope entails specifying areas within a site that will be included or excluded in the evaluation (e.g., subdomains, mobile versions, additional domain names, third-party content), identifying a standard or target (e.g., WCAG 2.0 Level AA), and listing supported browsers and assistive technologies. Next, explore the site and identify common templatesor page types, essential areas or functionality, and any out-of-the ordinary technologies that should be included in the evaluation. Pages that are relevant to people with disabilities (e.g., a page outlining accessibility features) should also be included.

In order to evaluate Web Accessibility of the web sites and web applications we used tools recommended by WebAim (https://webaim.org/) WAVE. WAVE is a free online tool from WebAIM that can help users identify accessibility issues on a page-by-page basis. It does this by inserting color-coded icons that identify accessibility issues, potential issues, and potential features that must be verified by the reviewer. [6].

Image 1: First page of the WAVE Tool

In order to analyse web accessibility of the ATutor, we tested available DEMO site of the ATutor LMS - http://www.atutor.ca/atutor/demo.php
We entered the web address of the demo web site in the WAVE APP and reviewed the report.

Image 2: ATutor Accessibility WAVE results

In the left menu WAVE app showed us the report which could be further analyzed. Contrast test showed many errors. This brought to conclusion that the GUI (graphical user interface) of the ATutor LMS should be improved in terms of color coding and contrast. Other marks showed good accessibility results.

5. CONCLUSION

It is very important for educational institutions to use available tools for accessibility testing. Free web tools exist and they should be used continuously. The problem is that educational organizations have competing priorities and often have to deal with shrinking budgets. For web accessibility to raise to the level of action for many educational organizations the problem must be well understood by those who will make decisions. As these individuals change, this critical component will need to be revisited. [6]

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ANALYSIS AND IMPROVEMENTS OF EXISTING E-LEARNING SYSTEMS AND A DRAFT OF AN E-LEARNING SYSTEM FOR DATA STRUCTURES PROBLEMS

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Abstract: *This paper presents and analyses existing e-learning systems for learning of data structures fundamentals based on automatic check of problem solutions. This approach has important advantages; the complete process of learning is performed by using a web-browser. The source code entered by a student is executed in real time and compared to the set tests. Data structures which will be discussed in this paper are: the stack and the stack implementation based on arrays. The system can be easily extended for other data structure types, which will not be discussed in details here. However, existing e-learning systems have some disadvantages, and this paper analyses these disadvantages, and propose a new system for e-learning of data structures in Java programming language, which is currently in process of developing at the Metropolitan University, and which has some advantages compared to existing systems.*

Keywords: *E-Learning, Data Structures, Java, Groovy*

1. INTRODUCTION

Students who learn programming, are familiar with standard programming languages and the basic elements of programming languages such as: variables, types, logical and conditional problems, loops, arrays, methods, classes and objects. In a previous paper - [1] , we analyzed obstacles and possible solutions needed during learning the basic elements of programming languages.

In computer science, an abstract data type (ADT) is a mathematical model for data types, where a data type is defined by its semantics from the point of view of a user of the data, specifically in terms of possible values, possible operations and the behavior of these operations.

Data structures can implement one or more particular abstract data types (ADT), which specify the operations that can be performed on a data structure and the computational complexity of those operations. In comparison, a data structure is a concrete implementation of the space provided by an ADT.

Different kinds of data structures are suited to different kinds of applications, and some are highly specialized to specific tasks.

Data structures provide a means to manage large amounts of data efficiently for uses such as large databases and internet indexing services. Usually, efficient data structures are key to designing efficient algorithms. Data structures can be used to organize the storage and retrieval of information stored in both main memory and secondary memory.

Based on previous considerations, we can conclude that a majority of concepts related to data structures, except arrays, is unknown to students who used basic elements of standard programming languages.

Data structures discussed in this paper are the stack and the stack implementation based on arrays. Also, it is an important advantage of the proposed approach, that the system is easily extendable to other data structures types.

Therefore, this paper presents and analyzes the existing e-learning systems for teaching data structures. Recent years have seen a rise of numerous e-learning systems for learning programming languages based upon a direct program code entry into a web browser and evaluation and display of corresponding output. This paper gives an overview and a description of the existing systems and their characteristics.

Based upon the previous analysis we will recommend a system adequate for the Data Structures course at the Metropolitan University. These solutions enable an interactive monitoring and checking of the problems that a student is working on, with the student himself being able to get feedback on his results in a significantly faster way.

2. ANALYSIS OF EXISTING E-LEARNING SYSTEMS FOR LEARNING DATA STRUCTURES

CodingBat e-learning system [2], developed by the Stanford University professor Nick Parlante, enables learning of the basic elements of Java and Python programming languages.

The basic advantage of the proposed system is that is completely free, and it offers a support for the Java and Python programming languages.

The problems are divided into multiple sections, where each problem includes the following. a definition of the problem, a group of test for each problem and the framework of the method that needs to be supplemented in accordance with the definition of problems and test.

The data structures supported here are arrays and maps, and the following table shows descriptions and numbers of problems for this data structures:

Table 1: CodingBat sections for arrays and maps

Section	Description	Number of problems
Array-1	Basic array problems - no loops	27
Array-2	Medium array problems - 1 loop	34
Array-3	Harder array problems - 2 loops, more complex logic	9
Map-1	Basic Map with get()/put() methods, no loops	9
Map-2	Maps with bulk data and loops	9

The total number of problems equals 88, which in our opinion enables the student to perfectly master the covered subjects.

With CodingBat being based on solution of specific problems, the GUI is significantly more simple than in the case of Codecademy [3] (discussed in [1]) and is made out of the following elements:

The following image shows CodingBat GUI:

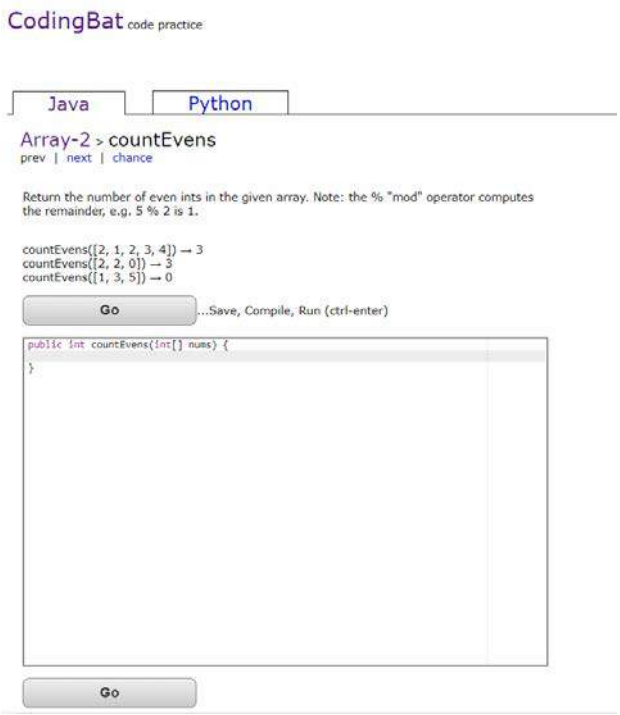

Image 1: CodingBat GUI

The disadvantages of this system are:

- Missing of a theoretical part
- GUI is too simple
- Missing of a support for two-dimensional arrays
- Missing of any support for all data structures except arrays and maps

E-learning system Codecademy [3], enables learning of the basic elements of programming languages.

Regarding data structures, Codecademy offers only a commercial course for Python (PRO Intensive Membership) [4], which is illustrated in the following table:

Table 2: Codecademy units, description and difficulty

Unit Name	Description	Difficulty
Unit 1 - Getting Started with Data Structures	Learn how data structures fit into computer science and about the node building block.	Easy
Unit 2 - Linked Lists	Create your first data structure. Learn how to build and use your own Linked List.	Easy
Unit 3 - Stacks and Queues	Compare two new ways to organize and access your data linearly.	Easy
Unit 4 - Hash Maps	Learn about key-value relationships and explore with hash maps.	Medium

Unit 5 - Trees and Heaps	Implement a data structure for an interactive story and order your data using heaps.	Medium
Unit 6 - Graphs and Data Structure Review	Build a maze using a graph and fortify your knowledge of data structures.	Challenging
Unit 7 - Asymptotic Notation	Learn about asymptotic notation and apply it to the data structures that you've learned.	Challenging
Unit 8 - Capstone Project: Local Restaurants	Build a predictive restaurant name search using your knowledge of data structures.	Challenging

The third solution discussed here, HackerRank [5], is not a classical e-learning system, and it is more adequate for students who are already familiar with data structures concepts.

The following data structures are covered: 1D and 2D Arrays, Linked Lists, Trees, Balanced Trees, Stacks, Queues, Heap, Set

The following table illustrates the number of examples and their difficulty levels for each data structure type:

Table 3: HackerRank problems

Data Structure	Number of problems and difficulty
1D and 2D Arrays	6 (4 Easy, 1 Medium, 1 Hard)
Linked Lists	15 (14 Easy, 1 Medium)
Trees and Balanced Trees	20 (8 Easy, 4 Medium, 2 Advanced, 5 Hard, 1 Expert)
Stacks	9 (2 Easy, 5 Medium, 2 Hard)
Queues	5 (3 Medium, 2 Hard)
Heap	4 (2 Easy, 2 Hard)
Sets	4 (1 Medium, 3 Hard)

The advantages of this system are:

- A rich GUI
- A sufficient number of solving problems for advanced data structures (linked lists, trees, stacks, queues, heap, sets)
- An evaluation of problem solutions in real time within the web browser
- A support for several programming languages

And disadvantages of this system are:

- There is no any theoretical part, which implies that students are already familiar with data structures concepts
- The number of solving problems is small for 1D and 2D arrays

The following image illustrates GUI for one of solving problems:

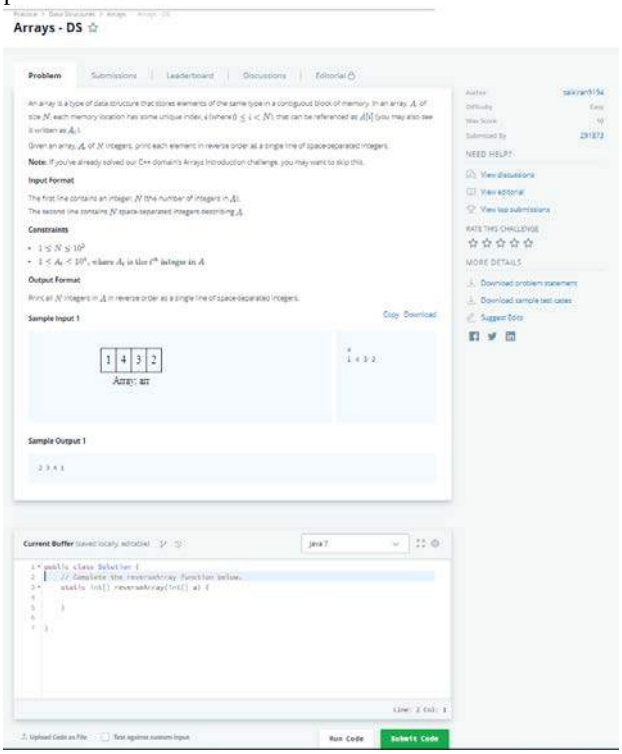

Image 2: HackerRank GUI

We can conclude that both systems have the following important constraints:

- There is no a theoretical part for all data structures
- There is no any support for videos
- Small number of solving problems for certain data structures
- Existence of identical problems for all students
- Inability of adding new problems
- Inability of translating them to a different language
- E-learning systems are becoming totally commercial

3. DESCRIPTION OF THE E-LEARNING SYSTEM JOE-DS ONLINE EDITOR FOR DATA STRUCTURES

Based on the analysis of the existing solutions, described above, a comprehensive and flexible system being developed at the Metropolitan University, intended to enable efficient e-learning of data structures, especially for Java.

