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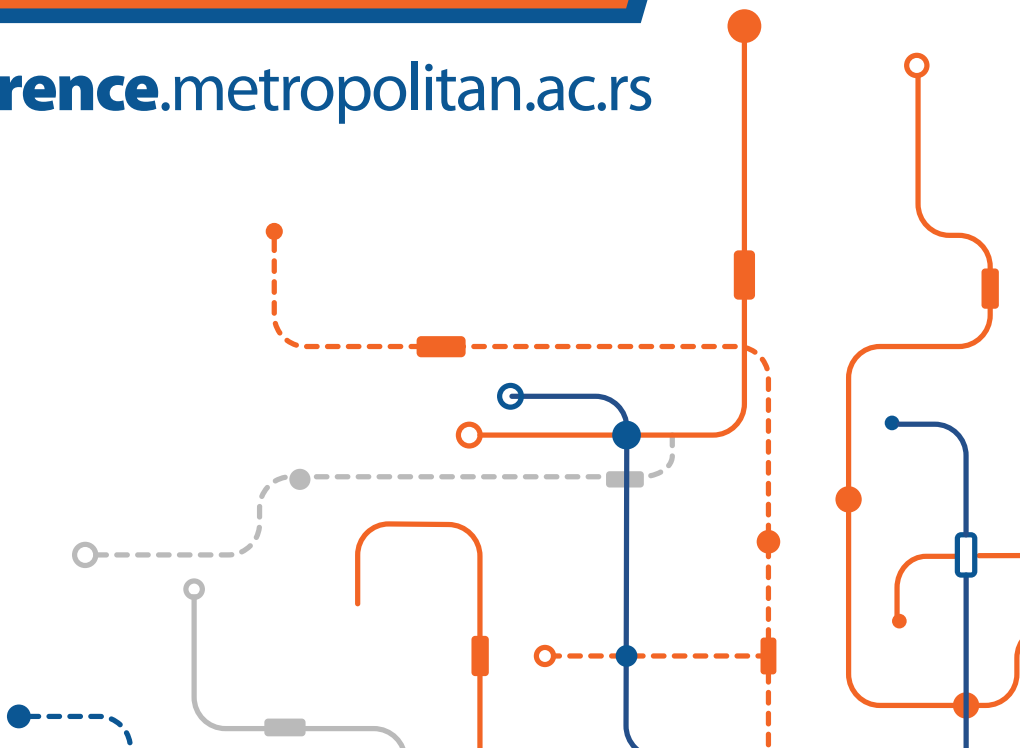

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The Conference Chair:
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The official language of the eLearning-2017 Conference is English. English will be used for all printed materials, presentations and discussion.

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OPEN EDUCATIONAL RESOURCES – KNOWLEDGE FOR ALL

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Abstract: *This paper gives an overview of Open Educational Resources (OER), their features and development, some challenges and initiatives, and the current situation related to OER in Serbia. OER are publicly available educational materials, released under intellectual property licenses that permit their free use and reuse. They promote institutions and individuals who publish them, and are suitable for creation of content for people with special needs. The OER concept has been embraced by major world universities, and several global, regional and national OER initiatives have emerged. In Serbia and the Western Balkans region in general, the importance of this concept has not yet been fully recognized. Existing regulations in Serbia open the possibilities for the development of OER, but awareness of the importance of OER, opportunities they offer, methods of development and implementation, and the use thereof needs to be raised.*

Keywords: *Open educational resources, Technology enhanced learning, Creative Commons licencing*

1. INTRODUCTION

The twentieth century brought some substantial changes in learning methodology. Learning in classrooms where teachers shared their knowledge with students by delivering lectures has been supplemented by a new approach. Development of new communication possibilities opened the path to distance learning – delivery of knowledge to students at a distance. Information and communication technologies (ICT), and the development of internet in particular, played an especially important role in this approach. Distance learning is nowadays in essence being delivered online, within the framework of Technology enhanced learning (TEL), a concept which, in its broadest sense, encompasses all educational activities supported by ICT. The main goal of TEL is enhancement of learning quality and learning results, design of efficient interactive learning environments and initiating changes in existing practices by introducing innovations.

Distance learning brought a change in the role of the students within the learning process. While they were historically basically passive recipients of knowledge, nowadays they are expected to take an active role in the educational process. Memorizing of facts within the formal educational cycle, from elementary school to university, is being replaced by an ongoing process of knowledge acquisition and renewal, throughout the entire professional career.

In addition to that, besides formal learning, managed and certified by educational institutions, two new forms of learning have emerged: non-formal and informal. Non-formal learning may still be offered by an educational institution, but it is usually not certified by a diploma or some similar certification. By contrast, informal learning is not managed by an institution, but rather by the individual learner him/herself [1].

A major step forward in informal learning in the 21st century has been the emergence and development of open education. It has been acknowledged that modern societies abound with educational inequalities, regardless of whether they belong to a developed, developing or underdeveloped country, while, on the other hand, world's knowledge should be regarded as a public good, for everyone to share, use, and reuse. The open education movement offered a possible answer to educational inequality [2].

An interesting historical example in the 1970s was set by the artist Joseph Beuys a teacher at the Düsseldorf Academy of Art, who is considered to be a predecessor of open education. Critical of the exclusionary admissions policy at the Academy, Beuys decided to accept all students who wished to attend his classes, whether they were enrolled or not. When the Academy's administration criticized him for that, he organized students to protest and occupied with them the Academy's admissions office. As a result, Beuys was fired from his position in 1972. Two years later, in 1974, Beuys established the Free International University for Creativity and Interdisciplinary Research with writer Heinrich Böll. They published together a manifesto, stating that the goals of the University are to recognize, explore, and develop the creative potential hidden in everyone. In 1978, after a lengthy lawsuit, the dismissal of Beuys from the Academy was declared illegal, and he was once again allowed to use the title of Professor, although his teaching contract was never reinstated. However, Beuys got back his old studio at the Academy, which he immediately put at the disposal of the Free International University [3].

This paper gives a brief overview of resources used in open education, namely, open educational resources (OER). In the next section, the basic features of OER are discussed, while Section 3 outlines their development, and Section 4 tackles the sensitive issue of intellectual property rights. Section 5 gives an overview of some international and regional initiatives related to OER, whereas Section 6 summarizes briefly the current situation in Serbia. The paper closes with a short conclusion.

2. MAIN OER FEATURES

The William and Flora Hewlett Foundation, which has been one of the major promoters of and contributors to open education, defines OER as teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and repurposing by others. OER include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge [4].

OECD (Organization for Economic Co-operation and Development) defined OER as digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research. OER include learning content, software tools to develop, use, and distribute content, and implementation resources such as open licenses [5].

According to UNESCO (United Nations Educational, Scientific and Cultural Organization), OER are teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions [6].

The Cape Town Open Education Declaration defines OER as freely shared through open licenses which facilitate use, revision, translation, improvement and sharing by anyone, published in formats that facilitate both use and editing, and that accommodate a diversity of technical platforms. Whenever possible, they should also be available in formats that are accessible to people with disabilities and people who do not yet have access to the internet [7].

The WikiEducator OER Handbook defines them as educational resources (lesson plans, quizzes, syllabi, instructional modules, simulations, etc.) that are freely available for use, reuse, adaptation, and sharing [8], and OER Commons, as teaching and learning materials that you may freely use and reuse, without charge, and which often have a Creative Commons or GNU license that states specifically how the material may be used, reused, adapted, and shared [9].

The main advantages of OER are the high level of accessibility of learning materials, continuous and easy modification of content once they have been created, and reduction of learning costs. They are convenient for creation of content for people with disabilities, and promote institutions and individuals who publish them.

OER offer benefits to different related groups: students, researchers and educators. They are helpful tools in revising courses and keeping them up to date, thus increasing the efficiency of learning, and they also offer to potential students an insight to their future university. Among the benefits for students is the reduced costs due to their availability, while at the same time they bring down the costs of course development.

Among the benefits offered to researchers and educators is the fact that OER stimulate and improve the quality of education, help gaining access to the best possible resources, promote scientific research and education, create more flexible educational materials, lead to new pedagogical practices, and allow researchers and educators to share expertise and curricula with other faculties/institutions. They also increase exposure and reputation of the faculty that uses OER to share their work, their research findings and their course structures with others working in the same field. The institution which supports OER increases its publicity, reputation, recognition and prestige among other institutions, deepens connections and collaboration with other colleagues, decreases duplication of work/research, and helps its faculty to become less dependent of publishers.

Summarizing features from the aforementioned definitions, OER can be defined as educational content, research materials, and best practice examples, freely accessible in electronic format, published under licenses that allow for their free use, reuse and distribution, targeted both for students and self-learners.

More specifically, OER materials can be curricula (syllabi, content modules), course materials (textbooks, assignments, simulations, learning objects, virtual labs), collections (journal articles, e-books, art galleries, video libraries) and tools (software, calculators, analytics).

The main features of OER can also be summarized within the 5R OER Framework:

- Retain – make your own copies
- Reuse – use in a wide range of ways
- Revise – adapt, modify and improve
- Remix – combine two or more
- Redistribute – share with others

There are, of course, some criticisms of the OER movement. One of them is related to the limited scope of the OER movement, and its failure to connect globally. According to this view, OER need to raise awareness of their power and potential and reach beyond the communities of interest that they have already attracted, or they will fail to support the majority of countries to improve their educational goals [10]. The altruistic motives, which are typically claimed by OER creators, were also challenged, with the argument that the production of OER is ironic, because knowledge for people cannot be produced, and thus they cannot be regarded as the real beneficiaries of OER. According to this view, individuals and institutions that are producing OER are those that have a benefit [11]. An interesting criticism is that OER are reinforcing the process of information imperialism, as the OER movement is mainly a movement led by the developed world, which implies that mainly information relevant to the needs of the developed world will become available online for free [12].

OER are often compared with massive open online courses (MOOC). Although there is a high degree of similarity between the two, there are also important differences. Without going into details, we will summarize these difference only briefly. The first difference, changeability, is probably the most important one. Whereas the essential feature of OER materials is that they can be remixed and

redistributed, MOOC are not changeable in any way, except perhaps, periodically by their own authors. The other difference is granularity. Namely, OER offer free class materials, like outlines and syllabi - rarely full courses, whereas MOOC represent full or mini courses. The third difference is the involvement of the creators. The OER concept does not envisage any participation of their authors in their usage. The authors place their materials on the internet for free use, but after that no further interaction is expected from them. On the other hand, MOOC include active participation of the faculty of the institution that has published them and interaction with MOOC users. And the last important difference is availability. As opposed to OER, which are available anytime, MOOC have a starting and an ending date, with a schedule to be followed, including tests and quizzes, and an evaluation at the end of the course.

3. DEVELOPMENT OF OER

According to [13] several factors were important in the emergence of OER. Besides the social factor, that is, the change in the educational philosophy and the technical factor, namely the development of ICT and availability of internet, both of which we have discussed earlier, two more factors played an important role: financial, a range of financial models developed to support OER and legal, the emergence of alternatives to standard copyright licensing, which we will discuss in more detail later (Fig. 1.)

Figure 1. The four determining factors for OER

Reusable learning objects, collections of items (content, practice, assessment) with the same learning objective, are considered as forerunners of OER [14]. The term, which appeared in the first half of the 1990s, is attributed to Wayne Hodgins and became popular among educators. Learning objects introduced the concept of digital educational materials designed in such a way as to allow their easy use reuse in various educational settings [15].

Building on the concepts of learning objects and open software, David Wiley initiated in 1998 the Open Content Project with the idea of promoting open access materials, primarily within the academic community. To that end the Open Publication License was developed within the project, as a predecessor of Creative Commons. The project was closed in 2003, but remained an important milestone in the development of OER, and Wiley their active proponent [16].

It is being widely accepted that the global OER movement was initiated by the MIT OpenCourseWare (OCW) project. Namely, in 2001 MIT announced that it plans to offer its entire course catalogue online, and effectively realized this in 2002. Utah State University, where David Wiley was assistant professor at that time, joined the initiative, and under Wiley's supervision a distributed peer support network for OCW content was developed, relying on members of academic community wiling to voluntarily share results of their work [17].

However, the term "open educational resources" was first officially adopted at the Forum on the Impact of Open Courseware for Higher Education in Developing Countries, organized in July 2002 by UNESCO in association with the William and Flora Hewlett Foundation and WCET (Western Cooperative for Educational Telecommunications) in Paris. Participants of the Forum adopted a Final Declaration in which they "express their satisfaction and their wish to develop together a universal educational resource available for the whole of humanity, to be referred to henceforth as Open Educational Resources" [18].

Another important international organization, OECD, followed suit, and its Centre for Educational Research and Innovation (CERI) published in 2007 a report entitled "Giving Knowledge for Free: The Emergence of Open Educational Resources", which states that "OER is not only a fascinating technological development and potentially a major educational tool. It, accelerates the blurring of formal and informal learning, and of educational and broader cultural activities. It raises basic philosophical issues to do with the nature of ownership, with the validation of knowledge and with concepts, such as altruism and collective goods. It reaches into issues of property and its distribution across the globe. It offers the prospect of a radically new approach to the sharing of knowledge, at a time when effective use of knowledge is seen more and more as the key to economic success, for both individuals and nations" [19].

Another milestone in development of OER was the Cape Town Open Education Declaration, signed to date by 2568 individuals and 269 organizations. The Declaration was a result from a meeting organized in September 2007 by the Open Society Institute and the Shuttleworth Foundation in Cape Town. It invites learners, educators, trainers, authors, schools, colleges, universities, publishers, unions, professional societies, policymakers, governments, foundations and others "to commit to the pursuit and promotion of open education" and "increase the reach and impact of open educational resources". It urges governments, school boards, colleges and universities to make open education a high priority stating that "Ideally, taxpayer-funded educational resources should be open educational resources. Accreditation and adoption processes should give preference to open educational resources" [20].

4. ISSUES RELATING TO INTELLECTUAL PROPERTY RIGHTS

Ever since they appeared, OER have been faced with issues relating to intellectual property rights. Traditionally, educational materials, primarily textbooks, were protected under conventional copyright terms, giving to authors of these materials exclusive right to their use and distribution, and protecting this right by law. The very concept of OER challenged this approach, and more flexible licensing options for educational resources started to emerge as an alternative.

In 2001 Creative Commons (CC) was founded by Lawrence Lessig, Hal Abelson, and Eric Eldred with the support of Center for the Public Domain, and the first CC licenses were published in December 2002. Earlier that year, David Wiley, the founder of the Open Content Project joined CC as director, and proclaimed CC to be the successor of the Open Content Project.

The CC project built on some earlier initiatives for defining free software licences, in particular the most popular of them, the GNU General Public License (GNU GPL or GPL), which guarantees to everyone the freedom to use, share and modify software developed under that license. The author of the license, Richard Stallman, called it a "copyleft license", and explained his motives, which could be likened to the motivation behind creating OER: "My work on free software is motivated by an idealistic goal: spreading freedom and cooperation. I want to encourage free software to spread, replacing proprietary software that forbids cooperation, and thus make our society better" [21].

CC provides a set of ready-made licensing agreements that are much less restrictive than the standard copyright licenses. CC licences are adapted to more than 70 jurisdictions worldwide, and have so far been used for more than 1.1 billion authored materials: literary works, videos, photos, audio, scientific research and open education resources.

CC licences are generated by combining several options: Share Alike, Non-commercial, No Derivative works and Attribution, as shown in Figure 2.

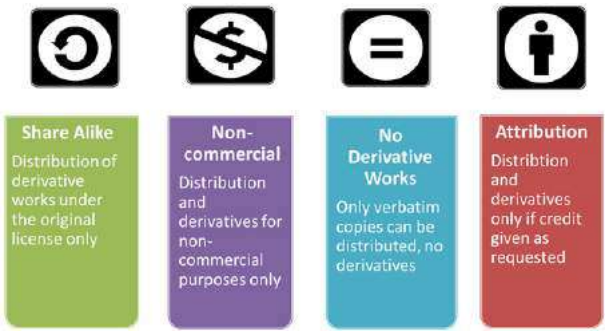

Figure 2. CC license options

The license with the Share Alike (SA) option requires that all work derived from the original must be further distributed under the original license. The Non-commercial (NC) option prohibits the distribution of both the original work and its derivatives for commercial purposes. The No Derivative Works (ND) option allows for distribution of only verbatim copies of the original, and prohibits derivatives. The Attribution (BY) option requires that in distribution of both the original and the derivatives, credit must be given to the author of the original. Given that all current CC licenses include the Attribution option, this became one of the main criticism of CC license, as this option creates considerable problems for derivative works based on multiple other works by different authors.

CC licences are summarized in Figure 3, ranging from the most accommodating (CC BY) to the most restrictive (CC BY-NC-ND).

CC licences thus provided both the legal and technical infrastructure for OER, which is of paramount importance for their long-term success. Under CC licences, OER became more broadly available and more easily adjustable in a structured manner. These licenses help educators to increase the visibility, and thus the impact of the educational resources they create, but also to reuse and adapt resources made by others, making them more appropriate to their own educational needs, and finally, they help everyone interested to search for and find relevant OER more easily.

Figure 3. The six CC licences summarized

5. INTERNATIONAL AND REGIONAL OER INITIATIVES

One of the largest global OER initiatives is the Open education consortium (www.oeconsortium.org). The consortium, supported by the William and Flora Hewlett Foundation, represents a global network of educational institutions, individuals and organizations from around 50 countries around the globe. Members of the consortium promote an approach to education based on openness, including collaboration, innovation and collective development and use of open educational materials. Their mission is to promote, support and advance openness in education around the world, and their vision is empowerment through education: a world where everyone, everywhere has access to the high quality education and training they desire, and where education is seen as an essential, shared, and collaborative social good.

Another consortium of interest is the OCW Consortium Europe (www.opencourseware.eu). The consortium was initiated by five universities and three third party organisations: Delft University of Technology, Universidad Politécnica Madrid, Universitat de Barcelona, Katholieke Universiteit Leuven, Université de Lyon (VetAgro Sup), OpenCourseWare Consortium, Creative Commons and European Association of distance Teaching Universities. In recent years over fifty European partners

from Austria, Belgium, Cyprus, Denmark, France, The Netherlands, Poland, Spain, United Kingdom joined the movement. At present, OCW-Consortium members offer over 14,000 courses online.

While in the United States, OER are offered by major USA universities, such as MIT, Carnegie Mellon, Berkeley, Stanford, Princeton, Harvard, Yale, Caltech, and many others, national initiatives targeting OER spread also in other areas. Thus, for example, the Ministry of Education of the People's Republic of China launched the China Quality Course (www.jingpinke.com) program, which offers more than 20,000 courses, and about a million OER. India, on the other hand, has established its National Repository for Open Educational Resources (http://nroer.gov.in/), which currently has more than 21,200 resources of various categories including videos, audios, documents, interactive objects and images. Even in Africa, the OER Africa (www.oerafrica.org) initiative exists, established by the South African Institute for Distance Education, and featuring about 900 OER from 15 categories.

6. THE SITUATION IN SERBIA

In Serbia, OER are not yet widely used in the educational system, nor are they recognized in official documents. Thus, there is a need for raising awareness of the importance of OER, opportunities they offer, methods of development and implementation, and the use thereof, in the academic community, but also among other participants in the educational system, teachers in elementary and secondary school, and last but not least, among the authorities responsible for education an all levels.

Some provisions of existing regulations open the possibilities for the development of OER but need further improvement at the national and institutional level in compliance with OER regulations in Europe. Thus, for example, the Information Society Development Strategy in Serbia up to 2020, adopted by the Government of Serbia in 2010, fosters application of information technology in education, emphasizes the development of digital educational content as one of the main goals to be achieved, and refers to the introduction of modern concepts of e-learning and open distance learning. Another strategy, the Education Development Strategy in Serbia up to 2020, adopted by the Government of Serbia in 2012, criticizes traditional tendencies of the education system for independence from other systems and promotes its openness, specifically targets openness and accessibility of higher education and provides opportunities for legal regulations for the realization of ideas related to OER. The current Law on Higher Education in Serbia, declares openness of higher education towards all citizens and general public as one of its main principles. It also complies with the European system of higher education, specifically promoting academic mobility of faculty and students, and provides a starting point for the development and implementation of OER through alignment with successful European practices and academic mobility. However, although this Law is scheduled for major revision, the new Draft law that has been circulated but the competent Ministry does not specifically mention OER.

Despite the lack of recognition of OER in official documents, several initiatives have directly or indirectly contributed to the open education movement in Serbia. One of the first was Wikimedia Serbia, founded in 2005 with the aim to allow free exchange of knowledge and participation in gathering educational content. The establishment of Creative Commons Serbia followed, and national CC standards were adopted in 2007. The Khan Academy Serbia has started the translation of Khan Academy instructional videos in 2013, but the project seems to be currently stalled. The University of Belgrade library Svetozar Marković organized a seminar of open access to education, open education and massive open online courses in 2014. Several faculties at the University of Belgrade already use Moodle open source software for blended learning, and University of Belgrade established its Center for e-Learning and Distance Education, with the main goals of development of a quality assurance system for university distance learning study programs, development of competency standards needed for educators in the domain of educational technology, creation of national and international development programs for distance learning and related projects, development of distance learning programs for persons with special needs, and development of electronic textbooks.