This system represents an advancement of the system JOE, describe in [1], so it supports the work with data structures,

where for every solving problem there is a group of tests, and these tests give a basis for the solution evaluation.

The system enables learning of the data structures in Java programming language, starting from scratch, including a theoretical part, and also including the input of the entire code into an integrated editor, as well as modifying/extending the already existing code and correcting the mistakes in the existing code.

The system was developed using Spring 4, where problems are given in XML format, and tests for problems in Java and Groovy languages, resulting in fast and easy extending of the system and adding solved examples and learning tests.

The developed sistem combines good characteristics of existing systems, and introduces some new options, and its properties and its advantages can be described/summarized in the following way:

- The JOE-DS system enables entering Java code in an integrated editor, including syntax highlighting
- Creating/adding any number of new problems and also theorethical tests for a given section (area of learning), which is not available in the existing systems
- Creating/adding problems and tests for this problems which enable modifying of existing excersise solutions and correcting errors (not available in CodingBat)
- Adding new sections with problems and theoretical tests (new learning areas), eg. a section about graphs (not available neither in Codecademy nor in HackerRank)
- Using videos (not available neither in Codecademy nor in HackerRank)
- Sending detailed messages to the user informing about his/her performance and syntax errors (more comprehensive compared to the existing systems)
- Easy producing several versions of the same course or similar courses, in any language (eg. Serbian), wnich is not available in the existing systems

So, the developed JOE-DS system combines good characteristics of the existing systems, and offers more flexibility and more learning comprehension compared with the CodingBat and the HackerRank solutions.

Image 3 illustrate the GUI of the proposed system, where the following example problem is demonstrated:

Given class ArrayStack contains:
- an integer array int arr[]
- size variable initialized with constructor
- index variable holding current top element index
- utility methods like isEmpty, isFull & size.

Implement:

- Stack push method throws StackOverflowError exception if stack is full.
- Stack pop method throws EmptyStackException exception if stack is empty.

Image 3: JOE-DS GUI – ArrayStack problem

Image 4 shows a test for the problem mentioned above, written in Java/Groovy:

```
import org.junit.runner.RunWith
import org.junit.runners.BlockJUnit4ClassRunner
import org.junit.Assert
import org.junit.Test
import java.lang.StackOverflowError;
import java.util.EmptyStackException;

@RunWith(BlockJUnit4ClassRunner.class)
class ArrayStack_Test {
    @Test(expected = StackOverflowError.class)
    public void popShouldThrowStackOverflowError() {
        ArrayStack stack = new ArrayStack(1);
        stack.push(0);
        stack.push(1);
    }

    @Test(expected = EmptyStackException.class)
    public void popShouldThrowEmptyStackException() {
        ArrayStack stack = new ArrayStack(1);
        stack.pop();
    }

    @Test
    public void pushShouldIncreaseSize() {
        ArrayStack stack = new ArrayStack(1);
        stack.push(1);
        Assert.assertTrue("Incorrect stack size after pushing element!", stack.size() == 1);
    }

    @Test
    public void popShouldDecreaseSize() {
        ArrayStack stack = new ArrayStack(2);
        stack.push(1);
        stack.push(2);
        stack.pop();
        Assert.assertTrue("Incorrect stack size after retrieving an element!", stack.size() == 1);
    }

    @Test
    public void pushShouldPutElementAtTop() {
        ArrayStack stack = new ArrayStack(2);
        stack.push(0);
        int val = 1;
        stack.push(val);
        Assert.assertTrue("Stack push does not put element at top of stack!", stack.pop() == val);
    }
}

import org.junit.runner.JUnitCore
import org.junit.runner.Computer

Computer computer = new Computer()
JUnitCore junit = new JUnitCore()

return junit.run(computer, ArrayStack_Test.class)
```

Image 4: JOE-DS GUI – test for ArrayStack problem

Image 5 shows a successfully solved example, after checking based on tests:

Image 5: JOE-DS GUI – solution for ArrayStack problem

4. CONCLUSION

This paper analysed the existing e-learning systems (CodingBat, HackerRank) for learning the data structures, which are based on automated evaluation of entered code, where existing tests are used, for every solving problem.

So, the developed JOE-DS system represents an advancement of the JOE system, which supports work with data structures, where for every solving problem there is a group of tests, enabling the evaluation of problem solutions.

The developed system combines good characteristics of the existing systems, and offers more flexibility and more learning comprehension compared with the CodingBat and the HackerRank systems.

ACKNOWLEDGMENT

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PART-TIME STUDY AND E-LEARNING IN EUROPE: INSIGHTS FROM ERASMUS+ PT&SCHE PROJECT

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Abstract: *Flexible delivery is often seen as an integral part of e-learning and lifelong learning. In some countries students learning at a distance or while working have equal status with on-campus students. Currently there is no agreed definition for 'part-time' studies across Europe. Part-time studies can refer to notional time spent learning, number of credits, time allowed for completing studies, or to funding arrangements.*

In this paper we consider part-time and e-learning in Higher Education in Europe with a particular focus on Serbia. Results from surveys with private sector employers, students and university teaching staff in Serbia are presented. While all agreed on part-time studies being introduced, students' and staff's views differed in terms of how to implement this new route to higher education qualifications.

Keywords: *E-Learning, Distance learning, online, Part-time studies*

1. INTRODUCTION

This paper draws on three surveys conducted for the Erasmus+ Part-time and Short Cycle Studies in Serbia (PT&SCHE) project [1]. The aim of this project is to test and report on part-time, online and short cycle higher education in Serbia with a view to its official endorsement and wider adoption.

Part-time study can be regarded as a large proportion of online or e-learning opportunities in higher education in Europe. Part-time study can be attractive to those who are working full or part-time and/or to those who have caring responsiblities and/or those who may not be able to study full-time for reasons related to their health/disability or geographical location.

Flexible delivery is seen as part of the approach to lifelong learning taken by a country but while full-time student status is clear and easy to understand in most EU countries, this is not the case for defining part-time students. The majority of EU countries recognise more than the sole status of full-time student (around 2/3 countries for which data are available) [2]. In the remaining countries there is no formal status of part-time student. Although students may in effect be studying part-time within the existing system, they are not officially recognised as a particular category of student. Other countries have laid down equal status for on-campus and distant learning students, or those who wish to study on a part-time basis.

It should also be noted that there is no agreed definition for 'part-time'. Sometimes the definition relates to the notion of time spent studying, while elsewhere it relates to funding arrangements, number of credits being studied or time allowed to complete the study programme [2]. Sometimes these components are combined in the definition. In addition, some countries have no fees for full-time students, but expect part-time students to contribute to their studies, and part-time students might also receive less financial support [2].

Funding for part time studies depends upon how countries regard life-long learning. When this is seen as part of the national approach to economic and human capital development then there is likely to be more public funding. Otherwise funding is a mixture of public and private sources. Some of this private funding is from business, as is the case in Serbia, while elsewhere it comes from the students. However, it should be noted that public funding is not always clear due to the nature of the financing [2].

2. PART-TIME HIGHER EDUCATION STUDIES IN EUROPEAN COUNTRIES

The share of part-time students varies significantly from country to country. The largest share of part-time students in 2015 was in Finland (41.80%), while the smallest share was in Portugal (5.51%) with some countries, such as Austria and Italy, like Serbia, not recognising part-time students at all [2]. When comparing undergraduate and postgraduate studies in various countries the share of part-time students is significantly different. For example, in Germany, Latvia, Lithuania, Hungary Romania, Slovenia, Norway and Switzerland there were more part-time students at undergraduate or Bachelor level. In contrast, in Bulgaria, Spain, Cyprus, Luxemburg, Malta, Netherlands, Slovakia, Finland and the UK the proportion of part-time

students was significantly higher at Masters level [2]. The countries of the EU also differ in relation to short cycle higher education [3].

3. PART TIME AND SHORT CYCLE HIGHER EDUCATION IN SERBIA

In 2016 members of the Erasmus+ PT&SCHE project conducted a survey to find out the current state of affairs in the different partner countries, namely Estonia, the Netherlands, Scotland and Slovenia. One of the questions to gather information about the different national approaches to the issues covered by the project was: are part-time degrees available? In all the other countries involved in the project part-time studies are available, therefore it is necessary to investigate further the situation in Serbia in relation to part-time higher education studies.

To better understand the current situation in Serbia it is necessary to refer to the Education Strategy 2020 and its accompanying action plans [4]. Serbia is starting from a position of not having any "precise data on the number of employed persons, who are changing or acquiring other qualifications through some form of part-time education in vocational schools does not exist, nor do we have data on the number of people who have lost their regular student status or have dropped out and are continuing their education as part-time students. therefore, we cannot assess the percentual amount of this key feature" [4].

In the Serbian law "Sl. glasnik RS", br. 88/2017 it is stated that institutions in higher education may lay down detailed regulations if they consider it necessary to provide a part-time mode of studying. Before 2002 part-time studies were possible but were abolished by a law in 2002 because they were had not been deemed to be successful. Even when part-time studies were not explicitly provided for by the legislative regime a student could complete their degree programme in double the number of years compared to the normal duration of the study programme. Thus, the status of student ceased in the case of expiry of twice the number of academic years required for completion of the programme "except in the case of studies at work" as "a student studying with work [i.e. a part-time student], … retains the status of a student until the expiration of the deadline determined in the triple number of school years required for the realisation of the study programme." [4]

4. FINDINGS

Three online surveys were carried out in 2016 to gather data from employers, students and university teaching staff on their attitudes towards part-time higher education in Serbia. This would let us know if there was a demand for part-time studies from employers in the private sector and students and also some of the practical challenges that the introduction of part-time studies might produce.

Survey of enterprises

An online survey was conducted to understand the labour market and employers' attitudes towards part-time studies. The survey was conducted during March 2016 and responses were received from 212 enterprises.

The first three figures below show the structure of the respondent sample in terms of industry sector, enterprise size and the management level of the person who responded to the survey.