A Tempus project involving regional universities from Serbia, Bosnia and Herzegovina and Montenegro, is also worth mentioning. This project, BAEKTEL (Blending Academic and Entrepreneurial Knowledge in Technology Enhanced Learning – http://baektel.eu/), was aimed at development of a TEL environment for creating, publishing and searching OER content by academic and entrepreneurial organizations in different formats and in different languages. Within the scope of this project, West Balkan universities created open educational content intended for lifelong learning of employees within enterprises. On the other hand, enterprises created best practice examples intended for enhancing the academic education of students. Search of content developed so far and described by metadata is available via the project portal (meta.baektel.eu).

There are also other initiatives offering open educational materials, such as the Petlja Foundation, established with the aim of improving algorithmic literacy in Serbia. Its founders believe that understanding algorithms and the skill of algorithmic expression is necessary for everyone, and that it is also important that those who are talented in programming recognize and develop their talent. To that end, the Foundation offers on its site (http://petlja.org/) free educational materials for elementary and middle school students related to algorithms and programming.

OER in Serbia may make a considerable advancement, if Serbia, as expected, joins the “Opening up Balkans” initiative, a regional pilot for openness. To that end a satellite event is planned during the 2nd World Congress on Open Educational Resources in Ljubljana, Slovenia on 19th September 2017, with the aim of aligning all main policy making bodies in the Western Balkans region into

the "Opening up Balkans" initiative. The initiative follows the idea elaborated within the EU Commission: "Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources" [22]. This new initiative will introduce the European agenda for Open Education, including all aspects of Openness such as Open Access, Open Educational Resources, Open Data, etc., into the Western Balkans with the purpose of maximizing the educational potential in the Region.

7. CONCLUSION

A relatively new approach to education, informal learning and open educational resources, has been a major step in reforming the traditional approach to knowledge transfer. Gaining speed within the 21st century, the open education movement is now recognized around the globe, including the least developed continent, Africa.

Despite some criticisms and shortcomings, as well as the very sensitive issue of intellectual property rights, the open education movement is moving forward, making OER, and thus knowledge in general, increasingly more available for all.

However, the situation regarding OER in Serbia, and in the Western Balkans region in general, is still far from satisfactory. Official documents practically do not recognize them, and the academic, and wider educational community in the region still did not fully grasp their potential. Some local and regional initiatives have emerged, but a concerted effort is still needed. A possibility for such a regional effort is offered by the "Opening up Balkans" initiative.

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PERSONALIZATION OF E-LEARNING BY USING OF ALTERNATIVE LEARNING PATHS FOR THREE CATEGORIES OF STUDENTS

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Abstract: *The paper presents the concept of group-based personalization of e-learning. Students are grouped in three groups (A, B and C), according to their knowledge, ability and motivation levels (also, A, B and C), and the e-learning system provides them with different and group-specific learning material, which is the most suitable for their knowledge, ability and motivation level. This is achieved by using fine-grain learning objects and a LMS system (LAMS in our case) that supports specification and implementation of learning processes specifically designed for each online lesson. This learning process provides branches in order to support three different learning paths, for three different student groups.*

Keywords: *: E-Learning, Learning objects, Personalized learning*

1. INTRODUCTION [1]

Personalized e-learning has been a long-term goal of research of many researchers, as it may allow use of different learning material by different students or group of students, according to their specific needs, capabilities, motivations and abilities. In this concept, each student, or a group of student can use only the learning material specifically generated and distributed to them, or to all students with same user profile.

A presentation of major research in this area is not the aim of this paper. There are good reports and state-of-the-art type of papers providing an overview of different approaches to personalized or adaptive e-learning research, such as [1]. Instead, we are presenting here the latest results of our research in area of personalized e-learning, as a continuation of our research presented on our eLearning-2015 International Conference [2].

2. ALTERNATIVE LEARNING PATHS

As presented in [2], we are aiming to generate three different learning paths for three categories of students, as discussed in [3]:

A. *Advanced students*, expecting more new knowledge then normally planned for average students. They are aiming to get the best marks (9 or 10), and have high motivation to learn, but also have high learning abilities.

B. *Average students,* usually aiming to get moderate marks, such as 8. They are motivated to learn, but do not have learning abilities, such as students of the category A.

C. *Students with low motivation for learning,* aiming just to pass and get the lowest positive marks, such as 6.

We assume that we can improve the quality and efficiency of studies of these students, if we provide them appropriate learning materials. In order to increase the motivation of these students, and to increase the efficiency of their studies, we aim to provide them different learning materials, which satisfy their learning goals, and are created according to their abilities. For instance, students of the category C will get the material providing them the knowledge, just enough to pass the exam. In any case, all learning materials need to implement a course syllabus with the knowledge, skills and learning outcomes specified by the Body of Knowledge of the programme, and allocated to the course.

The general idea is that each student chooses its category (A, B and C), and gets the appropriate learning material, for each course and each its online lesson. He also gets appropriate assignments, tests, and, at the end, exam questions or problems to solve. According to his choice, and achieved learning results, he may get appropriate grades (6 or3 7 for C students. 7, 8 or 9 for B-students, and 9 or 10 for A students). If a student decides to change his category, he has to satisfy all requirements planned for his new category (new learning material, new assignments, tests and exam questions).

[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

In order to generate three different sets of learning materials, for three different categories of students, Learning Management System (LMS(must satisfy the following requirements:

- must use fine-grain learning objects, to allow configurations of different learning contents, prepared for different category of students;
- must support creation of learning processes with branching of learning paths with learning and knowledge verification activities;
- must allow students to choose their categories, and therefore, appropriate learning paths of the specified learning process for each online lesson.

Figure 1, taken from [2], shows an example of four different learning paths generated from a single complex and generic learning process of a lesson. Each of these learning paths is designed for a specific category of students. Each learning activity is using an appropriate atomic or complex learning object (consisting of a set of atomic learning objects).

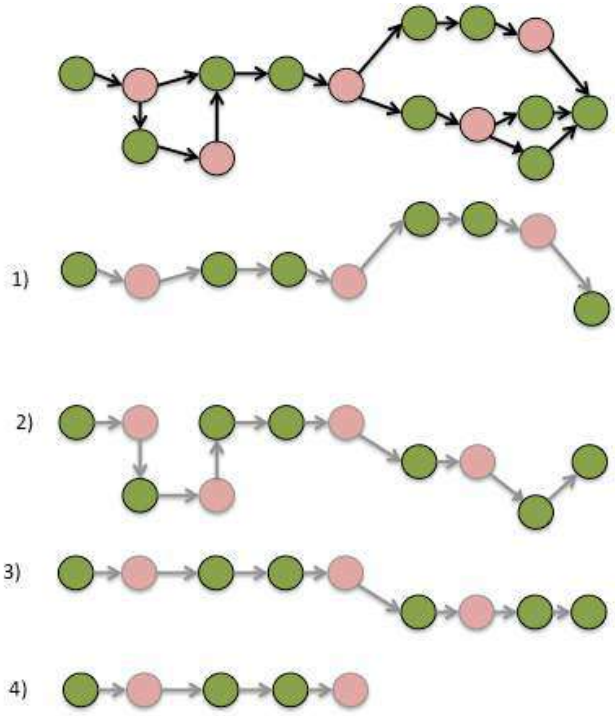

Figure 1: Four specific learning paths generated from a generic learning process (green circles represent learning objects, red circles represent knowledge verification activities)

As its LMS, BMU is using LAMS (Learning Activity Management System), as it satisfies above requirements. LAMS [4,5] supports both learning processes and learning objects. LAMS allows authors to integrate their learning objects with a variety of LAMS activities supporting interactions of professors with students, with other systems, such as wiki and external resources, and many usual activities related to learning and collaborative learning.

For each online lesson, an author has to create a complex generic learning process that can generate specific learning processes as sub-processes, for learning paths A, B and C. Each professor has to decide about target knowledge levels of students of categories A, B and C, for each of his courses. He has to prepare a list of learning objects and their sections, for each lesson and for each category of students. It is important to set "the red line", specifying the minimum knowledge level for students of the category C. They have to achieve the required learning outcomes specified for the program and each course. On the other hand, they should not read all learning objects, or their sections, created for students of A and B categories. So, they have to decide what to exclude from the list of learning objects, dedicated to the students of the learning category C. Similarly, they have to define the difference between knowledge levels of students of A and B categories.

Once they make separate lists of learning and knowledge verification objects for students of A, B and C categories, they have to specify the generic learning process for each lesson of their courses. This process must include:

- At least one **Branch activity** for selection of A, B and C learning paths. Selection of the learning path may be specified by each student, or by the results of assessment of his knowledge or may be group-based, when professor creates A, B and C groups of students for each course and, currently, for each lesson.
- **Learning activity**, providing a learning object with new knowledge and concepts students.
- **Knowledge verification activities** (LAMS Assessment, Multiple Choice, Q&A, etc.) may be inserted after each learning object (learning activity), or at least, after each complex object (containing other sub-objects, i.e. sub-activities)
- **Gate objects** (has a STOP sign), do not allow a student to go to the next learning object before he successfully passes a verification activity (such as Assessment). If a student fails to pass the test (LAMS Assessment Activity), the Gate Activity will will not allow him to go to the next learning object. The student has to go back, to read again the previous learning object and to verify his knowledge again.

Figure 2 shows a part of a learning process with these needed objects and activities

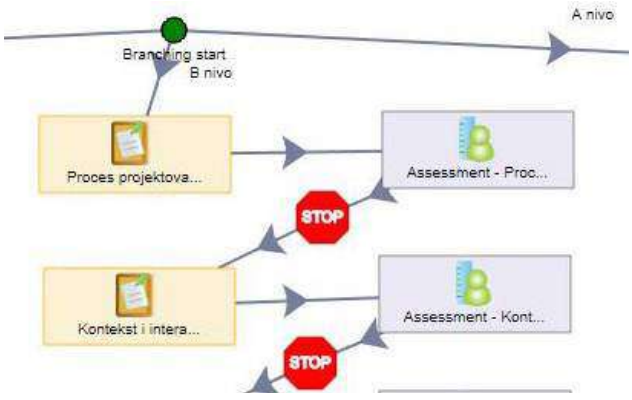

Figure 2: A part of a learning process with learning objects, and LAMS Branch, Assessment and Gate activities

A learning process may also include:

- LAMS **Additional Activities** to provide different validation and other activities that support students' interaction. Figure 3 shows some of them currently supported by mDita authoring tool developed at BMU [6].
- **LAMS Optional Activity** to give students an opportunity to choose next learning objects of ALMS activities for a set of provided optional learning objects and LAMS activitis.

Figure 3: mDita Selection and Specification utility for LAMS Additional Activities

Figure 3 also shows an option to select a Java Grader activity allowing automatic testing of simple Java programs (currently only methods), developed by BMU [7]. Other LAMS Additional Activities will be supported by next versions of mDita authoring tool, in order to increase the level of students' interaction with professors and teaching assistants, but also among themselves.

Figure 4 shows a part of a learning process with inserted some of LAMS Additional Activities – Assessment and Forum.

An author may create pretty complex learning processes for each online lesson by using LAMS Designer menu tag of mDita authoring tool. It allows an author to use one of specific strengths of LAMS, as it supports implementation of learning processes with learning and additional activities, with Branching, Stop and other activities provided for creation of complex learning processes.

In order to provide separate learning paths for A, B and C categories of students, a an author of a learning material needs to create a learning process with learning paths A, B and C, corresponding to A, B and C category of students. He also has to create lists of students in categories A, B and C, with their acceptance. During design of this learning process, an author may add, modify, change and specify learning objects and additional activities of the process, according to his needs and learning plan.

Online lessons with A, B and C learning paths allow implementation of a kind of personalization of e-learning, at least for three categories of students. The same approach may be implemented *for any other number of categories or groups of stude*nts. This approach is not feasible for implementation for *each student separately*, as it would require a huge manual work by authors of learning materials, as they would need to prepare separate learning processes for each student. Personalization of e-learning for individual students require different approaches, such as use of intelligent tutors. This is out of scope of this paper.

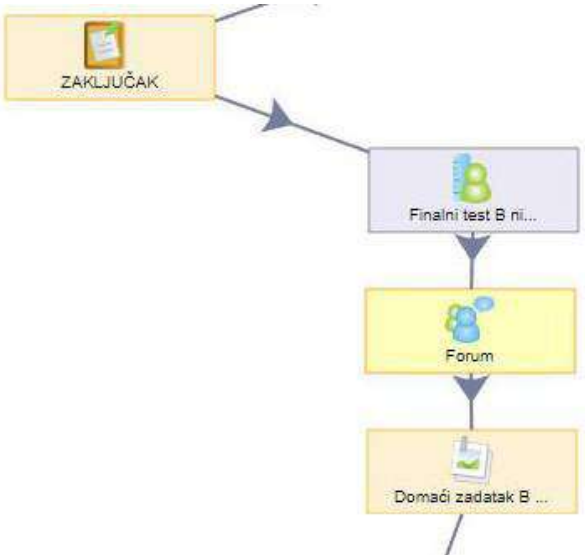

Figure 4: A part of a learning process with LAMS Additional Activities: Assessment and Forum

The concept of *a group-based e-learning personalization* may be implemented if a LMS supports learning objects and learning processes, such as LAMS. BMU is currently analysing this approach to e-learning personalization, and if results are positive, it will initiate its pilot implementation in next academic year.

The implementation of presented concept of group-based e-learning personalization require further improvement of our mDita Editor, as it has to provide a report with all learning objects and their sections to an author, so that he can then select learning objects and sections for each A, B and C learning paths, as a learning path specification utility. Currently we do it manually, and it is not convenient as it is time consuming. If it is done automatically by mDita, it would be much easier and faster for an author to create A, B and C learning paths.

Another kind of personalized e-learning with available technology is possible if an author designs a learning process with many LAMS Branch and Optional Activities. Input to a Brach Activity may be the result of knowledge assessment of the student or may be a manual selection of the student. When they come to an Optional Activity, they may choose one of offered learning objects or LAMS activities for their next activity. In this way,

different students may follow different learning paths of an online lesson. Different students may use very different learning paths, by combining Branch and Optional Activities, specified in a complex and generic learning process. Figure 5 shows this *resource-based approach* in a simple example.

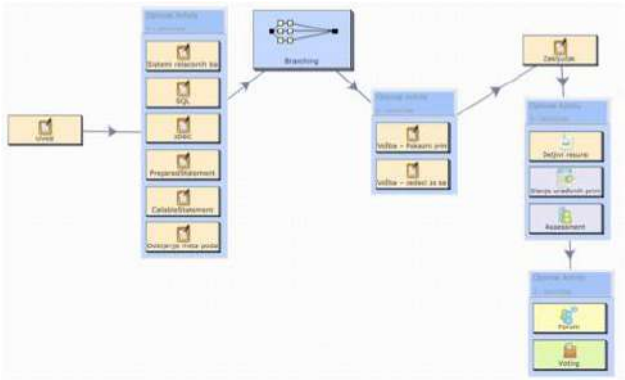

Figure 5: A case of implementation of the resource-based learning model

3. AN EXAMPLE OF USE OF A, B AND C LEARNING PATHS

In order to demonstrate the *A, B and C group-based approach to personalization of e-learning*, we chose a real lesson of a course: Lesson 7 "Software Design" of SE201 Introduction to Software Engineering course. It is a long lesson, lasting 3 weeks, with 3 hours per week of lecture, and 3 hours of tutorials per week. In total, the lesson has 9 hours of lectures and 9 hours of tutorials for in-class students (they also use our e-learning system, besides suggested textbooks). The lesson has:

- 18.123 words
- 12 complex objects (containing also sub-objects)
- 37 learning objects and sub-objects
- 204 sections (a web slide or page with learning content) with text and 74 figures, and with 36 sections with video clips

Figure 6 shows the learning process for this lesson, providing A, B and C learning paths, for A, B and C groups of students. Initial Branch Activity allows specification of branches (learning paths) A, B and C for respective, A, B and C groups of students, previously specified and this is automatically used in all next Branch Activities of the learning process. .

The learning path B, for B student group has less learning objects, assessment activities and sections, than the A learning path, planned for A student group. Analogically, the C learning path has less learning objects, assessment activities and sections than the B learning path, created for the B student group.

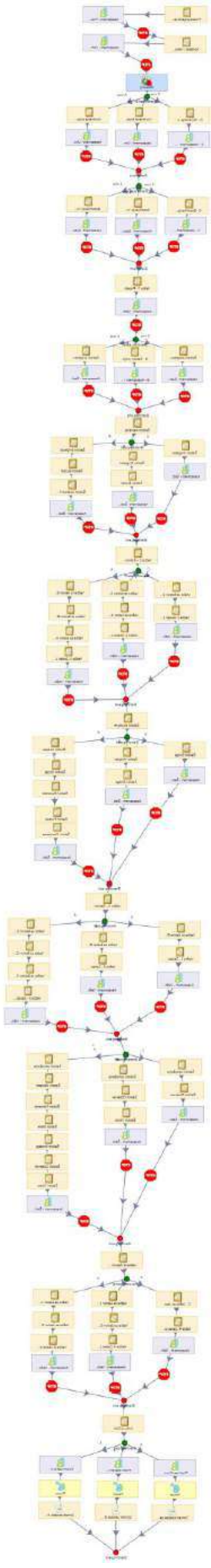

Figure 6: Lesson 7 learning process

Due to the complexity of this lesson, this process is complex and is not easy to display here, as presented in Figure 6. Figures 7 and 8 show parts of this process, highlighting important and specific parts of the process, which will be explained here in more details.

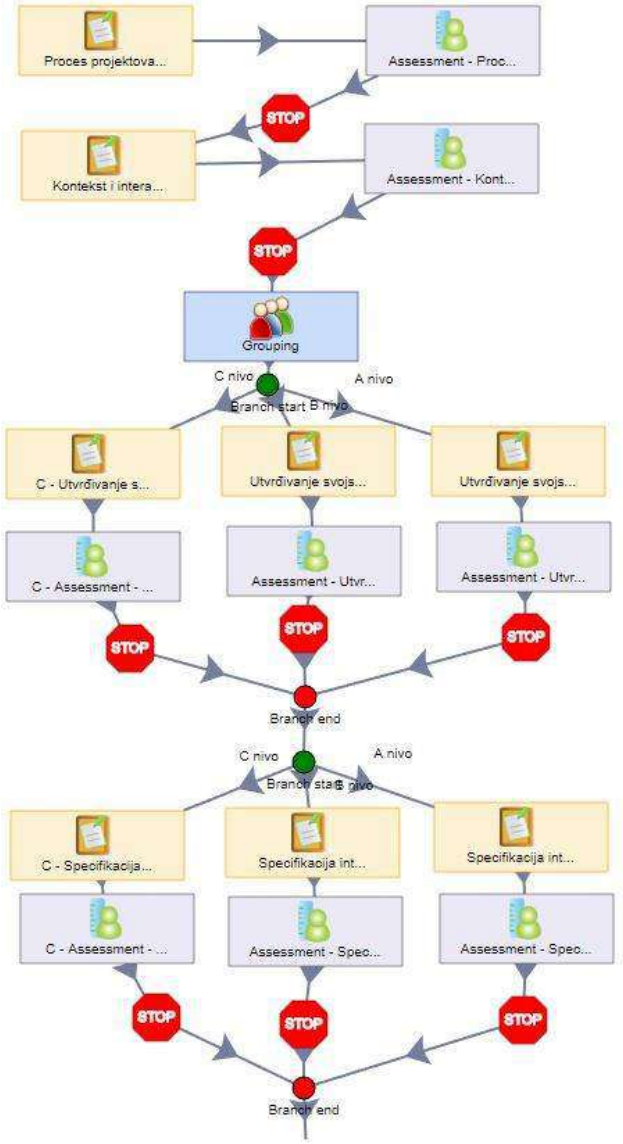

Figure 7: First part of the learning process

Figure 7 shows the first part of the learning process. As all three groups of student have to use first two learning objects, they use the same leaning path, that is valid for all three groups. After reading the learning objects 1 an 2, student has to verify his newly acquired knowledge, by passing two relevant Assessment Activities. If the does not pass and of them, the Gate Activities (with STOP signs) will not allow him to continue. He has to go back to a selected learning object to read again, an have new assessment (test) of learnt knowledge. As a Assessment Activity randomly generates questions from a pool of prepared questions, it is most likely that the student will get different questions than in the first attempt to pass the test.

When a student passes first two Assessment Activities, as part of a group, he gets access to the next learning activity, specified specifically for its learning path, and the learning workflow continue as specified by specific learning paths of each of three groups of students.

A learning process, shown in Figure 6, and partially presented in Figure 7, consists of different pathways according to student's level of knowledge, ability and motivation (A, B and C). . Each of these levels includes learning objects corresponding to this level. The learning process is designed to provide three different learning paths (A, B and C) for their different students' groups (A, B and C). At each "Branch" activity, all students belonging to the same group (A, B or C) are directed to the learning object belonging to their learning path.

Before the first "Branch" activity,, a "Grouping" activity is set, which allows grouping of students, and gropus A, B and C are created. . By using the Grouping activity, the Branch activity automatically assigns a branching path based on a previously defined group and directs all students belonging to the same group (A, B or C) through the path defined for each group separately. It is necessary to set up only one "Grouping" activity before the first "Branch" activity of the learning process (Figure 8). Once students' groups are created, all students of a group get the same learning objects, assessment activities and some of other defined Additional Activities. Practically, they all follow the same learning path, specified for their group.

In this example. the "Assessment" activity is placed

- after each learning object, in cases where the learning object has no learning sub-objects, or
- after the last of its sub-objects, in case of la earning object consisting of two or more sub-objects.

For each "Assessment" activity a question pool is created. In this example, the question pools for Assessment activities specified for complex objects, having sub-objects, have questions related to all its sub/objects. In case of simple learning objects (without sub-objects) its pool consists of questions related only to the content of this learning object.

"Gate" activities ar e represented by a "Stop" icon in Figures 6,7 and 8. A student who does not achieve a sufficient number of points on the test (Assessment Activity) cannot pass through the "Gate" activity, but has to go back and read the contents of the learning objects again and then re-enter the test.

The last activities in the learning process are:

- The final test within the "Assessment" activities, that includes a pool of all questions from a learning process of a certain level.
- The "Forum" activity, to support discussions among students regarding the lesson for that level.
- The "Share Resources" activity with a homework assignment for that level.

Figure 8 shows the case, when different branches of the process specify different number of learning objects. The learning path A has more learning objects than the learning path B, and this one has more learning objects than the learning path C.

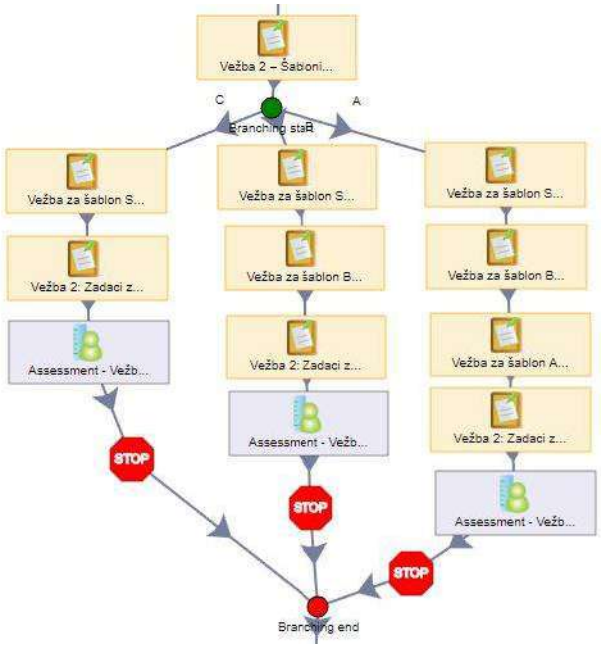

Figure 8: Process branches with different number of learning objects

4. CONCLUSION

The paper presents actual R&D work of BMU in area of personalized e-learning, i.e. the implantation of the concept of A, B and C group-based personalization of e-learning. Students are grouped in three groups for each course, according to their abilities, motivations and readiness for study work. For each of these three student groups, different learning material is automatically generated, allowing students to study learning material that is specially produced for each of groups. It is assumed that this will increase their study efficiency, as they will use learning paths that are the most suitable for their knowledge, ability and motivation level.

Generation of different learning material for different categories of students is achieved due to the use of a complex learning process that support three different learning paths, A, B and C, for A, B and C groups of students. One of the precondition for implementation of this approach to personalized e-learning is to use a LMS that support fine/grain learning objects and specification of learning processes with branching.

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BLENDED LEARNING FOR DIGITAL FABRICATION ONLINE COURSE USING EDX PLATFORM

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Abstract: *The paper describes development and implementation of eLearning courses on use of digital fabrication (DF) tools in STEM education, which was developed within project "Fab Lab Petnica - formation and incorporation with on going programs". The project aims were to establish educational Fab Lab Petnica and to use it as 1) platform for hands-on STEM education through "FabLearnLabs" approach and 2) channel to introduce high school students & teachers to basics of STEM entrepreneurship. The FL@S entails using fablabs - digital fabrication laboratories in STEM education (3D printers, open-source electronics, etc.). This paper presents developed online courses, which were used as a support for the face-to-face workshops for Fab Lab Petnica. Online courses were created and published using edX platform, for both authoring eLearning courses and for conducting the course through its Learning Management System.*

Keywords: *e-Learning, distance learning, online course, digital fabrication, fab lab*

1. INTRODUCTION

Blended Massive Open Online Courses (bMOOCs) have merged in as an alternative model for the typical in-class or strictly online courses, for better teaching and learning in higher education [1]. Blended MOOCs (bMOOCs) aim to merge face-to-face learning with online learning content in effective blended environment. bMOOCs use MOOCs' tools while avoiding some of the hurdles facing standalone MOOCs.

Over time, blended learning has taken many different definitions including:

"Blended learning is defined as a formal education involving partial learning through online delivery of content, instruction; and partial face to face classroom combined with computer mediated activities" [2].

Much research has been done to show the benefits of blended learning or flipped classroom [3]-[5], while some have evaluated blended learning model wrapped around published MOOCs content [6].

Forming of Fab lab Petnica[1] as the educational fabrication laboratory (fab lab) in Petnica Science Center was implemented by three partners: Fab Initiative NGO, Petnica Science Center (PSC) and Belgrade Metropolitan University (BMU). This project built on the PSC's programs for high school students and teachers in STEM education and the actions on promotion of digital fabrication and STEM entrepreneurship conducted by Fab Initiative NGO. The goal of this work was to create online content that will support face-to-face workshops, conducted in the efforts of forming Fab Lab Petnica.

Target groups for the courses were gifted high school students and their teachers. All participants were chosen by the strict procedure of PSC, so that highly motivated kids were selected. The aim of selecting both motivated students and their teachers were to: (i) improve student surrounding by educating high school teachers, (ii) motivate teachers and students to start their own science clubs based on FabLearnLabs *(formerly known as FabLab@School)* concepts, (iii) build knowledge that is necessary to build FabLearnLab-like science clubs ("mini-fab labs") that will provide opportunities to other students from the school. FabLearnLabs is the concept developed by the Transformative Learning Technologies Lab at Stanford University[2].

Paper is organized as follows. Section 2 describes conducted face-to-face workshops. Section 3 presents online content for the courses published on edX platform. Section 4 concludes the paper.

[1] Fab lab Petnica, https://www.fablabs.io/labs/fablabpetnica

[2] Transformative Learning Technologies Lab at Stanford University, https://tltl.stanford.edu/project/fablearn-labs

2. FACE-TO-FACE WORKSHOPS

Workshops for students and teachers were held separately. 46 students participated in 4-day student workshop. This workshop consisted of 3 different topics:

- 3D printing workshop - theoretical and practical lectures on 3D modeling and 3D printing where students gained knowledge on the various 3D printing technologies, 3D printer components, of the CAD and 3D modeling and post-processing of the printed model. Students work in groups to design and 3D print their own prototypes,
- Open source electronic workshop - theoretical and practical lectures on Arduino and Raspberry Pi and integration of the microcontrollers of Serbian-based Mikroelektronika company. Students were divided to groups based on the prior knowledge of electronics. The practical lectures entailed integration of the electronic components to the prototype printed during the 3D printing workshop,
- Fundamentals of entrepreneurship workshop - practical lessons on the lean startup approach, making of the business model canvas and training in pitching techniques. The students were encouraged to form groups that mimicked "a startup" and have trained to give mockup pitches [7].

Teacher workshop was focused on the following topics:

- Introduction to digital fabrication, fab labs and the FabLearnLabs program
- Introduction to 3D printing methods
- Introduction to open source electronics: Arduino and Raspberry Pi
- Introduction to entrepreneurship through fab labs
- Guidelines how to start a mini-fab lab in school/information on fab lab resources
- Connection of LEGO Education tools and FabLearnLabs program [7].

3. ONLINE STRUCTURE OF COURSES

Fab lab Petnica online courses were published on the edX system, which was used as Learning Management System (LMS). Courses were organized in the manner of bMOOCs (blended MOOCs) where students and teachers attended face-to-face workshops, and later the summarized learning materials were made available through edX platform. As these courses were planned as an online addition to attended face-to-face workshops, no graded assessments were planned.

Online lectures were made for both students and teachers, with goals to: (i) improve student learning and knowledge retainment, and (ii) implementation of digital fabrication implementation in schools, keeping in mind that teachers will later want to develop their own mini-fab labs in their respective high schools. The benefits of using edX platform are many. Both students and teachers were exposed to many information in face-to-face workshops. Later, as they would probably want to review and revisit some of the material, they were able to revisit summary of these activities on edX in the form of an online course at their own time and pace.

Online courses follow similar sequence of theoretical background, examples with step-by-step explanations, tutorials, and practice questions to test students' understanding. These tests are designed to evaluate student understanding and to engage them more in their readings, while providing instant feedback. As a part of this project three online courses were created: 3D Print, Arduino and FabLab Entrepreneurship (Figure 1).

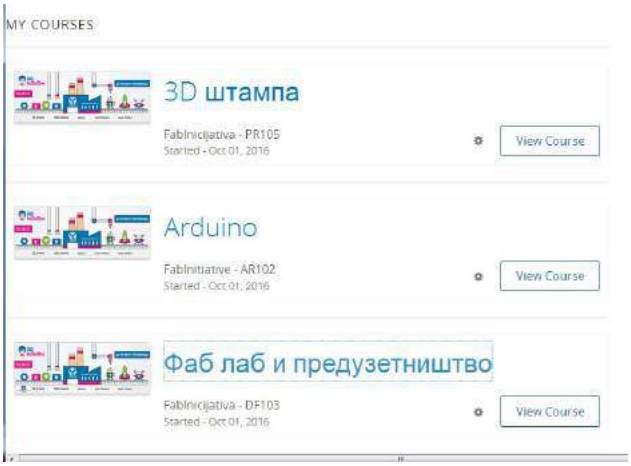

Figure 1: Screen capture of offered online courses 3D Print (in Cyrillic: 3D штампа), Arduino and FabLab Entrepreneurship (in Cyrillic: Фаб лаб и предузетништво).

2.1 FABLAB ENTREPRENEURSHIP

Lectures were structured so that learning objectives and outcomes are outlined at the beginning of the lesson, followed by the explanation of the importance of the given topic. This explanation is used to draw students more into the topic, so they would be aware from the beginning, what are the interesting applications of what they are about to learn.

An example of the course structure is given in Figure 2, which shows *Introduction* part of the FabLab Entrepreneurship course. On the left hand side, lecture is organized in its sections and subsection, while the content of each subsection is displayed on the right hand side, with a slideable bar, for content viewing. Each subsection contains one or more units, with lesson content.

Figure 2: Example of beginning of lecture structure (*Introduction: Course objectives, Expected outcomes, Why is this important?)*

Each lecture sequence consists of instruction, self-evaluation questions and videos. Whenever applicable, video was accompanied with a transcript, running simultaneously (Figure 3). Each transcript is interactive, so that a learner can click on the part of the transcript they are interested, and the video will automatically readjust to the part associated with that sentence.

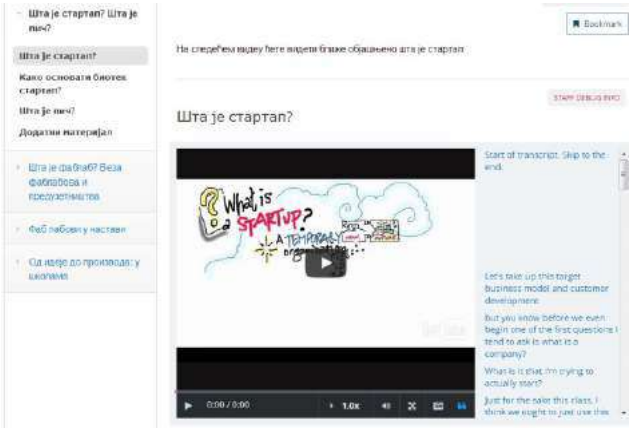

Figure 3: Example of the video with accompanied transcript

Among instruction and video are embedded exercise, which are designed to enable students to evaluate whether they understood the material covered in the lecture text or videos. These mainly represent questions with multiple-choice answers that require students to verify the covered concepts.

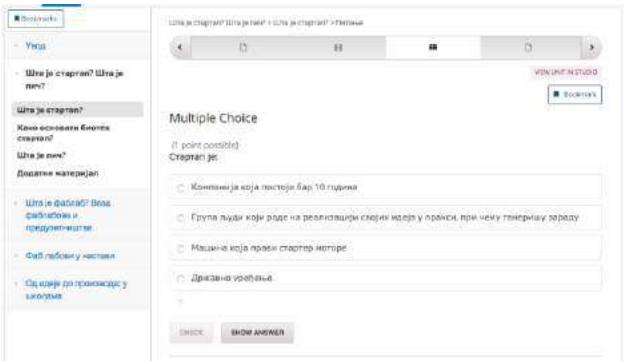

Figure 4: Screen capture about one of the multiple-choice questions

2.2 3D PRINT

3D Print course had a different structure than FabLab Entrepreneurship. 3D Print course consists of video lectures. These video lectures are modular video snippets, which represent short lectures ranging from 1 to 5 minutes, and are narrated by the lecturer in the lab setting. Video snippets are short on purpose, based on different studies suggesting that student attention span is roughly 10 minutes [8]. The course pedagogically introduces 3D printing, talks about different types of 3D printing, gives different examples of 3D printing outputs, and presents CNC machines.

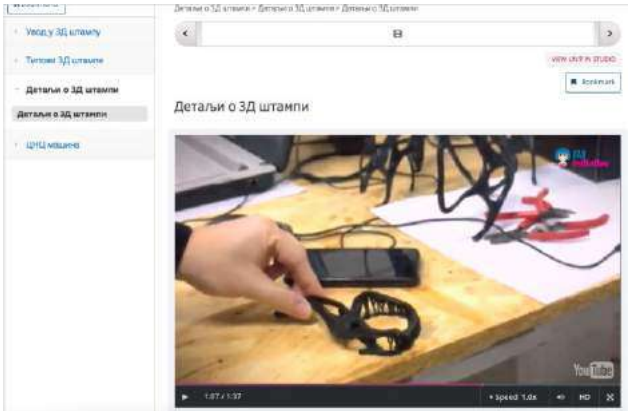

Figure 5: Example view of 3D Print course

*Lectures can be viewed at six different speeds, depending on individual preferences: 0.5x, 0.*75x, 1x, 1.25x, 1.5x, 2.0x. Besides different speeds, students are able to pause and continue at their own convenience (Figure 6).

Figure 6: Navigation tools associated with play/pause, time elapsed, button to speed up or slow down lecture

3. CONCLUSIONS AND FUTURE WORK

Fab lab Petnica project was implemented through held face-to-face workshops, followed by the online courses created to accompany the conducted workshops. Both face-to-face workshops and online courses were intended for both high school students and teachers. The full effects of blended learning in Fab lab Petnica have not yet been evaluated. Future research intends to analyze effectiveness of student learning and student experience. Dynamics of blended learning versus pure online learning will also be reviewed.

ACKNOWLEDGMENTS

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AN E-LEARNING APPROACH TO SOCIAL SCIENCES

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Abstract: *In this paper, we describe an approach to providing IT skills for working with human language data developed and applied within the master program Social Sciences and Computing and PhD study program Intelligent Systems at University of Belgrade. The approach is primarily aimed at introducing students to work with human language data and semantic technologies. edX and Moodle platform were used for e-Learning support, while for lectures in Python and R, Jupiter (formerly, IPython) Notebook interactive development environment was used. The approach also includes introduction to software packages for working with Wikipedia, Wikidata and DBPedia, the basic concepts of Unitex, and Knowledge Engineering with Semantic Web Technologies. Students are further encouraged to improve the knowledge and skills they acquired using the open educational resources.*

Keywords: *E-Learning, Open Educational Resources, LRMI, Microtagging, Semantic web*

1. INTRODUCTION

Motivation for studying Natural Language Processing (NLP), Computational Linguistics (CL) and Semantic Web (SW) comes with the surge of machine-readable natural language text and web resources. Information technologies and computer science have led to significant developments in social sciences, as well as to creation of new disciplines, such as computational linguistics and digital humanities. There is a growing necessity for enabling students of social sciences to acquire appropriate IT skills and knowledge. Of special interest are skills necessary for effective text analysis and text data management.

Vast amount of text, doubling every year or two, Web pages, emails, IMs, SMSs, tweets, docs, PDFs, bring not only the opportunity, but also an increasing necessity to extract meaning from text. Natural language processing is the technology for dealing with human language, as it appears in everyday spoken and written communication. NLP applications have become part of our everyday experience, from spelling and grammar correction in word processors to machine translation on the web; from email spam detection to automatic question answering; from detecting people's opinions about products or services to extracting appointments from email. Mediation of human interactions by computers enable the growing role of language in human-computer interaction.

In social and humanistic sciences in Serbia, there is still a deficiency and lack of IT education. To reduce this shortcoming, the graduate study program Social Sciences and Computing at the University of Belgrade[1], Serbia, was developed as a part of the TEMPUS project INCOMING (Interdisciplinary Curricula in Computing to Meet Labor Market Needs). It is intended for students who graduated in social sciences, but have no programming experience, based on the assumption that they could be more productive in their research if they had some coding experience.[1] Within the same project, PhD study program Intelligent Systems[2] is designed with the objective of enabling advanced students who have graduated from a master study program in an area of computing, to improve their knowledge and master methods and techniques of research activities in different fields of intelligent systems.

At the Faculty of Philology within University of Belgrade, at the level of doctoral studies, students are offered to take the course "Lexical Recognition in the Natural Language Processing (NLP)". This course contains introduction to

1 http://bg.ac.rs/en/education/interdisciplinary/computing.php

2 http://bg.ac.rs/en/education/interdisciplinary/intelligent-systems.php

main features of Unitex[3], an open access and open source corpus processing system. In this paper, we will outline some experiences from the aforementioned programs, related to use of technology enhanced support for teaching IT subjects for Natural Language Processing, Computational Linguistics and Semantic Web.

As a practical introduction to programming for language processing we used NLTK, a platform for building Python programs to work with human language data. After learning the fundamentals of writing Python programs, students were taught how to work with corpora, categorize text, analyze linguistic structure, and more. They had the opportunity to test the knowledge they have acquired using texts of the White Book, both in Serbian and English.

Another way to contribute to IT education in Serbia is the use and the development of Open Educational Resources (OER). A platform developed within the BAEKTEL (Blending academic and entrepreneurial knowledge in technology enhanced learning) TEMPUS project is used for collecting and sharing open resources among academic and entrepreneurial institutions in West Balkan countries. The OER course Lexical Recognition in Natural Language Processing (NLP) is offered at the University of Belgrade, Faculty of Philology at the level of doctoral studies, but also developed as an OER within the edX BAEKTEL platform [2]. PhD students were also advised to use OER course Knowledge Engineering with Semantic Web Technologies[4] to learn more about Knowledge Engineering and the Web of Data, RDF, Ontologies, OWL, Rules, and Reasoning.

2. TEACHING IN THE SCOPE OF SOCIAL SCIENCES AND COMPUTING PROGRAM

The INCOMING program was designed as a continuation of undergraduate studies in the broad study area of social sciences (economics, sociology, psychology, law, finance, management, languages, and so on, or a combination of some of these fields), but with a focus on application of modern computer technologies in these fields. Participating in this study program assumes that the students have already acquired some knowledge in a subset of these social sciences. It is also understood that students already have a basic knowledge of computer technology and that they are familiar with the basics of using computers and the Internet.

Within the masters study program Social Sciences and Computing, students are introduced to some of the more advanced techniques of using computers and the Internet, but always through application in a selected field of social sciences. A wide variety of courses offered allows each student to focus on the social science(s) that she/he is most interested in. [1] Some of the subjects related to NLP are: Introduction to Cognitive Linguistics, Digitization and Transdisciplinarity in Humanities, Digital Humanities, Digital Libraries and Programming for Linguists.

The Programming for Linguists classes were aimed for people who are studying linguistics, the humanities, or textually based social science topics, who have never coded before, but realize that they could be more productive in a lot of their research projects if they had some coding skills.

One of the most significant advances with the growing interest is Anaconda, one of several Python distributions, with key parts Spyder and Jupiter (formerly, IPython) Notebook interactive development environment for Python, including an editor. Its great success came from the form of programming called literate programming, a software development style pioneered by Donald Knuth. This type of programming emphasizes a prose first approach with human-friendly text combined with code blocks. It enables demonstration, on-line alteration, research, and teaching objectives convenient for NLP teaching. Literate programming allows users to formulate and describe their thoughts with text while writing code blocks in the same document.

Main part of the course was dedicated to Natural Language Toolkit[5]. It is a free, open source, community-driven project and it provides an easy-to-use interface to over 50 corpora and lexical resources such as WordNet, along with a suite of text processing libraries for classification, tokenization, stemming, tagging, parsing, and semantic reasoning, wrappers for industrial-strength NLP libraries, and an active discussion forum. [3] With the hands-on guide introducing programming fundamentals with computational linguistics examples, NLTK is suitable for linguists, students, researchers, and other users. Open source license of NLTK and the wide community of users create ab excellent environment for teaching computational linguistics using Python and for working on natural language problems. In order to foster independent work and promote self-study, students were given additional programing assignments for homework.