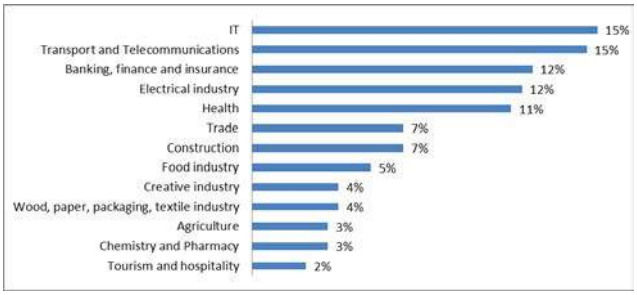

Figure 1: Respondent breakdown by industry sector

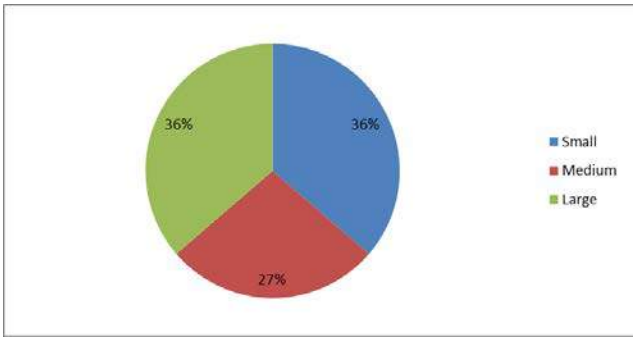

Figure 2: Size of enterprises that responded

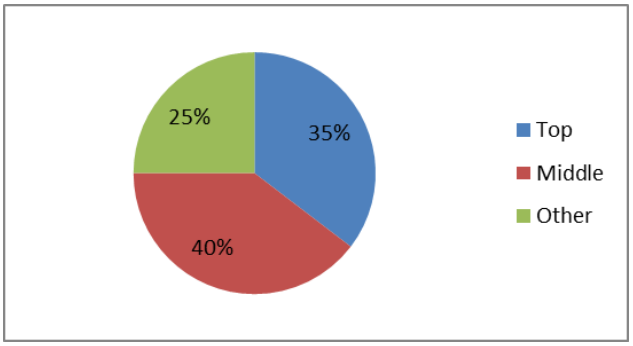

Figure 3: Management level of the responding person

The survey included questions on the status of the labour market in relation to vacancies that the enterprises needed to fill. It would appear there is space for additional education as 19% of enterprises have vacancies because they are not able to find the appropriate work force from the existing labour market. In addition, almost 40% of the enterprises have employees with secondary school education who are doing work for which tertiary education is needed.

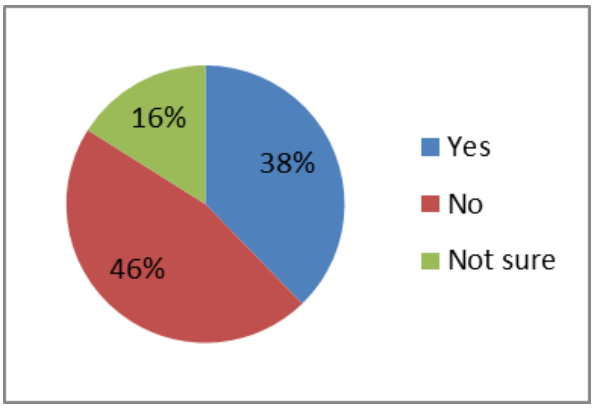

Figure 4: Do you have employees with secondary school education doing work for which tertiary education is needed?

The next figure shows that enterprises are willing to support further education for their employees. They are more inclined to support them through flexible working hours rather than days off (free days) or financial support. This would suggest that if flexible working hours are the most acceptable option to employers then it would be better if part-time studies were organised to fit around students' work commitments.

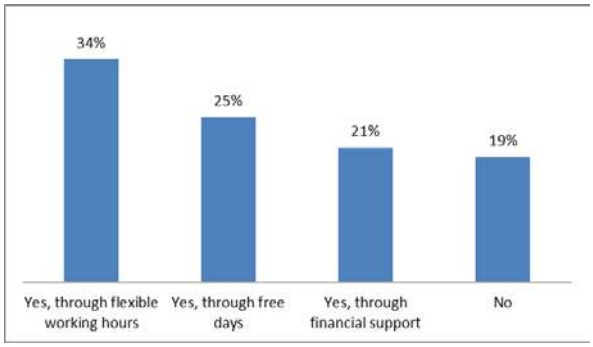

Figure 5: Will your enterprise support its employees to study and in which way?

Differences according to the size of the enterprise were analysed and it appears that the larger the enterprise the more willing it is to support their employees carrying out part-time studies. In addition, respondents from top management positions appear more open to additional studying by their workers.

Survey of students

During autumn 2016 researchers conducted an online survey of students to elicit their views on part-time studies. The goal was to understand students' needs and attitudes toward this kind of studying. The sample size was 821 respondents from higher education institutions across Serbia.

The figures that follow show the structure of the sample with 56% of respondents being female and 44% male. The sample's distribution by gender, field of study and level of study correspond to the distribution in the population. Age structure shows that a significant number of older students is included in the sample, and this is important because part-time studies are likely to be of more interest to older students with families, jobs, and other responsibilities.

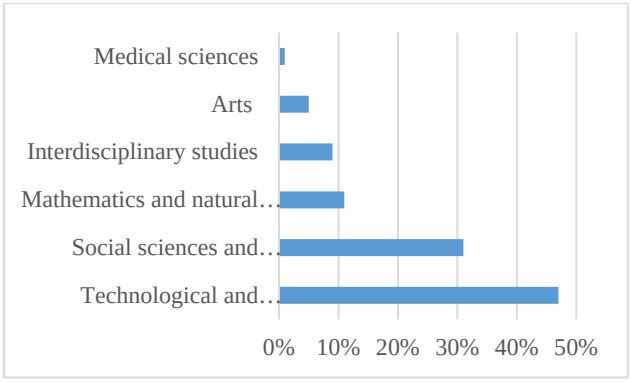

Figure 6: Distribution of students in the sample by academic field (n=784)

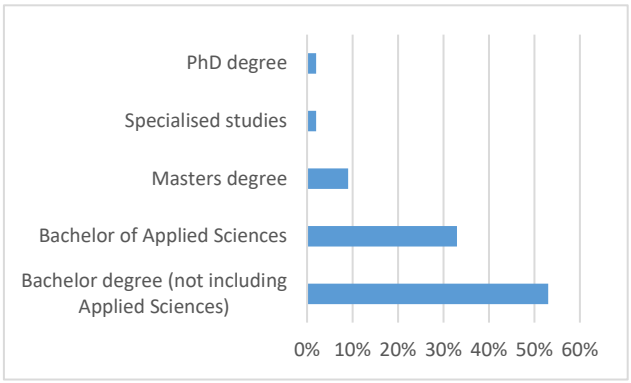

Figure 7: Distribution of students in sample by degree level (n=812)

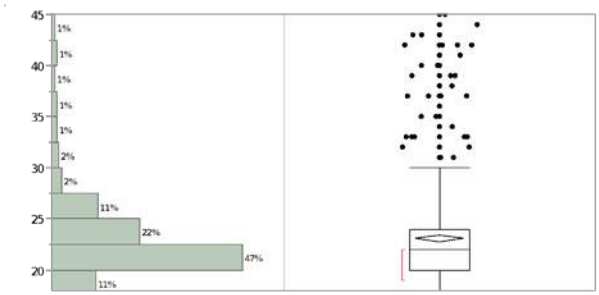

Figure 8: Distribution of students in sample by age (n=815)

Forty percent of students in the sample (n=817) had some sort of job (19% full-time and 21% part-time). This suggests that a significant number of students are interested in combining study with paid work.

The results of the survey suggest that a significant share of students in Serbia support the idea of introducing part-time studies into higher education in Serbia. Sixty-one percent agreed there was a need for part-time HE studies with 25% not sure and 14% against (n=818).

In the survey respondents were asked if part-time studying would be a good option for students who did not live where they were studying, for students who had children and for students with disabilities. The table below shows the responses.

Table 1: For which of the following categories of students, would part-time studying be a good option? (Multiple response question)

Options	Number	Percent
Students who do not live in a place where studying	331	40.32%
Employed students	576	70.16%
Students who have child(ren)	629	76.61%
Students with Disabilities	603	73.45%

From the results in Table 1, it would appear that students are aware of the social dimension in the HE system and its relationship with part-time studying. According to their answers, students with children will benefit most from part-time studying.

Data from the study suggests that a significant number of students would have enrolled as a part-time student if that possibility had existed when they were beginning their studies. In answer to the question "Would you have enrolled for part-time studies if such a possibility existed?" 42% said yes (n=816). The question "Would you have switched to part-time studies if such a possibility existed?" received a positive response from 39% (n=817).

Table 2: When should lectures and tutorials for part-time students be organised? (n=813)

Options	Number	Percent
During the working week at the same time as for the regular students	143	17.60%
During the working week in the afternoon	223	27.40%
During the weekend	327	40.02%
No classes	120	14.80%

The table above shows that the most popular option for when teaching should take place part-time students was during the weekends.

In relation to the financial aspects of studying part-time, the most popular response from students was that fees for part-time studies should be at the same level as for full-time students.

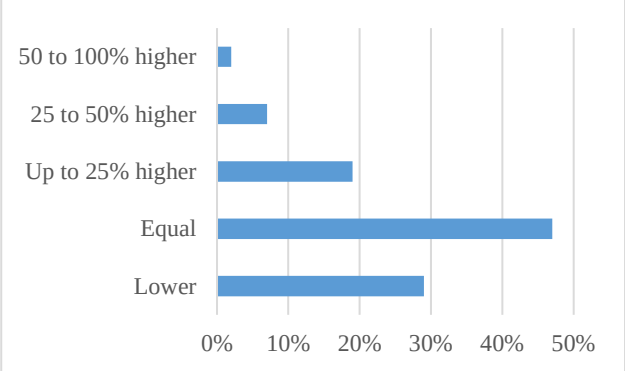

Figure 9: Should fees for part-time degrees be equal to, lower or higher than fees for regular studies?

When students were asked "How many ECTS credits should part-time study and short cycle studies undertake each year?", the average number of points was 45.64. Since the total of ECTS credits for full-time students is 60, this can be understood as the workload for part-time students being 25% lower than regular studies.

Survey of teaching staff

During autumn 2016 the research team conducted a survey with university teaching staff about part-time studies. The goal was to understand the needs and attitudes toward this new kind of studying from the lecturers' perspective. The sample size was 532 respondents from higher education institutions across Serbia. Data collection was conducted via an online survey.

Figures 10 and 11 show the structure of the sample across scientific disciplines and academic titles.