Our lectures also included introduction to software packages for working with Wikipedia (download, analysis and processing of articles, information extraction) and Wikidata.

Finally, students get the basic knowledge of Unitex, an inevitable tool for natural language processing. After an introductory Unitex lecture, they were further encouraged to improve the knowledge and skills they acquired using the open educational resources BAEKTEL platform [2].

The mastered material and gained knowledge were checked on the collection of texts taken from the White Paper Series for Serbian, with both published versions: Serbian and English. Students were introduced to Wikipedia-processing packages, which enabled them to perform automatic downloading, scraping, parsing, analyzing and processing articles and extracting information. Wikidata as a free and open knowledge base with structured data was an excellent resource for teaching and learning queering using Python and SPARQL. Wiki resources parsing was covered by several packages: Wikipedia, Wikidata, babel.core, pywikibot,...[6]

[3] http://unitexgramlab.org/
[4] https://open.hpi.de/courses/semanticweb2015
[5] http://www.nltk.org/
[6] https://pypi.python.org/pypi/Wikipedia/

3. TEACHING IN THE SCOPE OF LEXICAL RECOGNITION IN NLP

Given its interdisciplinarity, NLP itself is not envisaged as a study program in the Serbian higher education system. Some of its subareas are covered within courses at the Universities of Belgrade and Novi Sad. The most comprehensive education is offered to students at the Department of Library and Information Sciences at the Faculty of Philology, University of Belgrade. Prof. Krstev provides students with open e-learning material[7] for all subjects and her educational and research resources are valuable source for learning and research. The course Multimedia Document in the Library Information Science curriculum at the Faculty of Philology, University of Belgrade is organized as a team project of a whole generation of students in the last year of their studies, where each generation has to tackle a different topic important from the perspective of preservation of cultural heritage, and present it in a multimedia form. [4]

The course Computer applications in linguistics and philology, among other things covers: text encoding techniques, formation of machine readable corpora and tools for their processing, tools for production of indexes and concordances, dictionaries and lexicons in machine-readable form, elements of lexical statistics, production of frequency dictionaries, stylistic analyses, comparison of vocabulary, automatic text indexing, methods of morphological, syntactic and semantic analysis. [5]

The students of doctoral studies are offered a course "Lexical Recognition in the Natural Language Processing (NLP)", where they become familiar with the use of Unitex [6], the corpus processing system for which many valuable resources for Serbian have already been developed. Unitex is an open source system consisting of a collection of programs developed for text analysis by using linguistic resources program. The main topic of this course is natural language processing based on lexical recognition. From traditional presentations and learning material, the OER course Lexical Recognition in Natural Language Processing (NLP) was developed as its open and freely accessible version within the edX BAEKTEL platform[8]. The course consisting of 11 lessons comprises textual and multimedia educational resources accompanied with quizzes and assignments for self-evaluation. The material is organized as follows:

1. A brief overview of approaches and methods used in CL and NLP.
2. How to start working with it, main steps of text processing, formats used for input and output texts.
3. The concept of e-dictionaries
4. The simple methods of pattern matching
5. The advanced methods of text searching (regular expressions and graphs for more complex queries).
6. Advanced topics in the use of graphs
7. Special types of graphs (preprocessing graphs, graphs for the inflection).
8. The use of contexts in graphs (context-sensitive grammas and shallow parsing)
9. Multi-word unit (MWU) recognition
10. The use of morphological mode and use of information from e-dictionaries for output transformations by transducers
11. The cascades of transducers that transform a text and Named Entity Recognition System for Serbian

The evaluation[9] conducted after first year showed that video lectures incorporated in edX OER version were a valuable source and helped student to learn how to use Unitex and solve different problems from their field of study in social sciences.

4. TEACHING KNOWLEDGE REPRESENTATION AND SEMATIC WEB

The PhD study program Intelligent Systems at the University of Belgrade includes both topics Knowledge representation and Semantic web as elective courses, but also as lectures within obligatory (required) Artificial Intelligence Methods and Techniques course. During Short term scientific mission (STSM) in L3S Research Center, Leibniz Universität Hannover supported by COST IC1302, we improved our knowledge in teaching and using semantic technologies, but also in enhancing sharing and reusing educational resources and data. Learning about teaching and developments at the L3S Research Center from the Leibniz Universität, such as new tools and techniques for large content repositories and digital libraries, gave a new impulse to Semantic Web topics taught at PhD study program Intelligent Systems at the University of Belgrade.

Since the web has become an object of our daily professional and private life and the amount of information on the web is ever growing, students are guided how to (automatically) find useful information and use the knowledge contained in web documents. While traditional search engines have limited understanding of information content, the Semantic Web is an extension of the traditional web in the sense that information in the form of natural language text on the web will be complemented by its explicit semantics based on a formal knowledge representation. The students were taught that the meaning of information expressed in natural language can be accessed in an automated way and interpreted correctly, i.e. it can be 'understood' by machines.

So far web-scale integration of educational resources is not facilitated in Serbian practice, mainly due to the lack of take-up of shared principles, datasets and widespread knowledge of annotating schemas. However, linked data principles are used increasingly and guideline given in [7, 8] are used with students in order to annotate courses within on-line curricula. Lecturing about Web of data and

[7] http://poincare.matf.bg.ac.rs/~cvetana/Nastava/NoviProg.html

[8] http://edx.baektel.eu/courses/course-v1:UB+UB5+2015/about

[9] https://forms.office.com/Pages/ResponsePage.aspx?id=gEXpV0v8MUy3NS5b5rLtzVVEaWS9p1JNhNuK22y1Q3xUN0UzT0RWVU83OExXNVBFQjhQWlBXNVVHUS4u

how to access it, was complemented with practical exercise that students could test. The lecture covered technical issues affecting web pages on Google Search, e.g. how to implement structured data that can affect the appearance of the page on Search. Within practical activity, web pages containing courses curricula annotation were tested using Structured Data Testing Tool. After successful practice, part of the web site of the Faculty of Mining and Geology was annotated with shema.org proposed microdata. Namely, curricula for all subjects were annotated, as well as professors' references.

Despite growing interest in such embedded semantics, a thorough understanding of the need for its adoption for metadata in West Balkan countries is still lacking. During the STSM, at Leibniz Universität, the first study of data extracted from embedded annotations, utilizing the Web Data Commons as the largest crawl of embedded markup so far, investigated questions about the level of adoption of terms and types, the shape and characteristics of entity descriptions, and the distribution of data across the Web, for West Balkan country domains .rs, hr, .ba. We hope that this research will be a small contribution to overcoming lack of semantic annotation in .rs, hr, .ba domain.

5. CONCLUSION

High-ranked universities like Stanford offer to social science students courses in Computer Science, Linguistics, Statistics and Semantics. Experiences presented in this paper are a small contribution for filling the gap between traditional social sciences subjects and up-to date information technology, supported by e-learning. E-learning in general coupled with OER make organizing and teaching of the aforementioned subjects easier, since students generally come from all around Serbia and some of them even from Bosnia and Herzegovina. In general, students in social sciences have different initial IT knowledge, and OER help them to overcome possible lack of specific segments of this knowledge. Another advantage of OER is the ability to learn through self-paced education.

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CRITICAL E-LEARNING SKILLS AND CULTIVATING THEM

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Abstract: *This contribution examined critical e-learning skills and ways to cultivate them. It was found that innovative e-learning environments should call for different types of thinking (e.g., critical, creative, and complex), as well as cultivating communication and collaboration, while each learning activity encountered should be supported by an appropriate technology. As one technology can rarely be used to cultivate a number of learning activities, a system of technologies should instead be applied in a holistic way. To this end, the educator needs to develop a solid technological pedagogical reasoning through, for example, relating a set of pedagogies with a system of technologies supported by various pedagogical and technological scaffolds.*

Keywords: *Cs model, E-Learning, System of technologies, Technological pedagogical reasoning*

1. INTRODUCTION

There are many definitions of e-learning that include various terms, such as distance education, online learning, or internet learning. Many of them focus on the delivery function of this kind of learning (e.g., using electronic technologies to deliver education and training). Other definitions emphasize the use of e-learning to support communication and interaction. E-learning has also been viewed as an emerging educational paradigm – an innovative approach that delivers (to anyone, anyplace, and anytime) interactive, learner-centered materials by using a range of digital technologies (see [1] for different definitions). E-learning may also be used to denote technology-assisted learning i.e. learning with technology.

The outcomes of appropriate learning in general, and e-learning in particular, should cope with an increasing complexity of educational, scientific, social, cultural, business, or other contexts. What may critical learning skills be? In what way(s) should these skills be cultivated? In the rest of this contribution we will answer these questions briefly by referring to our own experience and several research papers.

2. CRITICAL SKILLS

A recently proposed 4Cs model underlines four skills that would promote successful citizenship in a global society. These skills are:

- creativity
- critical thinking
- communication
- collaboration.

These are the foundation of the full model of learning and innovation skills including:

- creativity and innovation,
- critical thinking and problem solving,
- communication, and
- collaboration.

Using them successfully would "separate [those] students who are prepared for increasingly complex life and work environments in today's world [from] those who are not" ([2], p. 2). As exemplified in [3], through the 4Cs model students would develop and improve a number of thinking and engagement strategies. These are, for example,

- analyzing, categorizing, contrasting, and evaluating (critical thinking);
- asking questions, improvising, designing, and problem solving (creative thinking);
- dealing with various attributes of messages exchanged (communication);
- brainstorming ideas with others, resolving conflicts, building teams, and making team decisions (collaboration).

These four skills can be recognized in, for example, recent ISTE standards for students for their work in the digital world [4]. According to these standards, student should use a rage of digital technologies to work in this world as:

1) empowered learner,
2) digital citizen,
3) knowledge constructor,
4) innovative designer,
5) computational thinker,
6) creative communicator, and
7) global collaborator.

The last standard, for example, requires students to use "digital tools to broaden their perspectives and enrich their learning by collaborating with others and working

effectively in teams locally and globally." As there may be confusion between skills and strategies (e.g., Is creative thinking a skill? Is asking questions a strategy?), it may be more appropriate to view creativity, critical thinking, communication, and collaboration (the four pillars) as cognitive activities, each comprising a range of skills (composed of sub-skills) and various strategies (composed of skills).

How many Cs activities should be present in innovative learning environments?

A model related to learning with technology, proposed almost twenty years ago, suggests there should be three Cs related to thinking. This is because we can speak of critical thinking, creative thinking, and complex thinking [5]. Their major activities/skills are respectively those of

- evaluating, analyzing, and connecting (critical thinking),
- elaborating, synthesizing, and imagining (creative thinking), and
- designing, problem solving, and decision making (complex thinking).

(Recall that [3] finds that designing and problem solving are strategies of creative thinking.)

Of course, these three types of thinking may be practiced individually, or in a group mode based upon communication and collaboration. If we accept this model, there would be five Cs activities that should be cultivated in today's learning with technology (see Table 1).

Table 1: 5C's model (based upon [4, 5])

Activity/Engagement	Underlying activities/skills
Critical thinking	Evaluating, analyzing, connecting
Creative thinking	Elaborating, synthesizing, Imagining
Complex thinking	Designing, problem solving, decision making
Communicating	Choosing of and working with communication tools and presentation media
Collaborating	Working in teams on various tasks and in various roles, enriching learning by considering multiple perspectives

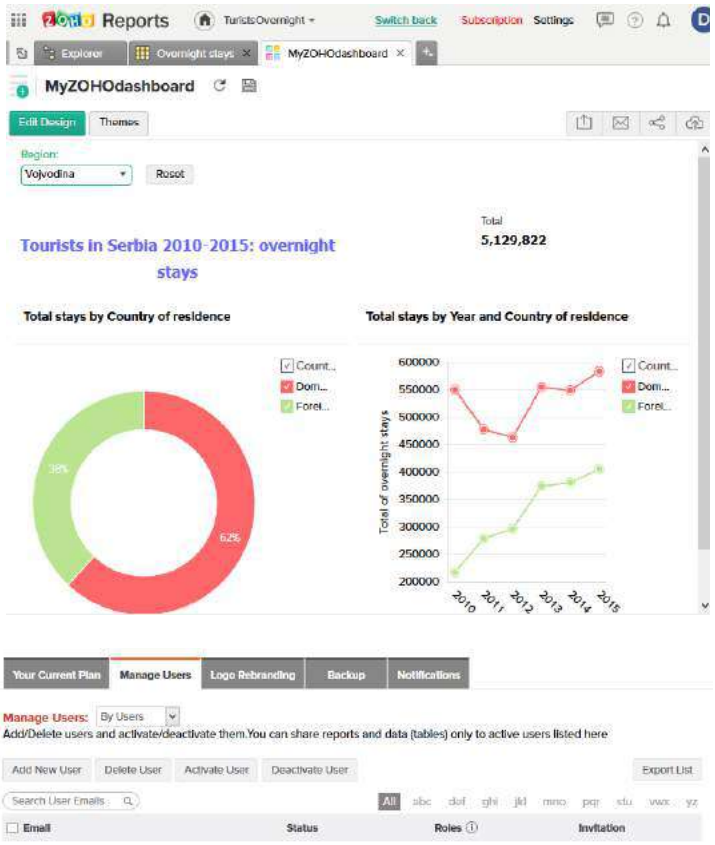

Image 1: A ZOHO dashboard

3. CULTIVATING THEM

To cultivate a particular skill, we need to use a digital tool that supports the development or refinement of that skill. Consider, for example, data modelling – a topic of increasing importance in mathematics, statistics, and computing education [6]. To cultivate complex thinking, we may use Neural Applet (http://aispace.org/neural), which supports this kind of modelling with neural networks. To cultivate complex thinking, as well as communication and collaboration, we may use a user-friendly ZOHO environment (https://www.zoho.com/reports/dashboards.html), which supports collaborative data modeling with dashboards (see Image 1).

Which kind of tool supports what thinking activities/skills? Following [5], we can make a distinction between tools for:

- semantic organization (e.g. concept maps, databases tools),
- knowledge construction (e.g. multimedia tools),
- dynamic modelling (e.g. spreadsheets, dashboards),
- interpretation (e.g. search tools, visualization tools), and
- conversation (e.g. conferencing tools).

Different types of digital tools may support different thinking activities/skills. As noted in [7], dynamic modelling tools may be used to promote all nine types of major thinking activities/skills listed above (see the last paragraph of the previous section), whilst interpretative tools may mostly be used to promote the activities/skills of evaluating, connecting, and imagining. Although conversation tools may primarily be used to cultivate evaluation, elaboration, and synthesizing, they may also support the activities/skills of designing, problem solving, and decision making when asynchronous conference tools are used.

As this brief note suggests, the development and refinement of a particular skill may be supported by different kinds of digital tools, and, for a particular task requiring a number of cognitive activities/skills, one tool may be more suitable than other(s). For example, we may prefer to use hypermedia for tasks that call for modelling domain knowledge. For tasks that call for modelling systems, concept maps may be the digital tool of our choice. And, regarding modelling problems, we may continuously choose between databases, spreadsheets, or a specific modelling tool such as Neural Applet. (For modelling different phenomena with different digital tools, see, for example, [8].) However, as underlined in [3], innovative, Cs-tailored learning experiences require educators (teachers, tool designers) to use a range of digital tools as a system of tools. This approach requires them not only "to choose the most appropriate technology for a particular aspect of a learning experience," but also "to holistically integrate multiple technologies into a dynamic and complete package where each aspect of learning is attended to and completely supported" (p. 78).

The requirement above demands a solid integration of pedagogical knowledge and technological knowledge. Referring to the framework of technological pedagogical content knowledge (or TPACK in short), it is clear that this integration requires educators to expand their pedagogical reasoning to technological pedagogical reasoning under the influence of their work with a system of digital technologies guided by the Cs model [3]. It can, for example, be done through connecting cognitive activities/skills (e.g., inquire, communicate, collaborate) with a system of technologies (e.g., Neural Applet, Movie Maker, Google Docs), supported by various pedagogical and technological scaffolds (e.g. a list of phases in an activity cycle, a description of tool affordances). However, as there are different ways to integrate content (i.e. subject matter), pedagogy, and technology in an appropriate way that may be subject dependent [9], this direction (from pedagogical reasoning to technological pedagogical reasoning) may in some cases be opposite (in case of computer science teachers, for example), or bidirectional with an influence on each other in an iterative way.

4. CONCLUSION

Innovative e-learning environments should call for different types of thinking (e.g., critical, creative, and complex), communication, and collaboration. To cultivate them, each learning activity encountered should be supported by an appropriate technology. As one technology can rarely be used to cultivate a number of learning activities (or it can be used but has rather complex tools), a system of technologies should instead be used in a holistic way. This demands educators to have solid technological pedagogical reasoning, which may be developed through relating a set of pedagogies (i.e. cognitive activities and engagements) with a system of technologies supported by various pedagogical and technological scaffolds (e.g., a list of phases in an activity cycle, a description of tool affordances).

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PERSONALIZED LEARNING SYSTEM BASED ON STUDENT BEHAVIOR AND LEARNING STYLE

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Abstract: *The paper describes advantage of system for distance learning based on the student activity in lesson and on the student results (self-assessment tests). Personalized adaptive systems represent the future for this type of learning. Based on results, system create different way through the learning process. The systems automatically check how much the student kept on certain activities in the learning process, create a student model, and after all create the learning path for the student. This avoids setting same lesson path for students with basic knowledge and those with advanced knowledge. The aim of the system is to get individual users needs, goals, and attributes, which may be important for systems that adapt to user at runtime context.*

Keywords: *Personalized learning, Adaptive learning E-Learning, Distance learning*

1. INTRODUCTION

Personalized adaptive systems for distance learning represent the future for this type of learning. The advantage of this system is that system is based on the student activity in lesson (self-assessment tests) and on the student results. Based on results, system creates different way through the learning process. This avoids setting same lesson path for students with basic knowledge and those with advanced knowledge. The aim of the system is to get individual users needs, goals, and attributes, which may be important for systems that adapt to user at runtime context. [1] The systems automatically check how much the student kept on certain activities in the learning process, create a student model, and after all create the learning path for the student. Before remedial teaching, all students took the prior knowledge assessment and the pre-test of the summative assessment and two-tier diagnostic assessment. Students then received remedial teaching and completed all teaching activities. After remedial teaching, all students took the post-test of the summative assessment and two-tier diagnostic assessment.

Result of this paper is best model to be used for possible implementation. System models of environmental phenomena have been described in many disciplines, for instance problem-solving methods and knowledge engineering, user models and human-computer interaction, and user / context models for adaptive user interfaces. [1] Based on the modeling of diagrams, this paper will show the exact appearance and functionalities of the future system.

Different students have different preferred ways to learn. Some may understand quickly through images, others may prefer texts and readings. [5] Some may deal well with theories, others may learn through experiments and examples. By gaining insights into different learning styles, it offers means to design and provide interventions that tailored to individual needs. [3] Moreover, several valuable advice can be provided to a wide range stakeholders. For example, for learners, insights into their own styles will enable them to be more confident in learning and optimize their learning paths. [6]

2. DEFINED METHODOLOGY

A variety of issues, such as the customization of learning content in computer-based learning activities, serve as the driving forces behind the wide range of adaptive capabilities. Many e-learning applications have been developed to accommodate a certain level of adaptability to an individual's performance based on their usage data, such as how many times they had visited for a particular learning module or which learning process patterns were seen. [2]

Based on personalized learning, and oriented toward students who listen to lectures via the Internet, this system serves for a better way of learning than the traditional one in the classroom. [3] For this type of teaching, this approach facilitates communication between students and professors, because at any moment they can share their opinions or if the student has questions, they can get an answer from the professor in short term.

Student's answers go to the algorithm which is defined so that the questions are determined based on previous responses of students. The principle is that when a student sends a response in the system, the algorithm processes it, and if everything is fine, it returns feedback to the student that they have accomplished the task successfully. [4] Also,

at that time, based on responses, from repository of questions it gives to the student the next question of the same or advanced levels. If the student did not answer the question in the required level then the algorithm takes from the database questions that are of lower rank and forwards to the student. When the user accesses the application for the first time, they get the first question which determines their level of knowledge, defining their subsequent learning. [12] The algorithm communicates with a repository of questions and at the same time it sends messages of help to students who work. [7] Help is used if a student has a problem in any step of solving tasks and it is addressed in this way. Students are also stimulated by system answers which show them whether they have accomplished successfully the task given by the system.

Personalization in online education not only facilitates learning through different strategies to create various learning experiences, but it also enables computer-based learning systems to include varied teaching or instructional packages. [2]

In this way, the system informs the student that they do not solved successfully the indicated task and suggests to the student to get back to lectures and study them further. [11] Also, the message includes an explanation of possible errors that could occur because the student's answer deviates from system response that is required. [9] The messages can be changed within the system, depending on the user (professor) or group of students using the above system. It is very important that the message is clear to the student and not too direct that it discourages them to continue solving new tasks.

The process of integrating learning styles into adaptive learning system can be divided into two main areas: learning styles prediction using online data (or the online learning styles classification model) and the application of this model into adaptive learning system. The development starts with choosing the learning styles framework. This is followed by the determinant of data sources and learning styles attributes and classification algorithm selections. [6]

3. MODELING OF PERSONALIZED ADAPTIVE LEARNIG SYSTEM

Student has the option, after registration to perform login to the system. Then the next step is to browse the courses within the system. When a student chooses a desired course, he/she can open a lesson (the learning process) and start reading. As part of the learning process, the student has the possibility to join the forum, get additional files that are available and submit their file through the form of the learning process. Also, the student can take a test which will determine the style (speed, pace, way) of learning and then move on to another lesson. Image 1 shows use case diagram for student user role.

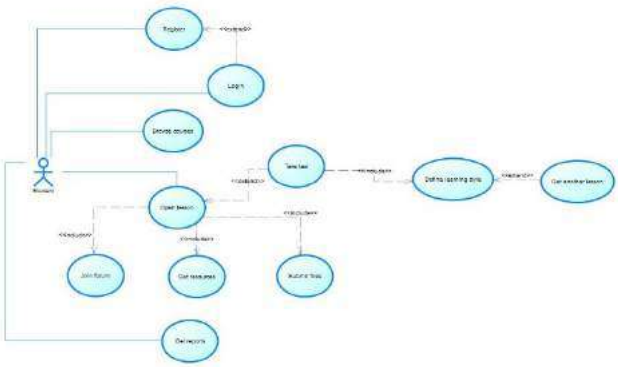

Image 1: Use case diagram for user role student

Student accesses the system (Image 2), if wanted student can start a course. Here is the first decision, if student does not want to start a course, student can get out of the system. If student decides to start a course, then must choose a lesson, and after selecting lesson, student can choose theory and practical tasks. If it is a theory, student passes through reading the lesson, discussion at forum, downloading shared resources and sending files. From the perspective of practical tasks (tests) users gives answers to questions and checks their evaluations. From starting the lesson, these processes are recorded in the student model, based on which the student receives the next the learning process

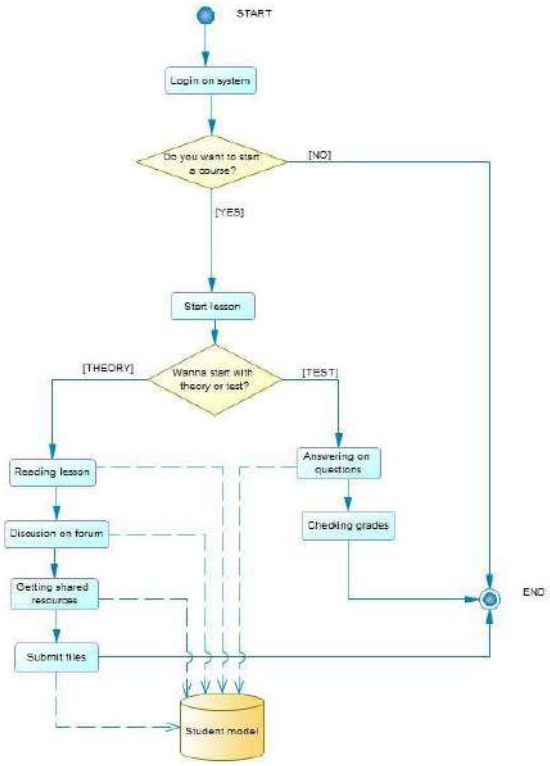

Image 2: Flow chart diagram for user role student

Image 3 shows the collaboration diagram for first learning path. The first student's access to lessons within a course takes place in the following manner. The student selects a course on the system and selects a lesson within the course. When the lesson is selected, the student gets access to the learning process. The learning process includes a theory

and practical test tasks. Student passes through the theoretical part and through the practical one. In this way, the student reads the lesson (theoretical part) and checks their knowledge by test set of predefined questions. Students can check their knowledge of independent testing which is not evaluated getting ready for the test that brings points. Time spent in the learning process in specific parts is counted. When a student goes through a learning process, system uses collected data for analysis and setting the next learning process to the student.

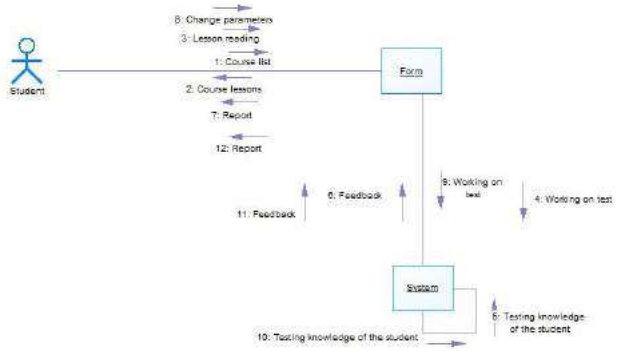

Image 3: Colaboration diagram – first learning path

After information from the first learning process, the system directs the student to another learning process (Image 4). Based on information from the student model, the learning process is defined. Student reads lesson, gets feedback from the system and takes the test. When the test is completed, the student receives feedback about performance on the test. Tested knowledge of the student is entered in previously obtained results in the system.

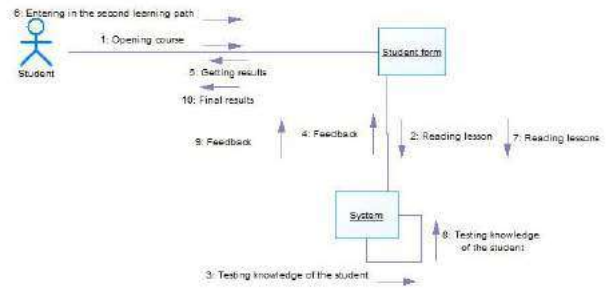

Image 4: Colaboration diagram – learning path

Use Case diagram for the professor shows the generation of a course in the system, followed by the development of educational materials such as lesson creation, material modification, activity modification and the creation of a learning process (Image 5). Also, the professor has the ability to check the student model, to plan activities and to download reports on students' activities. The last use case represents an evaluation of the student.

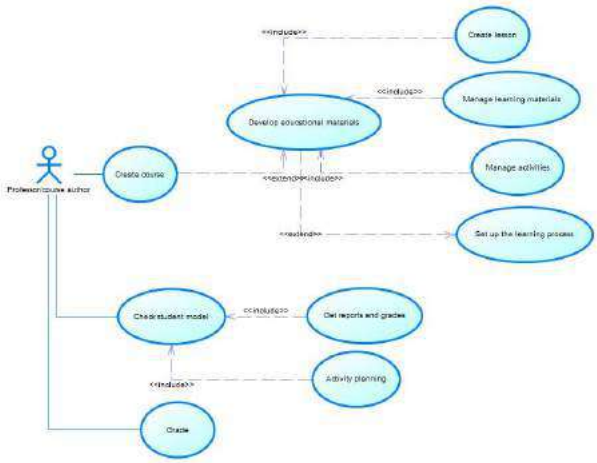

Image 5: Use case diagram for user role professor

Flow chart diagram for professor shows accessing the system, then creating a course and creating a lesson (Image 6). On the basis of modifying learning materials, professor-author of the course has the option of downloading material from the repository and the student model. From the repository of learning objects, professor takes teaching materials, from student model user receives data on students who are on the course. When basic lesson is set, the professor adds additional activities in the learning process and reviews the lesson. In addition, professor can review evaluations and reports from the system if necessary.

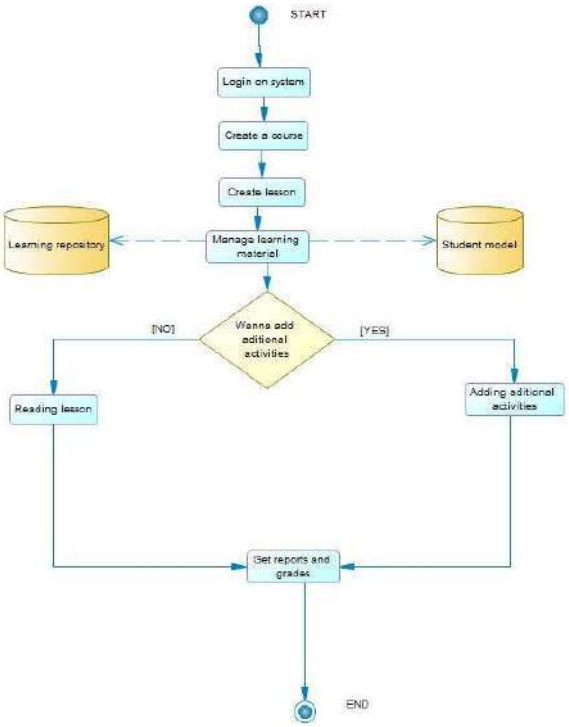

Image 6: Flow chart diagram for user role professor

4. IMPLEMENTATION OF PERSONALIZED ADAPTIVE LEARNING SYSTEM

The concept of learning path adaptation is developed from the field of adaptive hypermedia and depends on complex conceptual models, which is usually driven by sequencing rules produced in the courseware. In order to generate automatic learning path construction, knowledge elements are used to build a learning path and arrange them in proper sequence. On Image 7 is shown deployment diagram of the future system.

Deployment diagram consists of:

- Web server (Student administration)
- Application server (Student, course admin, learning process, course, course management)
- Database server (LMS DB, IS DB)
- User client

Web server has data on the student and communicates with the application server.

Application server provides information on the results of the students, the administrators and authors of the courses, the learning process that has been created, the course including the learning process as well as basic information about the administration of the course.

Database server contains system database and database of the central information system of the University.

User client accesses the application and gets the necessary information from the system.

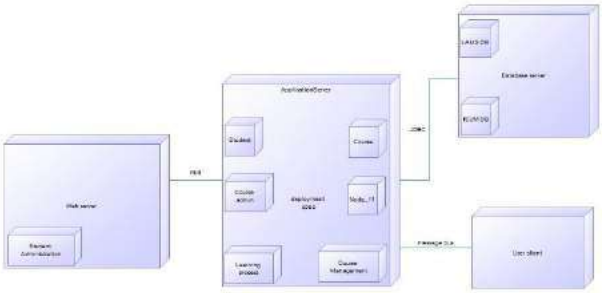

Image 7: Deployment diagram of the system

The system communicates with the database, repository of learning objects and question pool. The system itself is divided into components: lessons, test, questions and results and which have forms for the entry of certain data.

The Lesson component contains reading form, PDF form and content downloading form. This component of the system is used by the student.

The test component comprises a form to open the test, a list of questions in the form, form to enter responses and to submit the form. This component of the system is used by the student.

The Questions component contains forms for test creating, answers to questions and additional instructions when creating questions. This component is accessed by professor, author of the course.

The Results component displays obtained test results to the student and contains two forms for a result list and for results of the individual test. This component of the system is used by the student.

The choice and sequence of knowledge elements can be determined by several characteristics of the student, for instance by their learning styles, preferences, abilities or by some constraints, such prerequisites of the course and length of study. A learning path generation algorithm searches the best possible match between each student on one hand; and the learning objects or pedagogical requirements on the other hand.

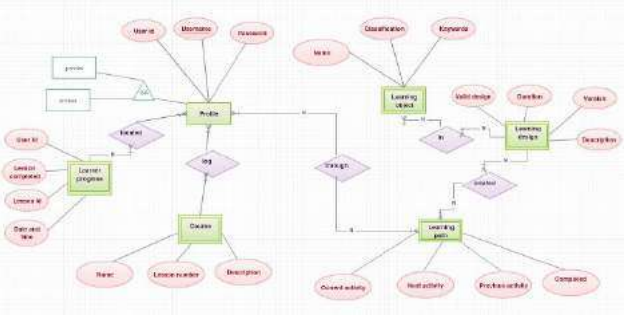

Image 8: E/R diagram of the system

Image 8 shows an ERD what data is being used in the process or program, and how the files are related. The E-R (entity relationship) data model views the real world as a set of basic objects (entities) and relationships among these objects. It is intended primarily for the database design process by allowing for the specification of an enterprise scheme. This enterprise scheme represents the overall logical structure of the database. ERDs do not show any program functions, nor data flow.

5. PROBLEMS IN MODELING LEARNING PATH

Although an adaptive learning path will improve learning efficiency in the online learning system, however implementing learning path activities in a real-world situation are quite different, especially when included it in the LMS. For instance, it is possible to adopt learning styles and learner profiles, however, it is tricky when including these parameters in LMS. It will require taking into account both the type of each learning task and the opinion of an expert to assess the students' learning styles. It also needs to map types of learning styles with the types of tasks to decide which combinations are better.

Another instance of the challenge is related to the number of learners, which actually affects the students' learning achievements significantly. Some researcher suggested to given consideration to the real-world learning objects and the number of students who visit the same learning objects. In learning path adaptation, this approached is called as social sequencing. As each learning object represents different concepts to be learned, it is dificult for the students to determine the learning path for visiting the target objects without any guidance. Hence, the solution in social sequencing will incorporate the experiences of other similar learners. However, if the learning path from social sequencing is not well arranged, the learners might fail to understand the relationships among those learning objects. This will likely cause the disorientation in the learning process.

The second type of challenge comes from the need to achieve competency from learning path adaptation.

Competency is defined as a measurable ability of an actor to perform a necessary action in context to achieve a specific outcome. Competencies such as prerequisites and learning outcomes are dealt with in meta-data definitions. By defining a competency as a learning object outcome and as the prerequisite for another learning object, then a constraint between the two learning objects might be established so that the first one must precede the next learning object in a valid sequence. The definitions of metadata description are attached to learning objects, and within those definitions, references to competencies are included (prerequisites and learning outcomes).

One of the goals of the study in the online learning system is to allow learners study in their own way. Although the learning is being personalized, however the curriculum is still needed to drive the direction of the learning. The adaptive learning path is expected to be one of the ways to achieve the curriculum. Therefore, further investigation in analyzing and mining the data from the interaction of the learner with the online learning system is essentially needed. The more relevant information on the models, the better adaptation and personalization will be.

Results of previous research into learning path has focused on optimization problem. Survey papers by offer probably the most comprehensive study related to optimization personal learning path using evolutionary computing approaches. Many works based on soft computing techniques has been developed to achieve an adaptive learning path. It would be interesting that further studies be undertaken in exploring soft computing techniques to provide adaptive learning path with the new massive (MOOCs) and seamless online learning environment.

6. CONCLUSION

Constructing and optimizing learning paths is a key issue in personalized online learning systems. This paper reviews the important related research issues. The issues can be categorized in a number of layers of abstractions that are instructive: issues related to the main concept and integrating all other the issues involved, issues related to the construction and optimization process, issues related the problem formulation and knowledge representation involved in adapting the learning path in the online learning system. Several approaches to each of those categories of issues were discussed. Specifically, we also provided our analysis along the following domain dimensions: the learning target, the learner, and the pedagogy. Although significant progress has been made in along all dimensions and categories of issues, there is clearly much work needed in this area.

Based on the modeled diagrams, personalized adaptive distance learning system is presented. Use case diagrams showed the manner of use of the system by two user roles, student and professor (author of the course). Modeling use case diagrams is followed by modeling flowchart diagram and dataflow diagram which shows the flow of data and processes within the system itself. Once the system process has been defined, the next step is the database model and class diagram to display the system classes. These diagrams completed the process of system modeling and display of all future functionalities.

The teacher responsible of the course can decide to use another personalization strategy (such as the second one in the sorted list of the personalization strategies) when student does not prefer or has some constraints to use the first personalization strategy. This opens two potential future directions. The first one consists of modeling the teacher preferences of personalization strategies (for example, the teacher likes to include a specific personalization parameter in the personalization strategy to use). The second direction deals with considering general constraints of using personalization strategies. These constraints could be pedagogical (when a specific combination of personalization parameters is not recommended from pedagogical perspective) or technical (when a specific implementation related to a personalization parameter is not available).

While the review offers insights into trends, open problems and recommendations for future research opportunities, it is still important to point out its limitations. As faced by many literature review researches, there is the possibility of missing out published papers in the field which may due to a number of sources.

First, there is a huge amount of search results as well as their synonyms that can be related to the topic. [5] For example, while there are authors associate the task of “detecting” online learning styles as learning styles “classification”, others denote it as “prediction” or “modelling” or “evaluation” or “diagnosis” etc. Or in an-other sample, the application of learning styles can be found in “intelligent tutoring systems”, “adaptive instruction system”, “personalised learning system” or “adaptive system” etc. Only top articles could be considered and as the result, the quality of the research is search engine’s efficiency dependent.

Advantages of modeling adaptive learning system are:

- Learner use cases in the system
- Identifying conflict use cases through the learning process
- The flow of data through the learning process
- Identifying processes that perform learning outcome of student knowledge
- Possible problems in checking student knowledge
- Improving the assessment process in the system
- Analyzing path of the user through the process of learning
- Checking the results of the review user process in system
- Identifying functionality in student testing part

One of the solutions it to base the University on its own research and analyses of students and consequently to develop and adapt the system to its own needs.

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EDUCATIONAL DATA MINING FOR STUDENT PERFORMANCE PREDICTION IN SLIDEWIKI OPENCOURSEWARE PLATFORM

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Abstract: *To better understand and optimize the learning process and environments in which it occurs, educational data mining (EDM) recently gained its importance and momentum. One of its popular application fields is dedicated to student performance prediction using data mining and machine learning techniques. This paper presents the conceptual approach to student performance prediction that will be deployed in SlideWiki authoring OpenCourseWare platform. In this regard, two different but complementary approaches will be considered: 1) student similarity based approach (discovery of students with similar performance) and 2) model-based approach (estimation of correlation among exam results). Both classification and regression methods will be implemented to discover students under "high risk" for dropping out from the course and to predict the future student achievements (such as final exam grades). For this purpose, relevant student-related features will be taken into account, such as past student performance, student engagement, student demographic and contextual data.*

Keywords: *Learning analytics, educational data mining, student performance prediction, e-learning*

1. INTRODUCTION

Learning analytics can be defined as measurement, collection, and analysis of data about learners and their contexts [1],[2]. The goal of learning analytics is to better understand and optimize learning process and the environments in which it occurs. It is closely related to the field of *Educational Data Mining* (EDM) [3], concerning the application of data mining, machine learning (ML) and statistics to information generated in educational settings (e.g. universities and intelligent tutoring systems) in order to discover new insights about how people learn [4],[5]. As OpenCourseWare (OCW) platforms are aimed to host open, web-based educational materials, usually organized as courses, while involving also course planning materials and evaluation tools, they represent challenging playground for application and exploitation of learning analytics. Nowadays, OCW platforms provide flexible learning environments and allow for automatic collection of student learning data including student activity, performance, etc. These large amounts of data represent a valuable source of crucial information for teachers and administrators alike, when analysed with appropriate data mining techniques. A variety of possible learning analytics application facilitates provision of detailed student performance metrics and even automatic online adaptation of the course modules, etc.

Until today, a number of studies were published, such as [6]-[9], focusing on student performance analyses mostly in educational institutions. Most of these studies were aimed to solve the problem of student classification into two categories (either pass or fail), i.e. to predict "high-risk" students of dropping out from a given course. For instance, authors of [6] applied different ML techniques (such as Naïve Bayes, k-Nearest Neighbours (k-NN), etc.) to classify students into dropouts and non-dropouts and showed that dropout-prone students can be detected using only students' demographic data. Several learning algorithms were investigated in [7] to predict the final test grades for students enrolled in a web-based course. In this research, students' results were categorized into three classes: dividing students into two ("pass" and "fail"), three (high, middle and low), and 9 classes (according to the achieved grade). Authors of [8] conducted a study on k-NN based classification of students into those who would "drop out" and those who would complete the final test of online touch-typing course. Moreover, a study included a regression in order to predict actual scores of the students' final test. In a study [9], k-NN was used to predict which level of study material is shown to students depending on their abilities and performance. These studies mostly showed that each of the ML algorithms could provide satisfactory results, performing roughly equally, while differences in performance could be experienced depending on the type of available input data.

In this paper, a high-level conceptual approach to student performance prediction was presented, aimed to be deployed in SlideWiki authoring OCW platform [10]. This

platform is being developed as a part of the H2020 EU research and innovation project SlideWiki (Grant Agreement No 688095) aiming to create a large scale accessible learning and teaching platform, using educational technology, skill recognition and global collaboration. During the course of the SlideWiki project, a designated "learning analytics" module will be developed to perform analysis of learning data acquired by SlideWiki platform. More precisely, this module will be designated to provide, among other tasks, student performance predictions based on past learning data. For such a task, two different, complementary approaches will be considered for deployment. The first one is student similarity based approach that will leverage performance prediction on discovery of students with similar past performance. On the other hand, the second approach is model-based approach that will be based on estimation of implicit correlation among exam results for performing the prediction. Classification methods will be deployed to discover students under "high risk" for dropping out from the course, while regression will be exploited to predict the future student achievements such as final exam grades. For this purpose, relevant student-related features will be taken into account, such as past student performance, student engagement and student demographic and contextual data. In this way, SlideWiki will provide support to both students and educators in the overall learning/teaching process, such as:

- prediction of students requiring additional support and attention, e.g. to identify students "at risk" in terms of dropping out or course failure,
- provision of tailored learning pathways or assessment materials to individual students based on identified achievement patterns comparing to other students,
- provision of relevant information to educators so that the additional teaching staff could be recruited or intervention could be planned to support students (individuals or groups), and
- identification of courses and teaching programs that need improvement, adaptation or development of new curriculum offerings.