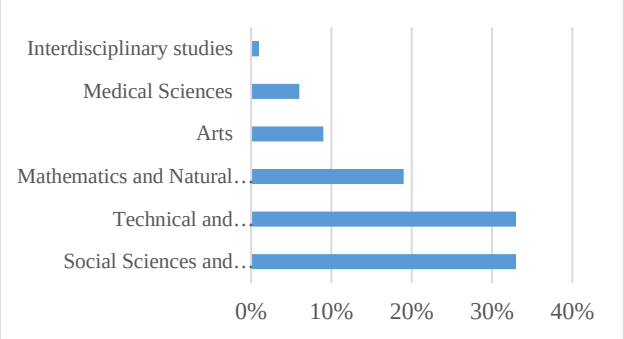

Figure 10: Distribution of sample by discipline (n=525)

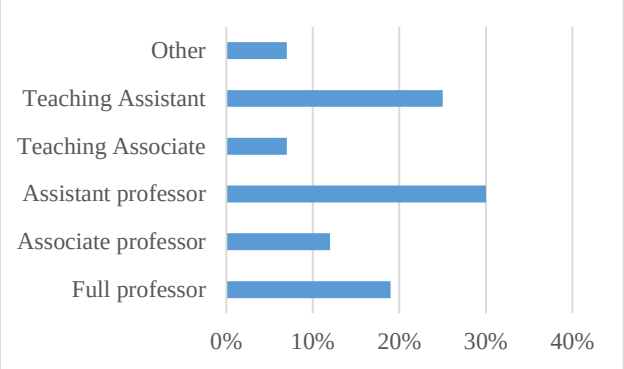

Figure 11: Distribution of respondents by academic title (n=521)

A majority of the surveyed teaching staff (59%) agreed there was a need for the introduction of part-time studies in higher education in Serbia with 23% not sure and 18% saying no (n=525).

Table 3: When should lectures and tutorials for part-time students be organised? (Multiple response question)

Options	Number	Percent
During the working week at the same time as for the regular students	196	36.84%
During the working week in the afternoon	460	86.47%
During the weekend	370	69.55%
No classes	211	39.66%

Table 3 shows that according to teaching staff the most appropriate time for part-time courses to be held would be during the working week. This is different compared to the responses of students. Students' response was that weekends would the best time for tuition for part-time studies.

The majority of university teachers in the survey thought that fees for part-time studies should be higher than fees for full-time studies (22.6%+19.2%+12.5%=54.3%) which is in contrast to students' opinion about fees being the same.

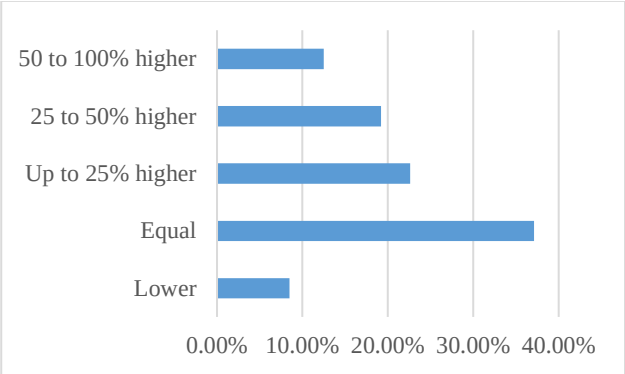

Figure 12: Should fees for part-time degrees be lower or higher than fees for regular studies?

The table below shows respondents opinions in relation to the introduction of part-time studies in specific scientific fields. More than half of the respondents think that in interdisciplinary studies and technical and technological sciences, part-time studies should be completely allowed. Around 40% of respondents agree with the partial introduction of part-time studies in all fields.

Table 4: Do you agree with the introduction of part-time studies in the following fields? (multiple response question)

	Part-time studies allowed?		
Study field	Completely	Partially	Not at all
Mathematics and natural sciences	42%	44%	14%
Technical and technological sciences	55%	34%	11%
Social Sciences and Humanities	44%	40%	15%
Medical Sciences	41%	32%	27%
Arts	42%	34%	19%
Interdisciplinary studies	52%	37%	11%

Table 5: For which of the following categories of students, do you think part-time studying would be a good option? (Multiple response question)

Options	Number	Percent
Students who do not live in a place where studying	195	13.8%
Employed students	459	32.5%
Students who have child(ren)	372	26.3%
Students with Disabilities	387	27.4%

More of the surveyed teachers were of the opinion that part-time studies would benefit employed students. This contrasts with the results of the student survey as the most popular reason with students who responded was that part-time studying would be a good option for students with children. Seventy percent of the surveyed teachers agreed that changing between status of full-time and part-time should be allowed.

5. CONCLUSION

With respect to part-time degrees it would appear that legislation should enable students of any age to study part-time. In particular, this should be as flexible as possible for older students, who might have family and work commitments, which constrain their options for study. Whether time measures, or credit measures are used to determine how fast, or slow, part-time studies take place may not be so important. The key factor appears to be that part-time study should be available to as many students as possible to enable them to enhance their current qualifications and gain the higher education qualifications they need for new, or preferred future roles and to help enterprises in the private sector to fill vacant posts. There are differences of opinion between students and university teaching staff about when part-time studies should be held and how these programmes should be financed. However, they are in general agreement that students should have the option to study part-time in Serbia as happens in most other European countries.

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ON SOME PEDAGOGICAL IMPLICATIONS OF SHORT-CYCLE AND PART TIME STUDIES: THE IMPORTANCE OF STUDENT COUNSELLING

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Abstract: *Nowadays short-cycle (SC) and part time (PT) studies are gaining popularity in higher education. Due to the specific nature of these programs, SC and PT studies pose several socio-pedagogical, methodological and psychological problems with a special emphasis on student motivation and life experiences. Further, the authors attempt to suggest solutions including the implementation of a student counselling system. At the University of Szeged this system was originally designed to offer help to all students, but, in our experience, in many ways it can be of extraordinary help for PT and SC students, too. Eventually, the paper comes to the conclusion, that a personalized student counselling system, both online and F2F, can be an example of good practice for all institutions, already running, or planning to introduce SC and PT study programs.*

Keywords: *part time studies, short-cycle programs, student numbers, personalized counselling*

1. INTRODUCTION

Recent challenges in education mainly derive from the impact of globalization in the areas of economy and culture, but, there are political, social, financial and technological implications as well. In addition, the operation of various economic, social and educational subsystems is closely interrelated these days, thus changes in one policy would necessarily generate changes in the other areas. It is this complexity and complicated interrelatedness of factors that explain the changeability and, in a sense, the vulnerability of our educational systems, especially both the form and the content of higher education.

As far as the form of teaching in higher education is considered, it has become obvious that new forms and new programs are needed to meet the challenges of our modern age. Since economy, education and training are segments of decisive significance in the complexity of modern life, it has to be noted that the introduction of new higher educational programs, including part time and short-cycle studies, play an increasingly decisive role in educational policies worldwide. The explanation behind this tendency is that PT and SC programs represent tools in employment policy by making potential employees or inactive work force (re)employable in one or another sector of the job market.

The content side of teaching and learning has recently undergone changes as well. As knowledge-based society is emerging worldwide, the production of values today is synonymous with the production of knowledge. But the word 'knowledge' has to be used in its broad sense here: it is not one hundred percent job-related knowledge, but, it is vital for job seekers to acquire a variety of non-work-related skills and competencies, and not only at school-age, but throughout their careers. This is one reason why the concept of lifelong learning, including part time and short-cycle programs, play an increasingly significant role in the socio-economic and educational systems of the modern world. [1]

2. EUROPEAN PERSPECTIVES

As it was revealed in the former paragraphs, the concept of lifelong learning primarily considers the human component in education and work, i. e. the knowledge, skills and competencies which are needed by students and employees throughout their working lives.

Considering all these changes it was in 2010 that the European Commission elaborated a Memorandum on Lifelong Learning [2], a 10-year developmental plan in the area of education and training. This document focused on a vision for easily accessible, career-oriented, initial and continuing training programs, flexible and student-friendly systems, including the appreciation of non-formal and informal learning. This document emphasized a learning outcomes approach to evaluation in education, and, most importantly, access to high-quality information and counselling. In the document it is Key Message Number 5 that calls for the rethinking of the theory and practice of guidance and counselling. In the past, as the document also reveals, the transition from education and training to working life took place only once in a person's life. People rarely combined education with a job or family commitments. Today, this pattern seems to be changing radically. People, throughout their adult lives and careers, need up-to-date information and advice on

'What to do and what to learn next' at several times. The transition from education to career has become more prolonged and unpredictable. It is quite common today that young people study and work simultaneously. In general it can be said that it takes young people longer to establish themselves.

On the other hand many middle-aged people seek a return to education to get better qualifications, better jobs, or, simply, to make more money. In short, there is a growing number of students also working and raising families, and a rising proportion of people already in full time employment doing studies simultaneously.

As it is revealed by statistical figures, in Europe there is a growing number of young people aged 20-34 (approximately one in five) who are neither in employment nor in education. For them the most commonly mentioned obstacles according to an adult education survey include the lack of adequate training programs and unpreparedness for further education. For those who want to work and study simultaneously, the lack of time due to family responsibilities, and conflict with work schedules can be mentioned. [3] In addition some psychological factors including the lack of motivation, the lack of self-confidence, the inability to cope with new teaching methods and materials may also represent difficulties for both the young and the middle-aged learners who, obviously, need special help to overcome their own difficulties.

In summary, it can be stated that it is essential for each educational and training institution to implement and operate efficient guidance and counselling services for their students; it is the part time and short cycle students who need this kind of professional assistance the most.

3. THE HUNGARIAN SCENE

In Hungary, due to the periodically changing birth rate figures, the number of school goers is uneven at all levels, a fact, that creates many problems in the national education system, and, which is extremely harmful from the point of view of short cycle and part time study programs. This feature makes long-term planning and the introduction of innovative approaches and new programs extremely difficult.

Today the most important new features of PT and SC programs in Hungary include the increase of the duration of practical training within the program, the support and preference offered to vocations in short supply, the reduction of the time period of training, the simplification of the examination requirements, the development of an external evaluation and inspection system. [4] The proportion of students enrolled in part time and short cycle study programs in Hungary is currently behind expected figures. In addition, dropping out is significant, too. While the proportion of young European men and women who were early leavers from education and training was 10.5% in 2017, the same figure in Hungary reached 12.5 %. [5] The reasons behind these unfavourable tendencies include the introduction of relatively high tuition fees, students' postponement of their studies for one reason or another, too frequent and often inconsistent changes in the education system, indicative of some kind of instability and changing preferences in Hungarian educational policy. This is why all training institutions in Hungary need to address these problems. At the University of Szeged remedial programs have been introduced; the ones in IT and foreign languages are very popular with all students, including part time and short cycle ones as well. Student counselling is also helpful. A national-level competencies test was also introduced in Hungary. First year students are tested at the very beginning of their first semester and they are evaluated on the basis of their performance. Depending on test results students may be referred to special remedial programmes or personalized counselling services.

4. STUDENT COUNSELLING AT THE UNIVERSITY OF SZEGED

Throughout its more than twenty-five years of operation, the Student Counselling Centre of the University of Szeged has committed itself to the promotion of students' physical and mental health as well as their overall wellbeing. To the end that achieve this goal, the centre provides students such services that serve the maintenance and development of their physical and psychological quality of life. Just like any human community, the group of students studying at the twelve faculties of the University of Szeged is not a homogeneous community but a mini society with a diverse composition, representing different social groups. Therefore, the arising life management problems embrace a considerably wide spectrum but naturally tinted with study field and generation-related characteristics.

Parallel to the university studies, students unavoidably face all kinds of developmental challenges, for example, they have to develop and consolidate their own personal identity, this is the last phase of their separation from parents, this period is also the stage for the adaptation to various communities and social roles as well as for the establishment and strengthening their social relations and networks, they also need to plan their career path, which requires the development of their professional, occupational and vocational identity. Taking the fast changing intellectual, social and economic challenges of our today's life into consideration, as they are formerly detailed, it is essential for these young adults to get prepared as early as their university years to give effective responses to these challenges of life in general and the labour market more specifically, and get enabled to develop their own individual coping strategies by acquiring proper and transferable problem solving and conflict management techniques. No universally applicable solutions exist, therefore, the range of services have been formed and enhanced in a manner to adjust to and meet the individuals' special needs and expectations since such services can only fulfil their essential role if they foster students' quality of life and personal development in an individually-tailored way.

Since the accession to the European Union, the university has taken part in many operative programmes (Social

Renewal, Human Resources OPs, etc.) and has implemented various higher educational development projects, in the framework of which, the Student Counselling Centre has taken an important role in designing and managing subprojects whose aims and objectives are to diversify psychological, special need and learning guidance and assistance in the spirit of tackling and preventing drop outs. The centre operates in three distinguished branches: besides online individual and face-to-face therapeutic counselling, the Equal Opportunities Branch offers services especially targeting at disabled, disadvantaged or special need students, including physical disability, speech impairment, spectrum disorders (e.g. Asperger syndrome, autism), various psychological developmental disorders (e.g. Attention Deficit and Hyperactivity Disorder, learning difficulties such as dysgraphia, dyscalculia and dyslexia). As an integrated service provision unit of the university, the centre caters for any full-time student who has an active status in the actual academic year.

In the last few years the number of students conducting short-cycle studies have used the individual and/or group learning assistance training programmes and services in a greater number. Though no exact research has been conducted so far but due to lower threshold of admission to short-cycle studies, the ratio of special need students seems to be higher than in more advanced studies. Among the remedial programmes, they can have access to group training on learning techniques where they can learn how to learn and enhance their learning strategies. Students with dyslexia can join special workshops where they are trained how to tackle their learning disability and develop their skills in a more effective way. For them the innovative juggling workshop was very successful, and they reported positive outcomes in their skill development. Based on indication, the centre can offer various learning aids (Internet accessibility for students with impaired vision, speech recognition devices, dictaphone, massage, physiotherapy, etc.). Students with learning disabilities may be granted concessions or extra time at exams, and can take part in dyslexic language learning courses as well. Supplementary individualized mentoring and counselling services (five-six session in each academic year) are available as well for free of charge. In more severe cases, the centre can mobilize its well-established referral network.

5. CONCLUSION

In conclusion, as István Polónyi [6], the most significant Hungarian researcher in PT and SC studies, sees it, it is a must that up-to-date education be learner-centred. In Polónyi's opinion, students in short-cycle and part time study programs can be roughly divided into two major groups. The first one comprises students, who might come from disadvantaged groups. Examples include those who are unemployed, early leavers, students with learning difficulties, former dropouts, senior students etc. They are the ones who either do not have any previous experience in higher education, or, if they do, it was a very negative, discouraging experience. A well-organized and personalized counselling system may help these students to overcome their initial difficulties. These students may be helped specifically with personal and online consultations, remedial classes, supplementary and graded teaching materials and psychological counselling services. Their progress has to be closely and individually monitored..

In the second group in Polónyi's opinion there are students who are already degree holders and who already work for their second or third qualification. These students are in search for better employability, higher social status and higher income. In the development and the running of programs for these students, the most important features include state-of-the-art teaching methods, high-quality teaching materials, foreign language classes, (possibly, bilingual teaching), excellent infrastructure and internationalization play the most significant role. But, professional guidance and counselling services are important for this group, too. These students primarily need information on additional opportunities, study abroad programs, good training sites, international conferences and publications, etc. To sum it up. in accordance with Key Message Number One of the Memorandum on Lifelong Learning issued by the European Commission in 2010, this group of students need information and guidance primarily to guarantee for them the " universal and continuing access to learning for gaining and renewing the skills needed for sustained participation in knowledge society." [7]

From the above the conclusion can be drawn that a personalized student counselling system, both online and F2F, can be an example of good practice for all institutions, already running, or planning to introduce SC and PT study programs.

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EVALUATION OF THE PILOT ONLINE SHORT CYCLE PROGRAM "PROGRAMMING IN JAVA"

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Abstract: *This paper presents an evaluation of the short program "Programming in Java" implemented at Belgrade Metropolitan University (BMU) as a pilot program of the project "Introduction of part-time and short cycle studies in Serbia" (PT&SCHE), funded by Erasmus+ European Union program and in realization from October 2015 to May 2018. PT&SCHE role is to prepare a legal framework for the introduction of short programs and part-time study programs primarily intended for both: (i) employed students who can't study regularly or those who want to improve their qualifications, and (ii) unemployed students who want to gain new competences for better jobs offered by the labor market. In order to provide a legal framework, it is very important to analyze the existing methodologies, techniques and best practices of PT&SCHE studies that are already been applied in other countries. Based on the analysis of the most appropriate model for the adoption and development of PT&SCHE in Serbia, this paper aims to analyze and discover the most relevant pedagogical and methodological approach in eLearning processes of short programs. This paper describes the teaching methodology and e-learning technology proposed and implemented by BMU for short cycle programs (SCHE). The paper also analyzes effects to students (their success and satisfaction), provides an evaluation of applied methodology the pilot phase of the short program "Programming in Java" realized by BMU.*

Keywords: *E-Learning, Short cycle program, PT&SCHE project*

1. INTRODUCTION

The Strategy for the Development of Education in the Republic of Serbia by 2020 identifies the need for part-time (PT) and short cycle (SCHE) studies, and appropriate action plans were adopted [1]. The Low for Higher Education, adopted in 2017, provided the legal bases for PT and SCHE studies [2]. The PT&SCHE Erasmus+ project [3] aims to implement these action plans necessary for the establishment of PT&SCHE studies in Serbia, providing the proven legislative frameworks. The results of the project will contribute to achieving the goals of the strategy, such as extending access to higher education, and adapting higher education to the labour market. The project is funded under ERASMUS+ program of the European Union, for realization in a consortium of 15 partners from Estonia, Great Britain, Netherlands, Hungary, Slovenia and Serbia.[1]

A short program enables a student to become capable of performing a particular job (for example, a Java programmer), as opposed to 3 or 4 year study programs that educate a student for a specific profession in a particular field (e.g. Information Technology Engineer) . In this sense, the program is a set of courses that provide students with qualifications for a particular job within 3 to 12 months. While study programs of basic and master studies, for a period of three or four years, train a student for jobs in one profession (for example, software engineering), a short program provides within 12 months a student for a particular job within a profession (eg, Java programmer).

Depending on the complexity of the work a student is studying, a short program can provide a qualification for a particular job, within a profession, at the 5th, 6th or 7th level of the European Qualification Framework (EQF) [4].

As general goals of PT&SCHE are to support widening access to high education, and making it more relevant and adaptable to the labour market, it was important to:

1. define the legal framework supporting the development and implementation of part-time (PT) studies and short cycle (SCHE) studies in higher education in Serbia,
2. define and develop online and face-to-face (F2F) learning methodologies and technologies for PT&SCHE, suitable for adults working students and
3. develop pilot implementations of five PT&SCHE online and face-to-face programs and at the end to analyze project outcomes and effectiveness of the

[1] This paper is the result of the Erasmus+ PT&SCHE project with project reference number 561868-EPP-2015-1-EE-EPPKA2-CBHE-SP sponsored by the EU

proposed legislation, adopted pedagogical and technological solutions in order to review the guidelines of PT&SCHE studies based on gained experience.

Based on existing methodologies, technologies and best practices for PT&SCHE studies, in European Higher Education Area (EHEA) and European Association of Institutions in Higher Education (EURASHE), SCHE implementation and best practices in member countries was analyzed [5]. Suitable models and online face-to-face (F2F) learning methodologies and technologies for PT&SCHE studies will be adopted and developed. Project participants from Programme Countries are not only involved in the analysis and transfer of best practices from EU, but they are also our advisors for choosing and adopting the most relevant pedagogical and technological solutions by giving advices in five pilot implementations of online and face-to-face PT and SCHE programs.

As the member of the project consortium, Belgrade Metropolitan University (BMU) was given the task to implement one of first pilot SCHE programs in Serbia. After an analysis of current labour market needs, BMU decided to develop a pilot SCHE program named "Programming in Java" with the aim to develop and test the most suitable methodology for SCHE programs. SCHE program "Programming in Java" was developed under the special control of project. This SCHE has passed also the standard internal review of BMU. In addition to the carefully prepared curriculum, lecturers and tutors were carefully selected from faculty members of BMU. This work represents evaluation of applied methodology of whole eLearning process during the pilot phase of realization program on BMU with the aim to define in what extent the proposed methodology was successful and what is to be changed in the future. This paper is organized as follows. Section 2 describes technical details of curriculum and training details of the pilot online program "Programming in Java". Section 3 describes the teaching methodology applied on short cycle program. Section 4 shows the evaluation of applied methodology. Section 5 concludes the paper.

2. THE CURRICULUM

Based on the European ICT Professional Profiles [6], which defined 23 work profiles, i.e. jobs at the first two hierarchical levels, leaving the third level to be define by ICT companies and ICT educators. According to this, BMU specified the job profile: "Java programmer" at the third level and launched the SCHE program "Programming in Java" to provide necessary competences its learners aiming to work as Java programmers. "Java Programmer" is the specialization of the work profile "Developer", specified at the second level of ICT work profiles.

European ICT Professional Profiles specifies, for each workplace, the following: job description, performance, main tasks and competencies, in the form of e-competences defined in the document *E-Competence Framework (e-CF)* [7]. For the *Developer* position, it has been defined that it must have five e-competencies (B.1, B.2, B.3, B-5 and C.4) listed in the *E-Competence Framework document (e-CF*) [7]:

1. B.1. Design and Development
2. B.2. Systems Integration
3. B.3. Testing
4. B.5. Document Production
5. C.4. Problem Management.