The remainder of this paper is organized as follows. Section 2 presents the underlying methodology for learning analytics in SlideWiki OCW platform and student performance prediction. Section 3 investigates different types of user-related features that will be exploited for performing the predictions of student performance. Student similarity based and model-based approach to performance prediction are briefly described and investigated in Section 4. Finally, Section 5 provides the concluding remarks of this paper.

2. UNDERLYING METHODOLOGY

As SlideWiki project aims to provide a large scale accessible learning and teaching platform, one of its goals is to deploy various advanced modules for performing analysis upon the user data (activities, performance, etc.) acquired by the platform. Therefore, the underlying methodology of SlideWiki should also specify conceptual

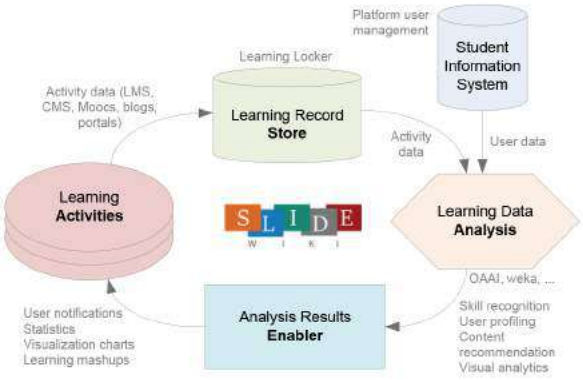

Image 1: Learning analytics in SlideWiki OCW platform [11]

approach and how these analytics modules will be integrated in the SlideWiki OCW platform and overall architecture. Conceptual approach to learning analytics in SlideWiki is shown in Image 1. It depicts all relevant modules, starting from tracking the learning activities (by the designated activity-service), storing the activity data (in Learning Record Store - LRS), performing the learning data analysis (by designated modules), to presenting the analysis results to the user (through the user notifications, statistics, visualization charts, etc.).

For representation of usage and learning activity data, existing and well defined data model xAPI (or Tincan API) will be evaluated as one of the candidates. To collect and store such data, Learning Locker will be considered as suitable solution for deployment and maintenance of LRS. In this way, SlideWiki will acquire and store all data regarding activities performed by the registered users/students in LRS. The acquisition of user data will be managed by the activity-service which will handle the events (i.e. user activity instances) whenever they are triggered. More precisely, each event will be sent out, according to adopted data model, by the originating module/service to the activity-service. Transformation of the received event according to the xAPI specification could be performed either by the activity-service itself, or by the designated xAPI-service upon the reception of the event (from the activity-service). Finally, xAPI compliant event/activity data will be forwarded to the SlideWiki LRS for storing.

In addition to data acquired directly by the SlideWiki OCW platform, external data (originating from the external Learning Management System – LMS integrated with SlideWiki platform) could also be stored into LRS and further exploited for analyses. In that way, all acquired user activity data, stored within LRS, will be made available to the different analytics modules of SlideWiki, such as [11]:

- *User Profiling & Skills Recognition* – Detection of user skills, preferences, etc. based on the collected user activity data. Skill recognition will also enable learners segmentation and user profile enrichment.
- *Content Recommendation* – Recommendation of content and teaching material (e.g., decks, slides, etc.) to the users based on their profiles.

- *Advanced Learning Analytics* – Student performance prediction and trend analysis by deploying ML techniques upon user activity and performance data. Activity and usage data (stored in LRS), combined with user profiles and learning content (stored in SlideWiki DB) will facilitate extraction of individual performance (e.g. course progress) prediction, early alerting for educators interventions, etc.
- *Interactive Visual Analytics* - Interactive web-based module (based on JS & HTML5 libraries) for the user to visualize, explore and analyze SlideWiki activity data. It will provide simple usage reports and statistics, as well as faceted browsing, trend visual analysis, graph analysis, time-lines, etc.

The aim of advanced learning analytics module in SlideWiki will be to provide insights into the students' learning process by forecasting the student performance. This considers prediction of student performance on future exams, i.e. the grade that student would most likely achieve. Prediction of future exam results will be leveraged upon student related data acquired by the SlideWiki platform, such as past student performance, i.e. the grades already achieved on previous exams. Furthermore, learning analytics module in SlideWiki will exploit implicit correlation among different courses (i.e. exam results) and will be implemented in two ways:

1) *student similarity search*, and
2) *model-based approach*.

Student similarity search will be leveraged upon discovery of students which have similar past performance (i.e. past grades and assessment scores) as the analysed student whom the prediction is for. Similarity with other students will be evaluated e.g. by comparing their performance and engagement. Based on student similarity search, the most similar students (to the student whom the prediction is for) will be taken into account for performance prediction. Prediction will be made based on the exam results that are associated to most similar students, but are not associated to the analysed student (who did not yet take the exam to be predicted). In this way, by discovering students with similar performance and based on their achievements on other exams (not yet taken by the analysed student), SlideWiki will be capable of predicting the future performance of the student.

The second way is model-based approach that will be leveraged upon estimation of implicit correlation among past exams and future ones. More precisely, based on estimated correlation coefficients, student achievements on future exams will be predicted. The correlation among exams of the same course or within the faculty department (to ensure that exams are correlated with each other) will be estimated based on the past exam results that are known (i.e. past student performance). Correlation among exam results will be identified in an offline optimization or training phase that will be further exploited to perform the prediction of student performance.

Leveraged upon relevant student-related features, SlideWiki will provide performance prediction using both above-mentioned approaches. In other words, only relevant input data, i.e. student-related features will be fed into the learning analytics module for performing the prediction. These student-related features should include all data relevant for the learning analytics, e.g. past exam results, student activities, duration and number of learning material visits, commenting and participation to related discussions, etc. The selection and type of student-related features are elaborated in Section 3, while more detailed analysis of performance prediction approaches and suitable ML techniques is conducted in Section 4.

3. USER-RELATED FEATURES

Prior to selection of suitable student performance prediction approach, it is important to identify relevant input data, i.e. student-related features (such as student performance, activities, contextual data, etc.) that will be fed into the learning analytics module. In [7] it was found that the lesson scores, i.e. the student past performance was the most influencing feature. The second most relevant feature was the number of attempts, while other features provided less information to the prediction. Moreover, the authors of [8] investigated different sets of features for prediction. More precisely, at first, features were simply included or excluded, while later on feature weighting was utilized. They also concluded that student past performance alone performed satisfactory, even marginally outperforming the combination of different features, while student demographic data provided only minor improvement in some cases.

As specific features have different relevance and influence to the prediction, to improve prediction performance, adequate feature weighting should be taken into account that will give preference to more relevant input data. Certainly, the extreme case of such investigation would be having exclusion or inclusion of designated features. Nevertheless, to maximize the prediction performance, domain knowledge should be provided as a support to the allocation of the best performing sets of weighted features. Having previously mentioned in mind, learning analytics module for student performance prediction in SlideWiki will analyse students based on the predefined set of student-related features. As previously mentioned, this set of relevant student-related features will unambiguously represent each student as a specific point in multidimensional vector space.

As part of relevant student-related features, the following will be taken into account:

1) *student past performance* (past exam results, i.e. grades that student achieved by taking the exams),
2) *student engagement* (e.g. duration and number of deck visits, search activity, participation to related discussion, deck commenting, exam attempts, etc.), and
3) *student demographic data* (e.g. age, skills, date and time, location, etc.) will be considered for analysis as well (particularly in case of student similarity search).

All data, i.e. student-related features, will be collected implicitly and automatically by SlideWiki platform

throughout tests and exams accompanying the teaching material (i.e. decks). After appropriate anonymization, these data will be stored in LRS of SlideWiki. Learning analytics will be performed directly upon LRS in order to predict future student performance (grades and exam results). In other words, by applying suitable ML techniques upon data stored in LRS (such as data mining, pattern search for similar students, model optimization upon preselected courses, etc.), performance prediction will be performed.

Moreover, apart from data directly collected by SlideWiki platform, additional data sources will be taken into account such as existing LMSs, integrated with SlideWiki platform in order to provide insights into the past learning activities of the students. Often, LMSs track a variety of information such as time when student accessed learning material, how many times it was accessed, grade that the student earned in each course, time when the student selected or changed his or her academic major, etc.

4. PERFORMANCE PREDICTION APPROACH

There is a number of approaches, including various data mining and machine learning techniques, which could be applied for learning analytics, i.e. student performance prediction (Baker [12]). Having in mind the goal of learning analytics in SlideWiki, existing methods for classification and regression will be considered for implementation. Classification methods will be utilized to classify the analysed student either as under "high risk" or "low risk" for dropping out from the course or failing the final exam. On the other hand, regression methods will be deployed to predict the future student performance as part of specific course or exam (as final exam grade).

Student similarity search

In opting for a most suitable technique, it should be kept in mind that SlideWiki will eventually have large, constantly growing and highly variable LRS of student activities and exam results, as it will be constantly updated with new teaching content and student engagement related information. Upon such LRS, learning analytics module will have to perform prediction of student performance, i.e. future exam results. Having this in mind, the first approach, leveraged upon student similarity by comparing their performance and engagement, does not require any "old-fashion" model training and provides solution directly applicable upon the LRS in finding the most similar students. In this regard, according to the literature, one of potential techniques suitable for implementation of such approach is *k-Nearest Neighbours* (k-NN) algorithm as one of the widely utilized techniques in machine learning and data mining. More precisely, k-NN algorithm represents a non-parametric method often used for classification and regression problems. As such, k-NN algorithm can be applied for similarity-based student performance prediction. Basically, k-NN algorithm will perform the similarity search upon LRS to find k most similar students, based on student-related features, i.e. student engagement and past performance. In addition, student demographic and contextual data (e.g. age, skills, date and time, location, etc.) will be considered for analysis as well. Each student represents a point in multidimensional space of student features (past exam results, visited decks, liking and rating, commenting, etc.), whereby each student feature represents a single dimension:

$$u = [u_1, u_2, u_3, \dots, u_m], \quad (1)$$

where u indicates the user/student, and u_i indicates the student-related feature (in m-dimensional space where set of m features defines a student).

In such multidimensional space, distance of the analysed student (the student whom the prediction is for) from other students will be calculated and k nearest "neighbours" (i.e. the students with most similar past performance and activities) will be extracted. Student distance will be calculated based on Euclidian distance in case of real value features such as exam grades and/or Hamming distance in case of features such as deck visits, likes, etc., as follows:

$$d_{u_i} = \sum_{i=1}^{m} w_i |u_i - u'_i|, \; u_i \in U, \quad (2)$$

where d_{u_i} indicates the distance between student u_i and analysed student u_i', w_i weighting coefficient per student-related feature, while u_i is taken from U representing all students of SlideWiki platform. In order to discover k nearest neighbours, corresponding weighting of student-related features (indicated by w_i) will be applied according to the feature relevance and potential impact on the performance prediction. Particularly popular approach to the weights estimation in the literature is the use of evolutionary algorithms (e.g. genetic algorithm) to optimize the feature scaling (Nigsch et al. [13]), which could be one of the possibilities.

Finally, by cross-matching student performance associated to k nearest neighbours (according to past exam grades, visits, comments, positive rates, etc.), average exam grade of specific courses will be evaluated by averaging grades achieved by k nearest neighbours, as part of regression analysis. In addition, as part of classification analysis, risk of "dropping out" from the course or failing the exam will be analysed based on k-NN as well.

Model-based approach

As part of the second approach, model-based performance prediction will be deployed in SlideWiki, while exploiting the implicit correlation among courses and exam results (e.g. within school department or other related courses). In this regard, performance prediction will be performed based on the past exam results (and/or course engagement) and it requires classical training or weighting coefficients estimation of underlying model (such as linear regression model, artificial neural networks, support vector machines, etc.). In other words, underlying model will be first optimized and then utilized for prediction of unknown variable, i.e. the future exam result. Apart from the exam results prediction, key applications of model-based approach include discovering relationships between student behaviour, characteristics and contextual variables in the learning environment [12].

As model-based approach does not provide sufficient generalization capabilities in terms of tackling new content and generally huge teaching material, and to avoid large, computationally demanding, complex models (due to

dimensionality of the problem) requiring permanent coefficient adjustments, performance prediction will be restricted to predefined set of related teaching materials (such as within one course/department potentially having high degree of correlation). To apply already optimized model on another set of teaching materials and courses, additional training and coefficients fitting are needed to be performed for targeted content. One of the possibilities to implement this more generalized solution would require possibility to perform training in an automatic way, by preselecting the desired courses (for model optimization), for instance, by teacher or professor.

Generally, model-based performance prediction consists of four phases [14],[15]:

1) The first phase (not counting pre-processing) is discovering implicit relationships and correlation in analysed data. This involves also identifying relationships between analysed variables (i.e. exam results and courses) through a model optimization upon the repository of data.
2) Discovered relationships and correlation coefficients must be also validated in order to avoid overfitting. This is usually carried out along with the model optimization.
3) Validated relationships, i.e. optimized model is then applied to make predictions about future events in the learning environment (i.e. results of future exams).
4) Predictions are used to support decision-making processes and policy decisions.

One of potential techniques for model-based performance prediction that will be taken into account is *linear regression analysis*. Regression analysis is often used for prediction purposes (Pedhazur [16]) and represents a statistical process for estimating the relationships among variables. In other words, linear regression is an approach for modelling the relationship between a scalar dependent variable y and one or more explanatory variables (or independent variables) denoted as X. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regression (Freedman [17]). In linear regression, the relationships are modelled using linear predictor functions whose unknown model parameters are estimated from the analysed data. Such models are called linear models (Seal [18]).

Given a data set $\{y_i, x_{i1} \ldots, x_{ip}\}_{i=1}^{n}$ of n statistical units, a linear regression model assumes that the relationship between the dependent variable y_i and the p-vector of regressors x_i is linear. This relationship is modeled through a disturbance term or error variable ε_i - an unobserved random variable that adds noise to the linear relationship between the dependent variable and regressors. Thus the model takes the form:

$$y_i = \beta_0 1 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i = \boldsymbol{x}_i^T \boldsymbol{\beta} + \varepsilon_i, \qquad (3)$$

where $i = 1, \ldots, n$ and ^{T} denotes the transpose, so that $\boldsymbol{x}_i^T \boldsymbol{\beta}$ is the inner product between vectors $\boldsymbol{x}_i$ and $\boldsymbol{\beta}$.

Often these n equations are stacked together and written in vector form as:

$$\boldsymbol{y} = \boldsymbol{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}, \qquad (4)$$

$$\boldsymbol{y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, \quad \boldsymbol{X} = \begin{pmatrix} \boldsymbol{x}_1^T \\ \boldsymbol{x}_2^T \\ \vdots \\ \boldsymbol{x}_n^T \end{pmatrix} = \begin{pmatrix} 1 & x_{11} & \cdots & x_{1p} \\ 1 & x_{21} & \cdots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{np} \end{pmatrix},$$

$$\boldsymbol{\beta} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{pmatrix}, \quad \boldsymbol{\varepsilon} = \begin{pmatrix} \varepsilon_0 \\ \varepsilon_1 \\ \vdots \\ \varepsilon_p \end{pmatrix}.$$

Linear regression models are often fitted using the least squares approach, but they may also be fitted in other ways, such as by minimizing the "lack of fit" in some other norm (as with least absolute deviations regression), or by minimizing a penalized version of the least squares loss function as in ridge (L^2-norm penalty) and lasso (L^1-norm penalty) regression analysis [19].

5. CONCLUSION

Learning analytics recently gained its importance and momentum in order to better understand and optimize the learning process and environments in which it occurs. In this paper, the conceptual approach to student performance prediction, aimed to be deployed in SlideWiki authoring OpenCourseWare platform, was presented. In this regard, two different, but complementary approaches were investigated for deployment: 1) student similarity search (discovery of students with similar performance) and 2) model-based approach (estimation of correlation among exam results). Both approaches will be considered for performing classification as well as regression, in order to discover students under "high risk" for dropping out from the course. Moreover, suitable student-related features, as input data for learning analytics module, were analysed considering past student performance, student engagement and student demographics data.

Challenges associated with implementing learning analytics module and EDM applications include storing potentially large amount of learning data. Moreover, different data sources may not always integrate seamlessly with one another (e.g. data coming from different LMSs), requiring efforts in terms of interoperability and integration. Nevertheless, implementation of the overall EDM strategy should respect privacy and ethics for all stakeholders involved [20]. Both student similarity search (leveraged upon k-NN algorithm) and model-based approach to learning analytics may suffer from three problems [21]:

- Cold start – both approaches require a substantial amount of existing data on student in order to make accurate prediction. Therefore, it is necessary to take into account the "initialization" phase for acquisition of student-related data or importing already existing student performance data (such as from external LMSs) before performing similarity search or model optimization.

- Scalability – as LRS database can eventually have large amount of learning data, high computation power will be required for proper analysis (particularly in case of k-NN). Among approaches that could improve the scalability are: similarity search algorithm (optimised linear search; bottom up search per teaching material), feature extraction & dimension reduction (clustering of similar decks/students; temporal constraint - only most recent records are used for model optimisation), dataset partitioning (analysis performed in parallel).
- Sparsity – often only the most active students are engaged (e.g. commenting, discussion participation, taking online exams) with a small subset of the overall content database. One of the remedies for this issue is to explicitly trigger the student engagement with the SlideWiki platform (e.g. asking a student to comment, to rate, search or to rank) and generally to take the online exams accompanying the teaching material.

As part of the future work, other ML techniques will be more thoroughly investigated for deployment of both student similarity and model-based approach into the SlideWiki OCW platform. Apart from k-NN and linear regression model, among other techniques that could be applied to the student performance prediction are support vector machines, artificial neural networks, decision trees, matrix factorization and Bayesian statistical models.

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AN ONTOLOGY BASED APPROACH TO ASSESSMENT IN MEDICAL EDUCATION

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Abstract: *Today, medical healthcare professionals are under the pressure to adopt advanced learning methodologies such as continued medical education, self-directed learning, and technology enhanced learning due to the need for permanent knowledge improvement. Regardless of methodological and technological differences, all educational approaches have assessment in common. The medical practice requires higher-levels knowledge assessment where ontologies represent one of the most promising approaches to automation because of the capability for fine-grain knowledge management and reasoning. In this paper, the reference ontology called MAMO – Medical Assessment Methods Ontology is proposed and used for semantic description of computer based medical assessment methods. It represents foundation for automatic generation of different assessment methods in medical education based on knowledge from a RDF/S Knowledge Base (KB). The semantic descriptions are evaluated on examples from various fields in medicine.*

Keywords: *Ontology, Assessment tool, Medical Education, online learning*

1. INTRODUCTION

Medical education (ME) concerns the practice of being a medical practitioner including initial training to become a Physician Assistant (PA) or a Medical Doctor (MD) through a medical school and internship as well as additional training thereafter through residency and fellowship. Goal of ME is to supply modern society with knowledgeable, skilled and up-to-date professionals who put patient care in first place, and commit themselves to further develop their expertise over the course of a lifelong career [1]. ME features constant advancement in practices, high level of knowledge specialization, very specific skills and frequent introduction of new procedures and treatments. Consequently, ME institutions are under high pressure to develop new and improve existing assessment methods in a context of new advanced curricula and teaching processes.

Assessment methods in ME have traditionally been based on faculty observations, oral examinations, and multiple-choice tests [2]. Major obstacle for the most of the assessment methods in medical education to address higher cognitive skills lies in the high cost of their construction because in order to show its full potential questions must be authored by a highly skilled professional. However, this is often not the case due to a number of reasons including difficulty to secure the right person for the job, high cost related to engagement of specialists, organizational and management barriers, etc. On the other hand, wide adoption of Semantic Web [3] and Linked Data [4] in different application domains strongly supported increasing level of maturity in using ontologies for knowledge representation, engineering, and management. Adoption of ontologies is particularly promising when scalability is needed, either due to massive data used or a large number of users involved, while the task in hand requires an expert level knowledge that is specific for the target application domain. The automation is supported by the formal foundations of ontologies that makes them effective for software implementation, such as in semantic [5] and Big Data technologies [6]. The formal foundations enable advanced domain modeling and algorithm development even in the most challenging applications where sophisticated human-expert reasoning has traditionally been the only choice.

Existing literature [7, 8, 9, 10, 11, 12, 13, 14,] presents successful application of ontologies for the generation of assessment methods in different areas of science. Assessment Design and Delivery System (ADDS) was designed to aid non-expert physics teachers in designing appropriate assessments [10]. OntAWare system [8, 9] focuses on the generation of SQL exercise problems for database students. Tutoring system (Tex-Sys) [7] was used for automatic generation of objective questions (i.e. MCQs, T/F) over ontologies. SeMCQ system [11,12] was developed to automatically generate Multiple Choice Questions (MCQ) at different levels of Blooms taxonomy from a given domain ontology. Ontology-based MCQ item generation system known as OntoQue [13,14] assesses the analogical reasoning ability of students.

Consequently, it can be concluded that when ontology is used, it is possible to focus generated assessment material on a selected level of knowledge. Because the process is automated, it is easily scalable. Therefore, the main research question addressed in this paper is how to successfully apply ontologies in medical education. To the best of our knowledge, this paper for the first time proposes ontology capable to describe most of the computer-based assessment methods in medical education.

The rest of the paper is organized as follows: In section 2 (Medical Assessment Methods Ontology) a brief overview of the most commonly assessment methods is given, along with a MAMO design description. In section 3 (Testing), two representative examples of semantic description of questions from various fields in medicine are given. Section 4 (Conclusions and future issues) concludes the paper and gives directions for future work.These instructions must be used for text processing. The instructions define the page layout, as well as styles to be used in formatting.

2. MEDICAL ASSESSMENT METHODS ONTOLOGY (MAMO)

Ontology is defined in different areas of science and philosophy in somewhat different ways. In information science, ontology is defined as a shared formal conceptualization of a domain of discourse. A domain ontology (or domain-specific ontology) formalizes concepts that define a part of the world together with terms corresponding to their meanings. Domain ontology is usually used as a semantic foundation of an associated knowledge base containing facts about the domain. In this way, formal reasoning about the domain, semantic search, automatic code generation and other advanced knowledge-based data manipulation techniques are possible.

For development of the Medical Assessment Methods Ontology (MAMO), the SABiO development process was adopted [15]. In order to define scope of MAMO, the two most important competency questions are identified: 1) What is the knowledge domain that the ontology will cover, and 2) What the ontology is going to be used for. Ability to support semantic annotation of different assessment methods in medical education is determined as what the main purpose of MAMO ontology should be. In addition, we envision MAMO to be used as the foundation for automatic generation of different assessment methods in medical education based on knowledge from a RDF/S Knowledge Base (KB). Hence, it is defined with a goal of development of formal specifications for medical assessment methods. Also, semantic descriptions of assessment methods represent foundation for other advanced knowledge processing applications, such as automatic generation of assessment materials.

2.1 MAMO capture and formalization

In this section, a summary of conducted exhaustive analysis of different assessment methods, that have been used in medical education since 1950s are given first. Then, it is used for development of conceptualization formalized in a form of concepts and relationships in MAMO ontology. Finally, design and implementation of the ontology is described.

Through years, assessment methods changed from mainly oral and written pan-and-paper examinations at the beginning, to clinical simulations and multisource assessments. The wide range of currently used assessment methods can be organized in the three groups: 1) direct observation assessments or oral examinations, 2) written examinations, and 3) clinical simulations. Since we are developing ontology that would be used for automatic question generation, we are focused on assessment methods that are suitable for computer based assessment (CBA). Among them are Multiple Choice Question, Extended Matching Question, (Multiple) True/False Question, Long Menu Question, Script Concordance Test and Comprehensive Integrative Puzzle. Because of their limited possibility for digital correction, Modified Essay Question (MEQ) and Short Answer Question (SAQ) are not easy to adopt for use in CBA, and they would be addressed in our future research.Beneath the title of the paper and names of authors, there should be a short abstract in English, whole page wide, italics (as presented in these instructions).

2.1.1 Knowledge assessment methods

Brief descriptions of each of the covered assessment methods are given in the following:

- Multiple Choice Questions (MCQ) are commonly used for assessment because they can provide a large number of examination items encompassing many content areas. MCQ can also be administered in a relatively short period of time and be graded by a computer [16]. MCQ usually consists of a stem and a set of candidate answers (where some are true and some are false) [17]. In the case of ME, the stem is in a format of short patient vignette.

- Extended Matching Questions (EMQ) are type of MCQs that are organized into sets that use one list of options for all items in the set. A well-constructed Extended-Matching set consists of a theme [18], a lead-in statement, a list of a minimum of 6 and a maximum of 26 options, and two or more cases [19]. Student is asked to select the diagnosis or action from the list of options. A larger option list minimizes cuing [16].

- Multiple True/False Questions (MTFQ) present students with a brief lead-in followed by several statements, usually 4 or 5 [19]. Each statement must be marked true or false. Any of the possible answers may be correct or incorrect. MTFQ has the advantage over MCQ in that the student must evaluate each possible answer, rather than selecting only one correct answer.

- Long Menu Questions (LMQ) focus on decision making process in the clinical practice regarding diagnostics, diagnosis and therapy [20]. When a student types a word in appropriate dialogue box, computer compares it with alphabetical list and shows terms in a pop-up scroll down menu. For example, if the answer was hypothyroidism and the letters 'hypoth' were entered, the computer would display the terms hypothyroidism, hypothalamus and hypothermia from the long menu list. As the entire text is typed in, the computer selects the appropriate term, which

then has to be confirmed. Because distracters are included in the LM list, wrong answers are also displayed [20].

- Script Concordance Test (SCT) is another method for clinical reasoning assessment. The format of SCT present students with an ill-defined case [21] in the form of a brief clinical scenario (patient vignette) in which the information provided is insufficient to reach a right decision. Each case is then followed by a number of items comprising a lead-in that provides a hypothesis, followed by an additional piece of information. Students are asked to evaluate the impact of this new information on the likelihood that the proposed hypothesis is correct [22].

- Comprehensive Integrative Puzzle (CIP) has format of an extended matching crossword puzzle. A CIP consists of 4 up to 7 rows and columns in the format of an extended matrix [19]. The left-hand column contains diagnoses or brief clinical vignettes. The students are expected to insert matching data into remaining cells, which they select from a multiple-choice pool of options indicated by letters (for example a–f). To complete any cell in columns I–VI [23] students must match the (a–f) options from a pool of distractors in the sections (I–VI) to each one of the diagnoses respectively. When all pieces of the puzzle are put together, each row reflects one medical case. The completed horizontal rows reflect integrative ability (diagnostic thinking and clinical reasoning) and the columns measure the student's proficiency in interpreting medical history data, physical examination findings, laboratory test results, ECG, imaging, special tests, pathology and pharmacology. The preparation of a CIP requires teamwork by the participants in the teaching of a systems-block: clinician, pathologist, microbiologist, pharmacologist, biochemist, radiologist, etc.

- Modified Essay Question (MEQ) is an open ended, semi-structured question format [24]. A similar format is also known as Short Answer Question (SAQ) [25]. Both MEQ and SAQ pose questions based on patient vignettes. Students answer open questions on diagnoses and proposals of therapy. Because of the possibility of score differentiation, MEQ and SAQ produce tests with a high reliability and have a high discriminatory quality. Correcting and scoring of MEQ and SAQ is time consuming.

2.1.2 MAMO concepts and relationships

Based on the aforementioned analyses, relevant concepts and relations have been identified and organized in the MAMO ontology as shown in Image 1. It should be noted that the figure shows simplified version with most important concepts in order to better understand MAMO ontology.

The root concept is a composite class *Test* consisting of an arbitrary number of questions. At the next level there are classes *MCQ*, *EMQ*, *MEQ*, *SCT* and *CIP*, named after corresponding assessment methods. Although some classes seem to have similar structure, they are conceptually different. Each individual instance of the *MCQ* class is in a containment relation with exactly one instance of the *Stem* class, exactly one instance of the *LeadInQuestion* class and several instances of the *Answer* class. In other words, each MCQ question must have exactly one stem, exactly one lead in question, and may have one or more answers. The *Answer* class is further specialized to *Key* and *Distracter* classes. The main characteristic of *EMQ* class is that there are several instances of the *Scenario* class and several instances of the *Option* class. Each instance of *Scenario* class is in a containment relation with exactly one instances of the *Option* class. On the other hand, instance of the *Option* class can be in containment relation with several instances of *Scenario* class.

Instance of the *MEQ* class is in containment relation with several instances of the *Element* class and *ExpectedAnswer* class. *Element* class has two subclasses, *MEQScenario* and *SubQuestion*. Relations between these classes and related entities are as follows: The main characteristic of MEQ is that it is open ended and semi-structured assessment method. This means that automatic rating is still not possible. However, instances of the *ExpectedAnswer* class would be a proper mean to match replies that students will input as their answers. For example, let us consider the following MEQScenario and SubQuestion instances: MEQScenario1: “A 27-year-old mother comes to a surgery to obtain treatment for her child's almost non-existent cold. After the child’s treatment she asked you for advice what to do since she has been feeling very tired for the past two months.” SubQuestion1: “What in your experience of general practice is the likely significance of the women’s statement?” For this instance of the *MEQScenario* and *SubQuestion* classes, appropriate instance of the *ExpectendAnswer* class would be: ExpectedAnswer1: Anxiety, neurosis, tension state, anxiety state, psychogenic. Depending on the implementation of the assessment software tool, students type answers in an input text box. Terms that are filled in by students are then matched with the subquestion’s instance. Different matching strategies that can exist, based on syntax matching or semantic similarity, or analogy, or some other approach, are out of scope of this paper and will be addressed in our future research. Depending on the degree of matching, students would be assigned appropriate scores.

The SCT represents set of instances that are in a containment relation with exactly one instance of the *CaseDescription* class, three instances of the *Hypothesis*, *NewInformation* class and five instances of the *LikertTypeScale* classes. *CaseDescription* class represents patient vignette with some missing information. The *NewInformation* class relates to additional information that is missing in the *CaseDescription* class. Instances of the *Hypothesis* class describe possible actions that reveal new information (i.e. instances of the *NewInformation* class). *LikertTypeScale* class models a commonly accepted grading scale that contains finite set of instances: strongly contraindicated, contraindicated, neither more or less indicated, indicated and strongly indicated. Since, students choose one of these instances as answer.

Each individual instance of the *CIP* class is in a containment relation with several (from 4 to 7) instances of the *Diagnosis* class and several (from 4 to 7) instances of the *CIPOption* class. In other words, each question consists of several diagnosis and options. The *CIPOption* class is further specialized into the *MedicalHistory*, *PhysicalExam*,

ChestXRayAndECG, *Laboratory*, *Treatment* and *Pathology* subclasses. Based on the difficulty level, *Option* class can have instances that are in relationship with one or more instances of the *Diagnosis* class. *CIPOption* class can also have instances that are in no relationship with instances of *Diagnosis* class that represent distracters in the question. Looking at the opposite direction, each instance of the *Diagnosis* class is in a containment relation with exactly one instance of the subclasses *MedicalHistory*, *PhysicalExam*, *ChestXRayAndECG*, *Laboratory*, *Treatment* and *Pathology*.

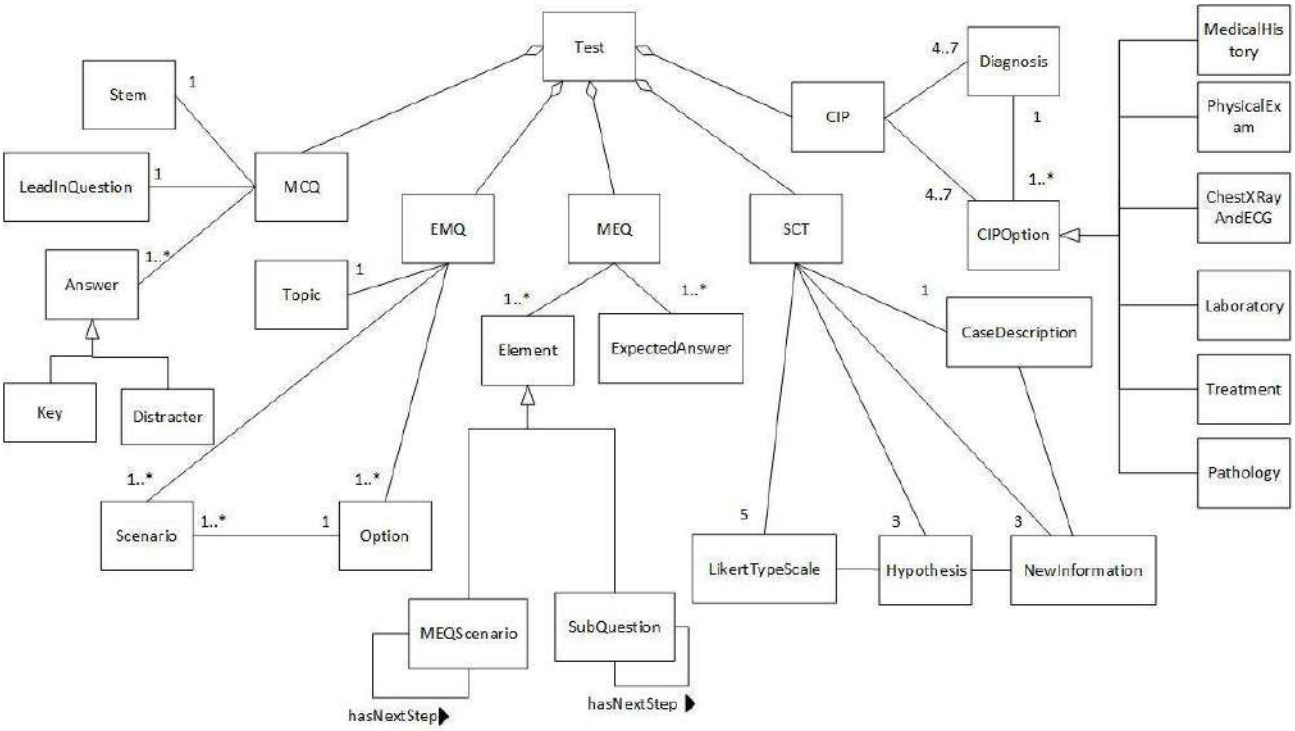

Image 1: MAMO ontology

2.1.3 Design and implementation

MAMO ontology was designed having in mind implementation in RDF(S) language with a goal to keep the resulting model "simple and small" and thus successful in practice. The full description of the class *Test* and the related entities is given in the RDF implementation file[1]. The MAMO ontology is developed using TasorONE[2], which is a free ontology editing service.

3. TESTING

In SABiO [15], ontology test refers to dynamic verification and validation of the behavior of the operational ontology on a finite set of test cases, against the expected behavior regarding the competency questions.

The Disease Ontology[3] (DO) was used as the domain ontology for testing MAMO ontology. Image 2 shows illustration of practical applicability, based on the DO, of the proposed EMQ method, which topic is from respiratory system disease field.

In addition to the testing of the proposed ontology in question design phase, a thorough evaluation would include testing in the software development and application user testing, but it is out of scope of the paper and will be addressed in our future work.

[1] http://www.tasorone.com/tsc/resources/AssessmentInMedicalEducation

[2] http://www.tasorone.com/tasorone/index.html?project=TasorProjects:AssessmentInMedicalEducation

[3] http://www.disease-ontology.org

```
@prefix rdfs:      <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd:       <http://www.w3.org/2001/XMLSchema#> .
@prefix rdf:       <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix doid:      <http://purl.obolibrary.org/obo/doid#> .
@prefix mamo:      < http://www.tasorone.com/tsc/resources/MedicalAssessmentMethodsOntology> .
@prefix oboInOwl: <http://www.geneontology.org/formats/oboInOwl> .

mamo:EMQTopic1      rdf:type              mamo:Topic;
                    rdfs:seeAlso          doid:DOID_1579 ;
                    mamo:topicText        "Respiratory system disease" .
mamo:Scenario1      rdf:type              mamo:Scenario ;
                     mamo:scenarioText     "A 50-year-old patient who is a pack a day smoker presents with a
                                           long history of productive cough and acute chest illness, dyspnea
                                           on exertion with occasional exacerbations in which they are bed
                                           ridden. PE reveals some wheezes. PFT reveals non-reversible
                                           obstruction, increased RV and decreased DLCO. ".
mamo:Scenario2      rdf:type              mamo:Scenario ;
                     mamo:scenarioText     "A patient with a history of atopic dermatitis, allergic rhinitis, allergic
                                           conjunctivitis presents complaining of episodic SOB, chest
                                           tightness that they describe as a band like constriction and a
                                           nocturnal cough. PFTs reveal reversible obstruction. ".
mamo:Scenario3      rdf:type              mamo:Scenario ;
                     mamo:scenarioText     "A patient presents with dyspnea and cough that produces thick
                                           tenacious mucous. PFTs reveal obstructive defect. They have 2
                                           consecutive sweat chloride tests. ".
mamo:Option1        rdf:type              mamo:Option;
                    rdfs:seeAlso          doid:DOID_1485
                    mamo:optionText       "Cystic fibrosis" .
mamo:Option2        rdf:type              mamo:Option;
                    rdfs:seeAlso          doid:DOID_3083;
                    mamo:optionText       "Chronic obstructive pulmonary disease" .
mamo:Option3        rdf:type              mamo:Option;
                    rdfs:seeAlso          doid:DOID_9415;
                    mamo:optionText       "Allergic asthma" .
mamo:EMQ1           rdf:type              mamo:EMQ ;
                    mamo:hasTopic         mamo: EMQTopic1 ;
                    mamo:hasScenario      mamo:Scenario1, mamo:Scenario2, mamo:Scenario3;
                    mamo:hasOpciton       mamo:Option1, mamo:Option2, mamo:Option3 .
mamo:Scenario1      mamo:hasAppropriateOption mamo:Option2 .
mamo:Scenario2      mamo:hasAppropriateOption mamo:Option3 .
mamo:Scenario3      mamo:hasAppropriateOption mamo:Option1 .
```

Image 2: MAMO ontology

4. CONCLUSIONS AND FUTURE WORK

Semantic technologies and ontologies in particular, are identified as primary candidates to provide technological foundation for the critical improvement of the Medical education in general and assessment particularly. Hence, further progress in this direction requires a set of ontologies for semantic descriptions of existing assessment methods as well as that would provide a solid foundation for future advanced approaches.

In this paper, we provided an overview of the assessment methods used in medical education. Ontology of medical assessment methods is proposed. The focus was on potential for application of recent advances in Semantic Web and ontologies. Literal review shows several new approaches that offer automatic generations for most of the assessment methods, most notably MCQs. Though, research conducted to date provides no records of adoption of ontologies for automatic medical assessment generation. Medical assessment methods ontology – MAMO that is proposed in this paper, is proven in semantic interpretation of each of the assessment methods. In the ontology, each method is modeled by means of a set of common concepts, such as Stem, Lead-in question, Answer, etc. as well as specific concepts, such as Instructions, Topic, NewInformation, Hypothesis, etc. Practical evaluation of MAMO was conducted on examples from various fields of diseases from Disease Ontology as domain ontology. Results show that the proposed ontology shows enough modeling power to semantically describe proposed medical assessment methods. One of the main goals for our future research is automatic generation of stems for each of the methods, based on the patient vignette.

Acknowledgements

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INTEGRATION OF SOCIAL LEARNING ENVIRONMENT AND ONTOLOGY-BASED SYSTEM FOR RETRIEVAL OF LEARNING OBJECTS

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Abstract: *This paper presents a model for integration of a social learning environment (SLE) designed to support project-based and problem-based learning and an ontology-based system for learning object retrieval (OBSLO). The goal of this integration is to provide personalized and collaborative learning environment. SLE is designed as a social network software tool that bridges the connection between institutional learning management system (LMS), Educational Management System (EMS) and external systems such as social networks (i.e. Facebook). While SLE supports problem solving and collaborative learning through interactions with both peers and teachers, its drawbacks are in high dependency on the LMS, meaning that learners have to read the entire lesson, presented as a sequence of learning objects (LOs). Integration of SLE and OBSLO allows for easier LO retrieval, while allowing the learner to focus only on LOs that are needed for solving the particular problem presented on SLE. By allowing the learner to retrieve only needed LOs, the system provides personalized content based on ontologically organized structure of course material, visually presented as a graph through which learners can easily navigate and reach relevant LOs. This paper explores the possibility of using such system for a Database course.*

Keywords: *eLearning, social learning environment, learning object ontology, ontology, knowledge sharing*

1. INTRODUCTION

Personalized learning refers to a diverse variety of educational programs, learning experiences, instructional approaches and strategies in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying material resources for learning, choosing and implementing learning strategies and evaluating learning outcomes [1] [2]. The aim of personalized learning is to put a student at the center of the learning experience in order to focus on the specific strengths, needs, interests, and goals of each student [3].

One of the ways to achieve personalization is by modularizing learning materials through a sequence of reusable smaller units called learning objects (LOs). LOs can be defined as digital self-independent learning resources that can be used, reused or referenced during technology-supported learning [4]. Ontologies can be used for effective LOs handling, combining, publishing, administrating and delivering [5]. Usage of the ontology is a good candidate to overcome the problem of LOs retrieval based on a set of metadata, and to provide the actual LOs reuse and effective LOs query processing techniques execution [5]. An ontology represents conceptual descriptions of the specific content as they help to identify appropriate items and relationships in a given knowledge domain [6] [7]. There are many examples that describe how the ontology enhances the flexibility of the learning process and provide personalized content for learners. Curriculum Builder in the Federated Virtual University of the Europe of Regions (CUBER project) presents an ontology-based framework, which supports learners in identifying higher education courses for their learning needs [8]. In the CUBER project the system helps learners to find courses that match their vocational requirements by using their profile information. The CUBER project requires students to go through the entire content of the lesson, without providing flexibility to view only its parts. Similarly, the Intelligent Web Teacher (IWT) eLearning system uses ontologies to automatically assemble and deliver personalized content to learners based on their learning profiles, leading to a higher percentage of students who successfully complete an exam [9]. An ontology-based system for learning object retrieval (OBSLO) is designed to provide personalized learning. It proposes two types of retrieval: ontology-based and keywords retrieval

[10]. Ontology-based retrieval enables learners to find LOs content that belongs to course concept of interest. Keywords retrieval presents LOs content related to lexicon terms. Even though OBSLO can function as a stand-alone system, the improvements to learning experience can be achieved by exposing learners to problem-based, project-based, and social learning. As social learning is hard to manage in traditional educational setting, a social learning environment (SLE) can be used. However, SLE implies that the learning space is not left entirely under the control of the institution, but students during the learning process can collaborate and communicate with each other and their teachers in the manner that mimics a social network [5]. Fulfillment of the individual personalized needs of a learner usually depends on a strong degree of social interaction with teachers and peers because this interaction sharpens the learner's thinking and elicits new interests about a given topic [4]. Many researchers have investigated different approaches for a high level personalization, while including various forms of interaction and communication between students and teachers. Topolor's adaptive personalized social e-learning system used social features and an appearance like Facebook in order to increase usability of personalized learning system [11]. Results of Topolar's research indicated that positive social interaction might help students relieve anxiety and promote student discussion participation, thus improving experience and learning efficiency.