The short program of the BMU called "Programming in Java" educates students get competences for work profile "Java programmer" within 12 months in accordance with the following de facto standards:

- E-Competence Framework (e-CF) [7]
- European ICT Professional Profiles (CWA 16458) [6]
- Foundational ICT Body of Knowledge [8]

The program content, i.e. body of knowledge (BOK) of SCHE program "Programming in Java" has been developed having in mind, the following recommendations of professional organizations IEEE Computer Society and American for Computing Machinery (ACM):

- Computer Science Curricula 2013 [9] - Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, December 20, 2013,
- Information Technology Curricula 2017 - IT2017 Curriculum Guidelines for Baccalaureate Degree Programs [10],
- SWEBOK V3.0 [11] - Guide to the Software Engineering Body of Knowledge,
- Enterprise ITBOK [12].

SCHE Program "Programming in Java" enables:

- Employed students to study and work simultaneously, because teaching is done partially online, i.e. via the Internet using the BMU eLearning system, and partially F2F (workshops);
- Unemployed students to qualify for Java developer, even in a shorter time than 12 months;
- Practical work in BMU computer classrooms within the workshops, for a total duration of 32 days (alternatively, students who cannot realize workshops on BMU can also realize them online);
- A two months internships in companies developing Java applications, at the end of the program.

The level of knowledge and capabilities of the "Java programmer", who completes this program: the initial, but with the possibility of rapid promotion after acquiring a relevant work experience, because the program content of the short program allows acquiring knowledge to the required programmer at the intermediate level of knowledge and skills.

By analyzing the curriculum of existing courses of academic programs of bachelor degree programs of BMU, their learning objects (LOs) of interest have been

identified, i.e. those who give the required competencies. The curriculum of SCHE program "Programming in Java" is determined by the mapping of relevant parts of the BMU Bachelor's degree programs.

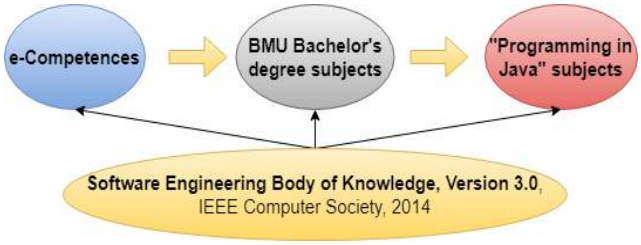

Figure 1: Procedure for determining the subjects of the short program "Programming in Java" and their program contents, as well as the learning outcomes

Figure 1 shows the procedure for development of SCHE Program "Programming in Java" curriculum. It is implemented in three stages where each of them has one or more courses:

1. **Preparatory stage** – aiming to prepare trainees for programming training, providing the some basic knowledge in IT systems and programming fundamentals. The following courses are included:
    a. KI101 Introduction to IT systems
    b. KI102 Fundamentals of Programming
2. **Learning stage** – providing programming knowledge and skills to trainees, as well as some basic soft skills that might be useful for their employability. This stage includes:
    a. KI103 Java 1: Fundamentals of Programming
    b. KI104 Java 2: Object-oriented Programming
    c. KI105 Java 3: GUI Programming
    d. KI201 Java 4: Data Structures and Algorithms - Part A
    e. KI202 Java 5: Data Structures and Algorithms - Part B
    f. KI203 Java 6: Advanced Java Programming
    g. KI204 Java 7: Java Enterprise Edition
    h. KI205 Java 8: Java Programming on the Android platform
    i. KI206 Software Development Process and Methodology
    j. KI301 Software Construction
3. **On-the-job training stage** – providing trainees one course (KI401) and one internship (KI402):
    a. KI401 Software Development Project
    b. KI402 Professional Internship - Java Developer

Figure 2 shows the table with course hours of all listed courses.Figure 3 shows courses offered as electives. These are selected online courses of regular BSc programs of BMU.

In creating a short program, several IT firms, especially those dealing with software development using Java technology, have been consulted to ensure that this short program is created by "tailor-made employers" who need to hire students who complete this program. The final quality indicator of realized short program is the percentage of student employment in the first three months after the completion of the short program. For each of the above defined courses, program contents and learning outcomes are defined, so in the end, they provide the required competencies for the Java programmer work profile.

#	Course	Duration (Days)	Teaching Days	Workshop Days	Teaching Hours	ECTS
1	Introduction to IT systems	15	14	0	42	4
2	Programming Fundamentals	11	8	2	30	3
3	Java 1: Fundamentals of Programming	17	14	2	48	5
4	Java 2: Object-oriented programming	13	10	2	36	3
5	Java 3: GUI Programming	17	14	2	48	4
6	Java 4: Data Structures and	16	13	2	45	4
7	Java 5: Data Structures and	16	13	2	45	4
8	Java 6: Advanced Java Programming	15	12	2	42	4
9	Java 7: Java Enterprise Edition	24	21	2	69	7
10	Software Development Process and	18	15	2	51	5
11	Software Construction	21	18	2	60	6
12	Elective Course	24	23	0	90	8
13	Intership (8 weeks)	40	0	0	0	3
	TOTAL:	**247,0**	**175,0**	**20,0**	**606,0**	**60,0**

Figure 2: Online teaching hours and ECTS of the courses of the SCHE program "Programming in Java"

No.	Elective online courses (Students select one course)	Number of Hours	ECST
1	CS323 C/C++ Programming Language	90	8
2	CS322 Programming in C#	90	8
4	IT381 Information Security and Safety	90	8
5	IT150 Database	90	8
6	SE321 Quality Assurance, testing and maitenance	75	8
7	IS345 Digital Content Management	75	8

Figure 3: Electives courses of the SCHE program "Programming in Java"

The program provides 606 hours of active teaching and 60 ESPB, i.e. credits that can be recognized if the student decides to enroll later on one of four BSC degree programs of BMU: Software Engineering, Information Technology, Computer Games and Information Systems. In the normal duration of the 12 month program, students will have: nine months for active learning, two months of internship and one month for annual leave. Learning is performed in blocks, i.e. according to the "course-by-course" system. It is planned that on each course, a student spends at least three hours a day. Including Saturdays (or 18 hours per week) using the e-Learning System of BMU. Figure 4 shows the table with start and end days of major groups of training activities of the SCHE program "Programming in Java", lasting, in total, 12 months and providing 60 ECTS.

	Start Date	End Date
Introdutory courses	1.10.2017	5.11.2017
Online training courses	7.11.2017	13.7.2018
Summer Holidays	15.7.2018	5.8.2018
Internship (8 weeks)*	8.8.2018	28.9.2018

* Student has to realize its 8 weeks intership in this perod

Figure 4: Start and end dates of training activities

Learning material provided by the BMU's e-Learning System contains web pages with multimedia contents (text, figures, Java codes, video and audio content), but also a PDF version of each lesson, the textual part of each lesson in PDF format (as an additional teaching material), and the student is not required no additional literature (although it is always useful to use other sources of knowledge). In addition to online classes, a two-day workshop in the computer classrooms of the University is planned for each course. All students get work assignments (as home works) and one project per course. If a student is prevented from participation in workshops, this/her workshops can also be organized online. After the completed project and all assignments and tests that are being evaluated, the student takes the exam of each course.

After successfully completing professional practice on every course, the student receives the Certificate of Successful Completion of the Short Program, with an appendix containing the obtained grades on all subjects of the Short Program with a list of course learning outcomes and competences.

3. TEACHING METHODOLOGY

The Java Programming training program uses the following structure of activities (Figure 5):

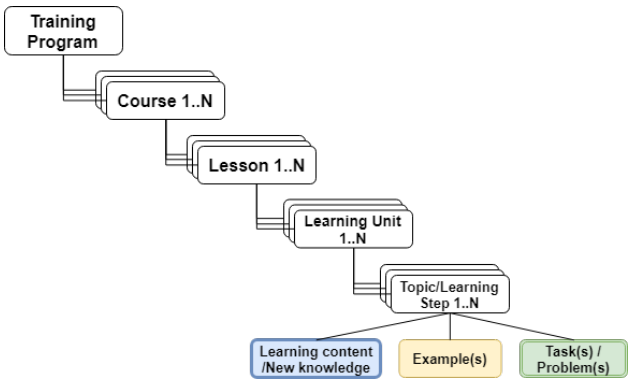

Figure 5: The structure of Java Programming Training Program

The Training Program consists of Courses. Each Course has a different number of Lessons. A Lesson describes the objectives, procedures, materials and evaluation for a particular class or a particular day. Each Lesson consists of one or more Learning Units. A Learning Unit provides a new and short concept depending on the content. Each Learning Unit has a clear learning objective regarding to change the level if knowledge and skills of trainees. A Learning Units consists of one or more Topics. A Topic or Sub-Topic is an atomic learning concept with a clear learning outcome. Especially for SCHE programs BMU decided to implement a "Step-By-Step" learning methodology. Each Step provides a small chunks of new knowledge to trainees, related to a Topic, and immediately followed by one or more given examples (solved problems) and by tasks or (unsolved) problems that trainees have to solve by using this newly acquired knowledge.

Figure 6 shows Learning Units with their Thematic Steps (Topics), each with three types of sub-steps:

- New knowledge acquisition (a learning concept) – a small chunk of new knowledge or a new concept
- Presentation of examples of solved problems demonstrating use of new knowledge
- Tasks (unsolved problems) to be accomplished by each learners – given problems to solve

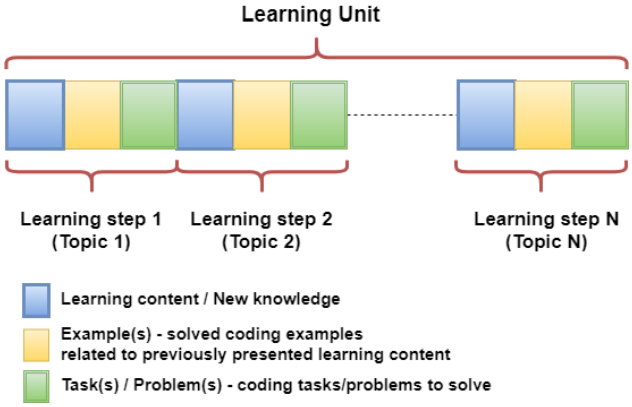

Figure 6: A Learning Unit and its steps and sub-steps

The "Step-By-Step" learning methodology has been developed by BMU for SCHE programs aiming to provide high level of applied knowledge (Bloom Level 3). A trainee learns how to implement newly acquired knowledge, as a trainee must demonstrate his implementation capability by solving given problems. The granularity of Topics/Learning Steps should be as small as feasible, in order to achieve high level of integration of knowledge acquisition and its application activities. A Learning Path of a trainee is a Learning Process leading to the Learning Goal (achieving an appropriate knowledge and capability level) consisting of many Learning Activities related to hierarchically structured knowledge (Learning Units/Topics/ Sub-Topic).

BMU has structured its learning materials according to requirement of the "Step-By-Step" methodology. BMU has a large repository of Learning Objects (LOs) ("any entity, digital or non-digital, that may be used for learning, education or training" [13]) – one for each Topic or Sub-Topic. Use of Learning Objects (LO) with fine granularity, allows easy configuration and generation of new learning material specifically created for a specific Study or Training Program. Use of LOs with fine granularity provides also a high reusability of the existing and previously developed LOs. An appropriate Learning Material may be efficiently developed for new Curriculum with high degree of reusable learning objects. Implementation of the concept of LOs, with fine

granularity, BMU is able to create in few weeks the learning material for “Programming in Java” training program and its curriculum. Online delivery of learning material by using BMU eLearning System, provides an efficient mechanism for delivery of learning materials to all trainees, and their additional interaction using its interactive activities.

4. EVALUATION

During the pilot phase, through all courses, learning activities were logged in the eLearning system (LAMS v3.0) including: time spent on learning online materials, the number of solved tasks and assessments, as well as other interactions with the resources provided by eLearning system. Information system of BMU (ISUM) tracks all marks and other data about progress of students by course, such as: number of points per tests and projects, the number of points scored in the exam and the final grade. In the process of evaluation is included 8 trainees who passed the entire training process.

Five trainees gave up at the beginning of the course. Their reasons for giving up are of personal nature, so we will not take them into account during the analysis. It is important to note that at the time this paper was written (September 2018), only two students successfully passed all the exams in the first test period, and six more has to pass the correction exams. In order to analyze relatively poor results in the first test period (only 25% successfully passed all exams), we analyzed the use of learning materials and other activities provided by the eLearning system in order to determine the extent to which the system was used and what resources were most used.

Comparing the time spent in learning and number of failed exams, it is evident that trainees T3 and T8 spent less time in learning from others who have fewer failed exams. In this part, it is very important in some way to motivate students to use the e-learning system to a greater extent.

Table 1: Time spent in learning by trainee

	Number of failed exams (max 13)	Projected learning time in hours	Time spent in learning
T1	0	606	780
T2	3	606	585
T3	8	606	120
T4	0	606	980
T5	2	606	780
T6	3	606	330
T7	3	606	300
T8	8	606	80

At the end of the evaluation, trainees were asked to complete a questionnaire shown in Table 2. Prior to the questionnaire, the participant had to mark the place where the workshops were held (Nis or Belgrade). We identifies 5 trainees from Belgrade and three trainees from Nis.

Table 2: Trainee satisfaction questionnaire

QUESTIONS	MEDIAN ± STD
Q1: How satisfied are you with the work of the instructor during the duration of the course?	4 ± 1.05
Q2: How satisfied are you with the realization of the course?	4 ± 1.09
Q3: How satisfied are you with the level of knowledge that you acquired after completing the course?	4 ± 1.11
Q4: How satisfied are you with the quality of teaching materials?	4 ± 0.99
Q5: How satisfied are you with the organization of teaching materials by the "step by step" rule?	4 ± 1.09
Q6: How much is the weight of the teaching material adequately distributed?	3.5 ± 0.7
Q7: How satisfied are you with the LAMS system?	5 ± 0.99
Q8: How satisfied are you with the use of the LAMS system in the form of tests and other learning activities?	5 ± 0.48
Q9: To what extent are practical examples relevant to the material?	4 ± 0.83
Q10: To what extent is it necessary to add materials to external resources?	3.5 ± 0.83
Q11: If it is necessary to add resources to the teaching materials that would be?	/
Q12: Assess the adequacy of teaching materials in line with the latest IT developments	3.5 ± 0.99
Q13: Assess the quality of the applicability of the acquired knowledge after the course passed?	3 ± 1.11
Q14: How satisfied are you with the quality of the skype consultation?	4 ± 0.93
Q15: How satisfied are you with the quality of mail consultation?	4 ± 1.16
Q16: How satisfied are you with the quality of the workshops held during the course?	5 ± 0.7
Q17: How satisfied are you with the number of classes scheduled for the course during the course?	3 ± 0.86
Q18: Choose the model that you find most suitable for the realization of workshops (once a week, once in two weeks, half and at the end of the course, at the end of the course, other)	/
Q20: How satisfied with the compatibility of exams tasks and teaching material	5 ± 0.7
Q21: Choose the model that you find most appropriate for the course that you attended (a time longer course, a less intensive course or a more intensive course, a shorter period of time)	/
Q22: How satisfied are you with the support of the services of the Metropolitan University?	4 ± 1.4
Q23: Which areas in this course do you consider necessary to further improve:	/
Q24: Here you can write your suggestions, compliments or possible comments about the course	/

The questionnaire used the five-point Likert scale, ranging from the lowest point (1) to the highest (5), and additional essay questions. Questionnaire also provided

an option to enter comments in order to give their suggestions and comments in the form of an open-ended question. Questions Q1-3, Q14-17 and Q22 had the goal to give answers to the questions about the satisfaction of the course, instructors, organization and supports from BMU services during the course. Analyzing those results students expressed that are satisfied with instructors (Q1) 4 ± 1.05 (with the median 4.00) and with realization (Q2) and level of knowledge (Q3) that are acquired after completing the course (respectively 4 ± 1.09 and 4 ± 1.11 with the median 4.0). Also, the participants answered that they are satisfied with the method of carrying out Skype consultations (Q14), 4 ± 0.93 (with the median 4.0) and a little less mail consultation (Q15) 4 ± 1.16 (with the median 4.0), which is logical in relation to the type of course where it is sometimes difficult to explain the problem in writing. Trainees consider the workshops as a very useful especially that it was organized in the traditional way in classrooms (Q16), 5 ± 0.7 (with the median 5.0), but consider that there is insufficient number of traditional classes of workshops that are necessary for an adequate understanding of the material (Q17), 3 ± 0.86 (with the median 3.0).

Some questions has a relatively high standard deviation due to a limited number of trainees, but at this stage we can conclude that trainees are satisfied with quality (4 ± methodology (4 ± 1.09) of learning materials thru Q4 and Q5, but also the trainees opinion is that the difficulty of the teaching material is not adequately distributed, 3.5 ± 0.7 (with the median 3.0), although they think that the examples (Q9) and exams (Q20) are relevant to teaching material 4 ± 0.83 (with the median 4.0). Trainees are absolutely satisfied with BMU eLearning system (Q8) 5 ± 0.99 and they agreed that tests and other learning activities are of the great help in learning process (Q9) 5 ± 0.48 (both with the median 5.0).

Lower satisfaction of the students is observed in the assessment of the conformity of learning materials with IT trends (Q12) 3.5 ± 0.99 and the applicability of the acquired knowledge after the course (Q13) 3 ± 1.11. We believe that such results may be due to insufficient practice of the participants and overloading information that needs to be channeled through practical work. Certainly, BMU has the task of further improving teaching materials in order to increase the adequacy.

Students responded positively to “Programming in Java” short cycle program even through their comments thru Q11, Q18, Q221, Q23 and Q24. Students considered the course to be useful and interesting:

“Program is good”,

“It's a good and interesting course”,

“The program is very useful and provides a lot of practical knowledge for future employment.”

Additional comments and suggestions points on other questions of an essay questionnaire are generally similar and we can conclude that it is necessary to improve:

“Everything is good, but there is a lack of traditional work in the classroom with instructors”,

“More teamwork is needed”,

“The course needs to be slower and less intense.”

Comment such as: ”Links to online resources would be helpful” indicates that learners also consider that additional online resources would be helpful if they were linked to LO.

Conclusions that can be made for the improvements of short cycle “Programming in Java” program from given results are the following:

- Workshops must be organized more often and should be longer
- It is important to provide additional resources to LOs or assigned problems, such as Internet resources and
- The extent of the course and its intensity should be re-examined.

5. CONCLUSION

This work deals with evaluation of short cycle program "Programming in Java" implemented as a pilot program of PT&SCHE project and aims to provide one critical source of information in the order for the future improvement of courses, curriculum, and instructor's pedagogic efforts. Today, everyone can find all possible information on the Internet. However, if the learning process is routed and controlled by an appropriate technology and methodology as implemented in the short program "Programming in Java" realized as pilot program of PT&SCHE project on BMU, then the learning process is much faster, easier and more effective as shown in conducted evaluation. Therefore, future analyzes and improvements will be directed at what is considered by trainees as a lack in the current implementation of program, such as the intensity of the course with the increasing of the work with instructors.

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IMPLEMENTATION OF ONLINE PILOT SHORT CYCLE PROGRAM WEB APPLICATION PROGRAMMER

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Abstract: *Short cycle programs are a new form of study in higher education system of the Republic of Serbia. The realization of such programs is a great challenge because the curriculum and teaching methods of such programs must be adjusted with the goal and the duration of study that is in this case much shorter than in regular study. This paper describes the implementation of the pilot online short cycle program Web application programmer in School of Electrical and Computer Engineering of Applied Studies in Belgrade.*

Keywords: *Short cycle program, teaching of Web programming, E-Learning, online*

1. INTRODUCTION

Technological advancement has caused changes in the way people live. In the past, the learning process was preparation for professional work and took place during a period of life before employment. However, today, people have to improve throughout their entire life, and often re-qualify because the labor market changes rapidly, with some jobs completely disappearing, or the number of needed people dropped in some fields, while new jobs appear in some other areas. In addition to the changes that are caused by the labor market, it is often necessary that people in the same workplaces have to be trained to use new technologies. So lifetime learning is really necessity for most people.

In response to these needs, the Law on Higher Education of the Republic of Serbia, adopted in September 2017, envisioned short cycle study programs. This form of study aims to enable re-qualification of people who have completed studies (have 180 ECT or more) and can't find a job in their profession or have completed studies in the field of short cycle program a long time ago but they do not manage to apply new technologies in their field. The point is to enable people in short time to learn necessary skills. To make this possible, the short cycle program must be well designed and implemented.

The School of Electrical and Computer Engineering of Applied Studies in Belgrade has created four short cycle programs. Two online programs in the field of computing: Web application programmer and Computer Programmer/Analyst, and two face to face programmes: Vehicle diagnostics and Professional development of professors and teachers. In this paper the implementation of online short cycle program Web application programmer is described.

The goal of this program is to train a student to master and implement web technologies in order to create web applications. This short cycle program has five courses: Web Design, Standard User Interfaces, Object Programming, Internet Programming and Visual Programming Techniques.

2. ORGANIZATION OF THE PROGRAMME

School of Electrical and Computer Engineering of Applied Studies in Belgrade has an extensive experience in distance learning. Since 2012/13 school year our school has a distance learning study program The New Computer Technologies. A lot of learning materials were developed for the realization of online teaching, and during the years those materials were changed and adjusted to online learning along with improvement of the whole teaching process. More details about this program can be found in [1].

This experience helped a great deal implementation of the program. Of course a lot of changes had to be made because courses in the short cycle program had to be more practical, and performed in shorter time then the courses for regular students. In preparing materials for short cycle programs and in general in their organization, it should be taken into consideration that program participants have different backgrounds, as some of the students are from technical professions and have previous knowledge, while some students have previous education in other areas. That is why it is difficult to make a choice of courses and make the syllabus of courses so that all students can successfully prevail the program. Also, emphasis on these courses had to be on the practical work of students, while the theoretical aspects were reduced to a minimum. That is why new syllabus and learning materials had to be created for realization of each course according to this demands.

Short cycle program Web application programmer was organized at School of Electrical and Computer Engineering of Applied Studies in Belgrade in 2017/18

school year. A lot of people were interest in this program, and we received in just three days three times more applications of candidates than we could enroll. It was not easy to choose between registered candidates, so as we thought that a more uniform level of knowledge of the received candidates would be the best criteria for selection. Image 1 shows that all selected candidates have completed some of the technical faculties or the Faculty of Mathematics, and they all have some basic knowledge of working with computers.

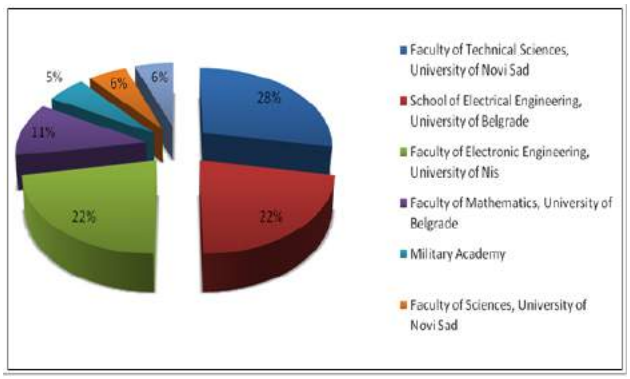

Image 1: Previous education of enrollment of students

Eighteen students from the all over Serbia were enrolled to short cycle program Web application programmer Image 2. Students did not pay tuition fee.

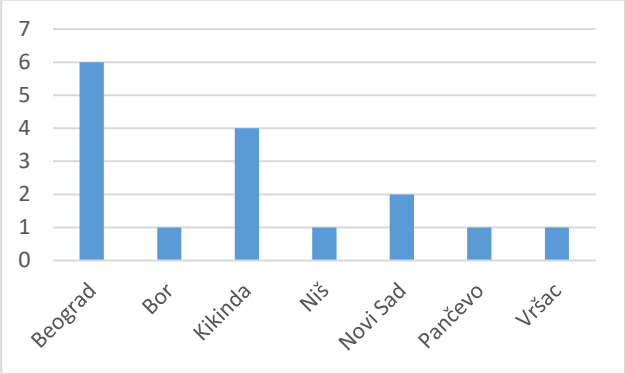

Image 2: Place of residence for enrollment of students

In the Introduction of this paper the list of courses was given. The goal of this selection, and of the program in general, is to prepare students step by step to develop web application starting with creations of static web sites, then making dynamic websites. Course Object Programming serves as an introduction for more advanced courses. In course Internet programming students develop complete web applications using Java technologies. The course Visual Programming Techniques trains students to use Microsoft tools to create web applications.

The program was organized so the courses were sequential. First course was Web Design that does not require any special previous knowledge. Then Standard User Interfaces, Object Programming, Internet Programming and Visual Programming Techniques in given order because student had to master the knowledge of previous course to follow next course. Every course had the same dynamics. Four days in the week teachers posted learning materials on Moodle platform with an explanation of what students are expected to master in that lesson or in which order to use the material if they were placing more files in the one lesson. Friday was reserved for consultations both electronic and consultation in School. Of course every day students could communicate with teachers or other participants via private messages or forums (Image 3). Every week students had assignments which they had to complete during the weekend. Those assignments were web applications were student applied knowledge acquired in lessons from the previous week.

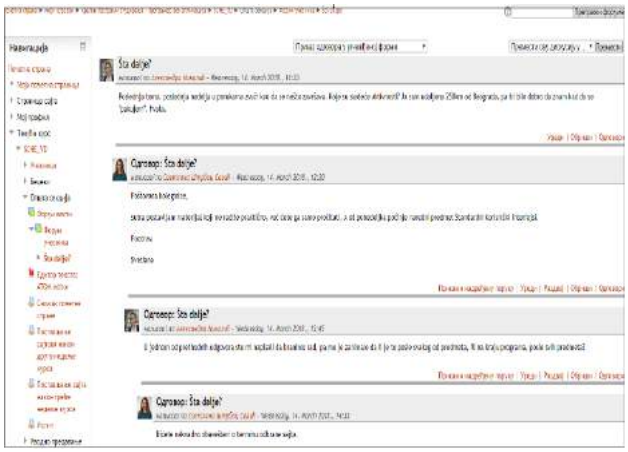

Image 3: Example of online discussion via forum of participants

All the courses were held online, only first workshop was organized at the School. This workshop has been organized before program started. Students were informed of the organization of courses, and they got their accounts on both Moodle and Odoo platform and they got a brief training of using of both platforms. They were offered to attend to workshops or consultation in School but since most of them work and some of them are not from Belgrade we had no such demands.

3. TECHNICAL REALIZATION OF THE PROGRAMME

One of the prerequisites for the realization of the program was the choice of Learning Management System (LMS) to be used. Within the framework of Erasmus + project "Introduction of Part-Time and Short Cycle Studies in Serbia", a LMS Odoo has been developed and installed on School server, but it was not completely finished and adjusted to needs of teachers and student until the beginning of the program. For this reason, LMS Moodle was used, although all the learning materials are also posted on Odoo LMS. LMS Moodle has been and still is used in our school since the beginning of the school year 2007/8, when school had provided Learning Management System (LMS) server and opened its website at LMS Moodle [2]. Since that year, the school has been continuously working on the administration and updating of this site. LMS Mooodle is used on the program for regular lessons, exercises, consultations and assessment test over the Internet. For more comprehensive audio-video teaching materials, LMS Moodle system allows links to YouTube and other pre-reserved addresses on the Internet, with the previously developed and set audio-video lessons / instructions for exercises. Moodle system tools also have integration with blog tools, current social networks and other Web tools, which are given to students for working

on their homework and seminar papers. In addition to its built-in and integrated Web tools and other multimedia content, Moodle system contains a database of students, teachers, classes of objects, their topics, activities and resources, and its user Web portal [3].

On the first workshop students were trained to use LMS Moodle, and they all got their accounts on the platform. One of the advantages of using Moodle was that some students were already familiar with using Moodle.

For every course on the program new course was opened in LMS Moodle. In image 4 the structure of the course Web Design is visible.

As it was mentioned earlier in the paper new materials were created for every lesson of all five courses. The template of developed learning material was the same for all courses. All the lessons have as least one pdf document in a specific template, and some lessons have other additional learning materials: demonstrations, examples etc.

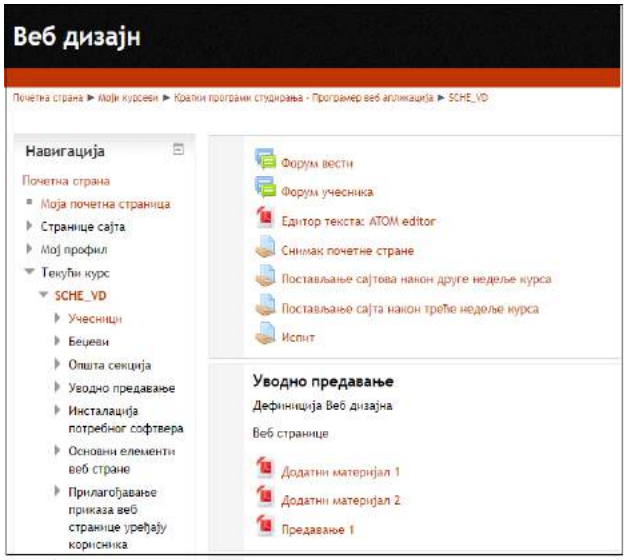

Image 4: Screen shot of course Web design

4. KNOWLEDGE TESTS

Every course of the program had assignments every week. Those assignments were practical mostly, depending on the subject, creation of web applications. Assignments were reviewed and evaluated by teachers. Students got comments on their application, and recommendations for their improvement. Of course students could ask teachers or other students for help on some issues while they worked on the assignment. During the course students got points, but whey had to take exam for getting a grade of the subject. Every subject on the program had different number of points that students could get during the realization of the course. Teachers insisted that student respect deadlines because as it was previously mentioned it would be very difficult to keep up with next demands on the same course or the following course. Of course some flexibility existed. Because almost all the students of the program are employed.

Some courses included online tests. On Image 5 is one example of online test on Object programming course. Exams for each course were held at School and each student had to come to School and do the exam on every course of the program. All the exams were practical demonstrations of knowledge through creation of appropriate web applications and a discussion with the professor.

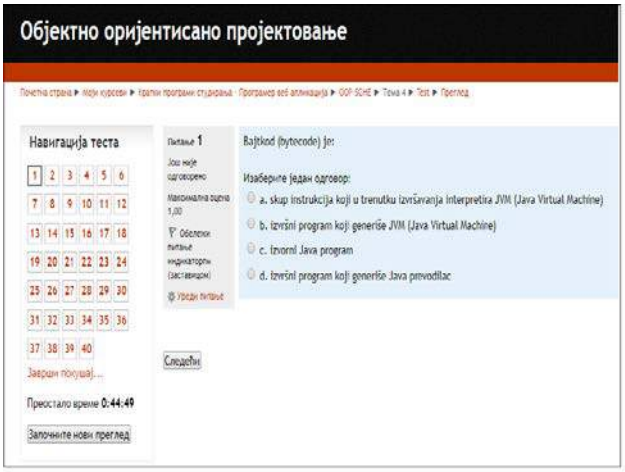

Image 5: Example of online test

Students are allowed to take the exams in every examination period. Number of times for student to take an exam is not limited. For students who are not from Belgrade special exam schedule was made so they didn't have to travel to Belgrade more times in one exam period. Of course all students could choose if they want to take exams in regular exam period or in the exclusive term.

Until this moment eight students have successfully finished the program and they already have certificate of successful completion of the program. Twelve students, including eight students who finished the program, were active during the whole program, and we expect that they will pass the rest of the exams in October exam term. Some of those four students have already passed few exams. One student dropped out on during the second course. Other nine students were not constantly active, but they still want to finish the program. Most important is that they are satisfied with the knowledge they got, but they all think that it was very hard for them to do the assignments every week the whole semester with no beak between the courses. Most of them thing that the program should last longer because it is very demanding.

5. CONCLUSION

Shot cycle program Web application programmer provides rapid adoption of knowledge in web programming. The program is very demanding and students must be very motivated and disciplined to follow the dynamics of the program. Based on the experience acquired during the pilot program, analyzes and improvements will be made considering learning materials and some organization issues.

Web application programmer successfully preformed pilot short cycle program. After finishing this program, students get one set of Web programming skills that gives them a lot of options to find a job, and gives them the basis for further improvement.

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