SLE was designed to support learning activities from an institutional e-learning system and also to guide students through a community based discussion to collectively work towards the solution or task completion [12][13]. By bridging the connection between institutional learning management systems (LMS), Educational Management System (EMS) and external tools, SLE mimics the structure of a social network. SLE does not serve only as an architectural component, but also as a pedagogical and social tool used to stimulate motivation and learning activities of students by providing students with both instructional- and problem-based learning. But, the main problem with SLE is that it highly depends on the LMS, which may slow students down in their learning process. Mainly, in SLE learners have to go through the entire lessons, viewing LOs one by one, without being able to view only one segment of the lesson.

In order to provide the platform that mimics the structure of a social network which increases the interaction between learners and their peers, includes problem-based and project-based learning and at the same time enables personalized content suitable for solving particular problems or projects, this work proposes the integration of SLE and OBSLO, which has not been done in previous works. The aim of this integration is to allow learners easier content retrieval by navigation through OBSLO's course ontology enabling the retrieval of content that is needed for a particular project and problem solving posted in SLE.

The paper is organized as follows. Section 2 describes integration of SLE and OBSLO. Section 3 defines models for teaching and learning activities in the SLE-OBSLO integrated system. Section 4 concludes the paper.

2. SOFTWARE ARCHITECTURE FOR INTEGRATION OF SLE AND OBSLO

The architecture that provides personalized learning by using OBSLO through SLE is based on service-based framework and uses both web services (WSs) and mediator elements for integration. The integration of OBSLO and SLE, as well as the integration of SLE with other components LMS, EMS and external tools (i.e. Facebook) does not require any modification of pre-existing systems (LMS, EMS and OBSLO), as it uses their embedded WSs. As such, SLE is a scalable system, making it possible to integrate newly developed external components. This scalability provides an opportunity to integrate systems that allow implementation of different learning strategies.

The proposed architecture is presented in Figure 1. It includes integration of four independent systems using WSs:

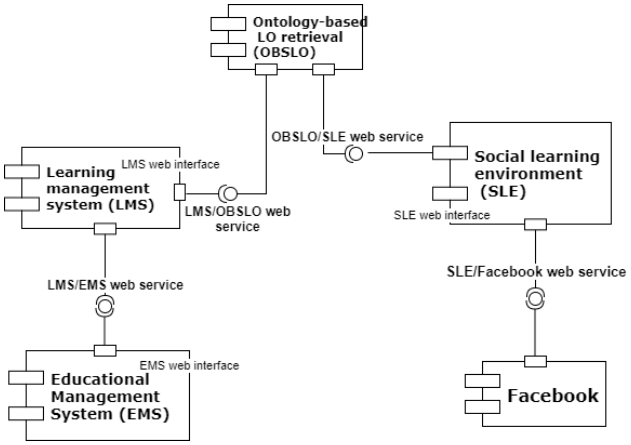

Figure 1 - Platform architecture of the integrated system

1) **Educational Management System (EMS)** is based on the relational database containing data about courses, students, their exams and grades, etc. By using LMS/EMS WSs, EMS provides its administrative data to LMS such as user information and course administrative data.

2) **Institutional Learning Management System (LMS)** stores LOs in the repository and facilitates access, manipulation, administration and LOs retrieval from the repository by using LOs metadata. LMS arranges LOs in the appropriate learning sequence for each lesson. Besides LOs, course lessons also include different types of self-assessment activities. These activities are useful for both students and teachers, where teachers can assess and analyze knowledge and engagement level of students. Once the LOs content and self-assessments are created, the lesson can be published on LMS for instructional learning.

3) **Ontology-based LO Retrieval (OBSLO) System** is used for effective retrieval of LOs from the repository. LOs are retrieved based on the ontology, which is defined at several levels. At the highest level are curriculum for the entire academic major, followed by course and its topics, which branch out to their subtopics. At the lowest level are LOs. This structure is presented in Figure 2. OBSLO

provides visual representation of the course as a course topic/subtopic graph through which learners can easily navigate. Lower level nodes inherit ontology characteristics from the higher level nodes. In this way, it is known which LO is related to which higher level nodes. In OBSLO, the nodes are interconnected by three types of relations:

(i) *"part of"* (PO) relation used between different topics in order to describe that a subtopic is a part of another higher-level topic. For example, *Subtopic 1* and *Subtopic 2* are parts of *Topic 1* from the *Course 1* (Figure 2).

(ii) *"has resource"* (HR) relation used between a topic/subtopic and LOs indicating that LOs contain content that is used for higher-level topic or subtopic. For example, *LO2* is in HR relation with both *Subtopic 1* and *Subtopic 2* from *Topic 1*, indicating that LO2 is used to explain both of these subtopics (Figure 2).

(iii) *"order relations"* (OR) between LOs. OR relation is used in two cases: (a) mandatory relation providing an information that LO has a pre-requisite LO, which should be learned before accessing that specific LO (b) optional relation used only as a recommendation which LOs may be learned. This relation is typically used when student wants to gain deeper knowledge about a topic. For example, *LO2* is mandatory for learning *LO4*, which means that learning of *LO4* can start once *LO2* is learned. Similarly, after completing *LO1*, the learner has an option to learn *LO6*, which will deepen the current knowledge.

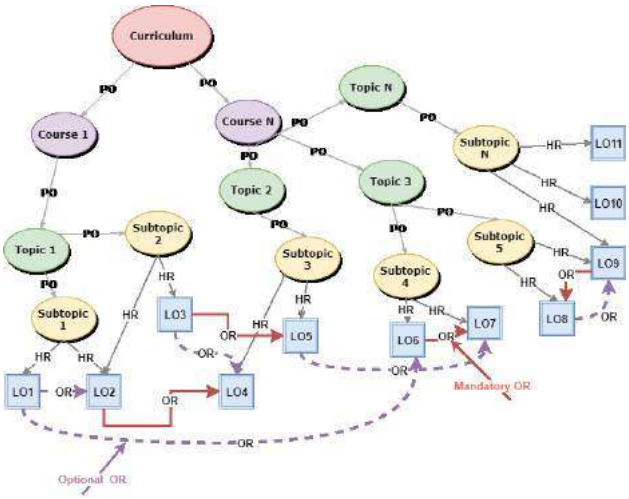

Figure 2 – The conceptual ontology model

For the needs of this work an ontology for a Database course that is based on IEEE Computer Society's Information Technology 2008 Curriculum Guidelines for Undergraduate Degree Programs is used in OBSLO (Figure 3). Figure 3 represents six key subtopics that are 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).

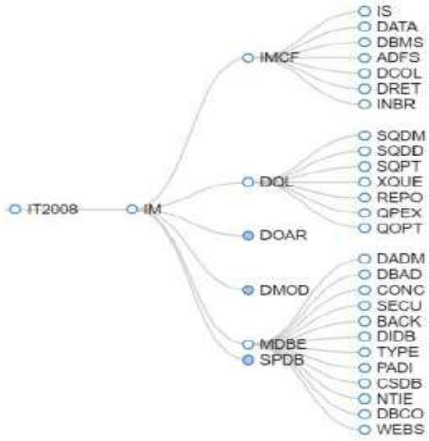

Figure 3 - Key concepts for the Database course

Figure 4 presents how LO *Drop table* is related to their prerequisite LOs (*Alter table* and *Delete table* as a mandatory and *Rollback* as an optional LO) at the lowest level of ontology.

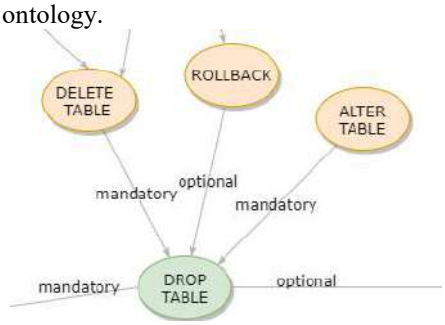

Figure 4 – Example of relations between LOs for the Database course

OBSLO can provide single or multiple LOs based on the posted problem on SLE. Each time a LO is selected during the student navigation through course ontology in OBSLO, this LO is retrieved from LMS and its content is passed to OBSLO through LMS/OBSLO WS.

4) **Social Learning Environment (SLE)** is used as interactive learning space where teachers manage course activities by posting discussions, tasks, and problems. SLE has access to OBSLO through OBSLO/SLE WSs. These WSs enable easier retrieval of specific learning content, needed for resolving the particular problem in SLE. Learner has an option to select particular nodes in OBSLO's course ontology. When the root node is selected, the student is presented with the entire content of the lesson through LMS, including all of the instructional learning activities. However, when the student does not need to access the entire lesson, but rather only a specific content in one lesson, the learner can access that content through OBSLO's ontology tree. In such case, it is useful to recommend the learner other content that is relating to the one he/she has selected, and for this purpose OBSLO uses defined interconnection LOs relations.

SLE also enables access to social networks, such as Facebook. Any announcements from SLE about new learning events in SLE can be posted as private posts on a students' Facebook wall.

3. SLE ONTOLOGY-BASED TEACHING AND LEARNING ACTIVITIES

Examples of learning and teaching activities the using OBSLO-SLE integrated system are given in this section. Teaching activities include creation of learning content, as well as the interactive activities that include project-based and problem-based learning. Learning activities are designed for two types of learners: (a) learners with background knowledge (non-beginners), and (b) learners who have not been introduced to a topic (beginners).

3.1. Model of teaching activities

The model of teaching activities is shown in Figure 5. It includes following activities:

1. Creation of ontology that will be used by OBSLO. This activity assumes that the teacher inputs titles for all nodes and defines relations between them. Based on the defined relations, OBSLO can visually present course ontology as a graph.
2. For each defined LO in OBSLO, the teacher creates learning content. The teacher also enriches LOs with metadata, such as LO title, author, learning objective, level of difficulty and keywords. Metadata is used to provide additional information about LO in order to support its retrieval and reusability. As instructional design of lessons contain both learning content and self-assessment activities, the teacher needs to create both of them.
3. Once the LOs content and self-assessments are created, two activities take place
    a. Lesson can be published on LMS.
    b. SLE automatically creates interactive learning space. Learning space is used for each lesson for students and teachers to discuss and post problem- and project-related activities. From these activities, SLE allows viewing of different related LOs through OBSLO, as previously discussed. It is a good practice for teachers to create initial problems, tasks, discussion questions, and/or resources that are posted on SLE.
4. The teacher can choose to post an announcement on Facebook about the posted problem or task activities to engage students.

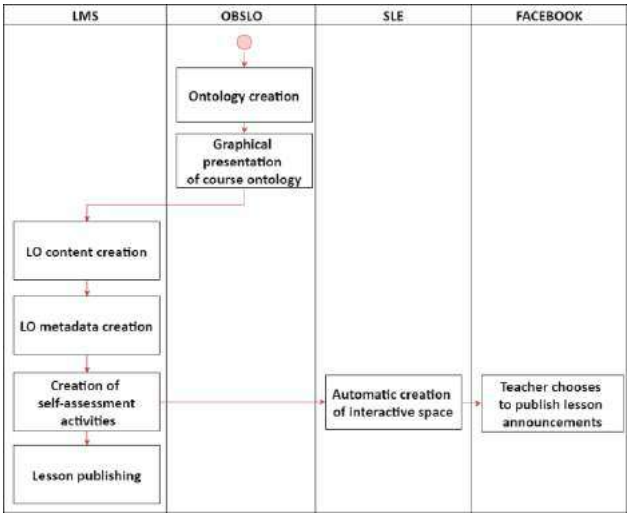

Figure 5 - Model of teaching activities

EMS is excluded from this example as the given example illustrates the activities from the ontology creation and EMS is used as previously described to store and retrieve administrative data that are passed to LMS using LMS/EMS WSs, without any action needed from the teacher.

3.2. Model of learning activities

In this section a model of learning activities is illustrated. All activities are explained by example of a lesson from the Database course. An example of the ontology tree for the topic *Database query language* is presented in Figure 6, while the model of activities is shown in Figure 7. Examples of learning activities shown in a flow diagram in Figure 7 are as follows:

1. When the learner receives an announcement that the lesson activity is available on SLE, the learner can access the SLE in order to solve posted problem and/or tasks. The learner is also allowed to create their own tasks and publish Facebook announcements about it.
2. Before problem solving, the learner can choose to view learning material needed for solving the given problem. The placement of students in the learning content depends on the level of the learner:
    a. Beginner will choose to view the entire lesson by choosing the highest level node in the lesson ontology. In the case of the Database course lesson ontology shown in Figure 6, the learner will be positioned at the *Database Query Language* topic.
    b. Non-beginner, who has some knowledge about the problem that is being solved, has an option to focus only on the content of personal interest. For example, in the case of the Database course the learner may choose to view topic *SQL Data Manipulation* (Figure 6).

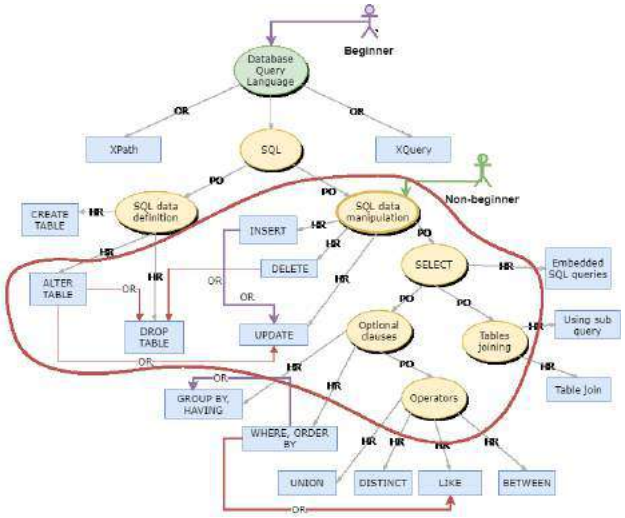

Figure 6 - Ontology tree for lesson related to Database query language for the Database course

3. Once the learner chooses the topic, due to existing relations between nodes, related topics and subtopics would also be presented. The learner can go through selected topic hierarchy until the lowest level content is reached. When selecting subtopics on the lowest level, the learner will be able to see all LOs that are in HR relation with that subtopic and their prerequisite Los. When *SQL Data manipulation* subtopic is chosen, its related subtopics *SELECT, Optional clauses, Table joining* and *Operators* will also be presented. Also, LOs that are directly connected to *SQL Data manipulation* subtopic, *Insert, Delet*e and *Update,* with their prerequisite LOs *Alter table* and *Drop table* will be accessible to the learner, because *SQL data manipulation* subtopic is their lowest level topic.
4. Once presented with a subtree of a subtopic and related LOs, the learner can choose a specific content in a subtree. Similarly as in the previous step, should a subtopic be selected; all of the related LOs will be presented to the learner. For each selected LO, the learner can view its relevant content in OBSLO, which is passed to OBSLO from LMS. However, the learner will be prompted to learn all of the prerequisite mandatory LOs that chosen LO may have. On the other hand, should LO be in relation OR with optional LOs, the learner can choose if optional LOs will be viewed.
5. Once the learners chooses topics/subtopics with its belonging LOs, the learner can again attempt to resolve the assigned problem. At this stage, the learner can choose to take part in peer discussion and collaborative problem solving on SLE. At the same time, the student can share useful resources needed for successful completion of a problem to the rest of the group. During this process of peer discussion, collaboration and resource sharing, the teacher has a role of moderator and can post additional tasks and resources needed to gauge students' progress and continuation of their engagement.
6. If the learner still has difficulty in solving posted tasks, he/she can improve their knowledge by choosing another topic/subtopic, which can be useful for solving the problem. This process should be repeated until all tasks and problems related to the lesson are successfully resolved.

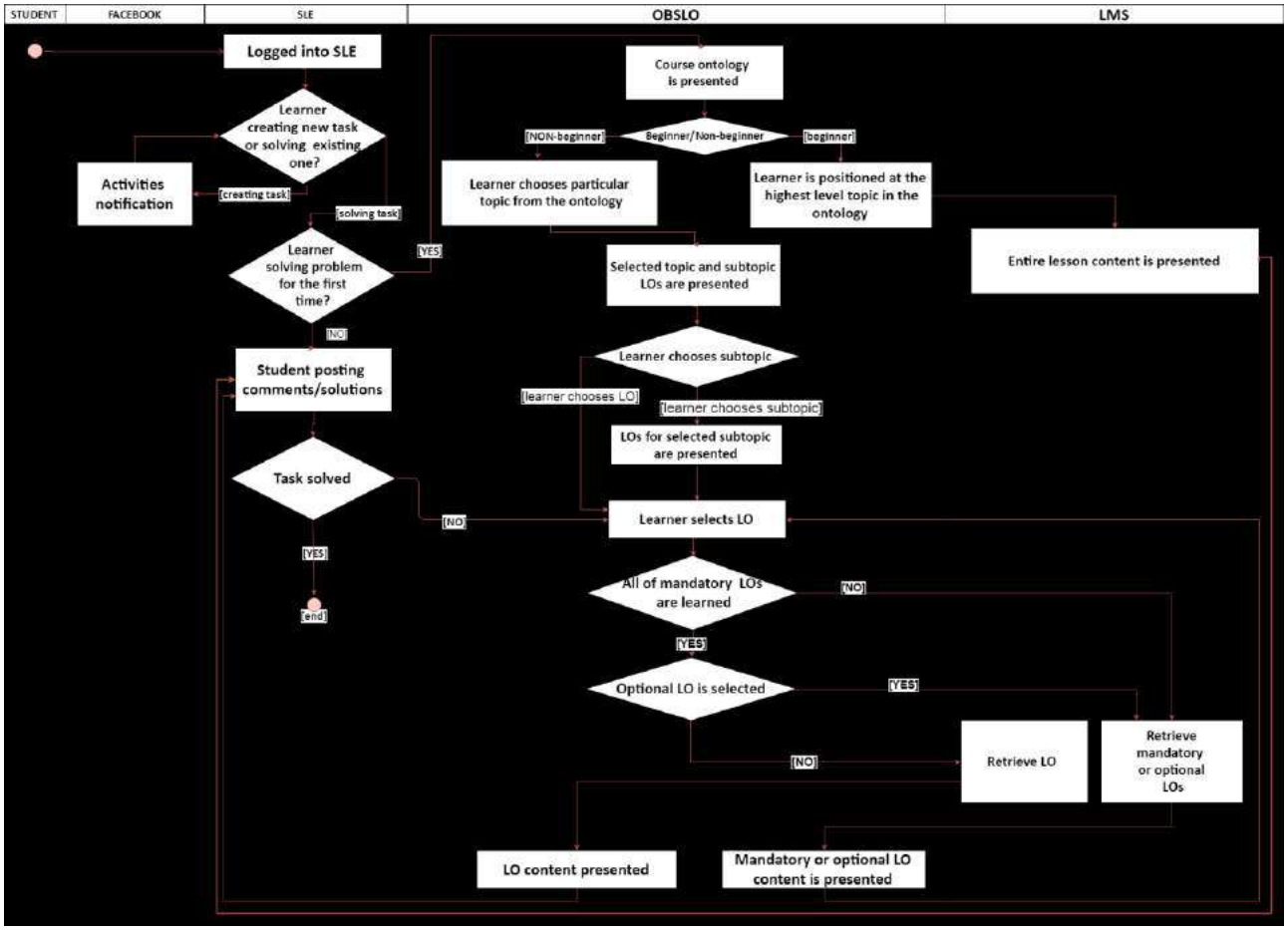

Figure 7 - Model of learning activities

4. CONCLUSION

This paper addressed an implementation of personalized learning through the usage of ontology-based online course built on learning objects and social learning. The aim was to enhance learning experience for students. In order to achieve this type of personalization and to provide interactive and efficient learning space for increasing the communication between students and teacher, and also to motivate students for active learning through collaborative problem solving tasks, previously developed systems OBSLO and SLE needed to be integrated. This paper presented software architecture for integration of both, as well as an example of teaching and learning activities for the usage of the integrated systems. Although this system provides a lot of flexibility in problem- and project-based learning, it is evident that the learner can be overwhelmed with the amount of material in his/her learning path, especially when beginner learners are introduced to concepts for the first time. Therefore, future work should analyze efficiency in the learning process with the focus on visual improvements and presentation of learning material in order to resolve an information overload problem.

ACKNOWLEDGMENT

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IMPLEMENTATION OF GAMIFICATION IN AN E-COURSE BASED ON ARCS MODEL FOR STUDENT MOTIVATION

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Abstract: *Students' motivation is an important factor in ensuring the success of an e-learning course. Thus, in order to ensure that learners remain motivated throught the learning process motivational design has been used during the development process of the e-course. The use of gamification that is a new technique of instructional design in the e-learning field, can increase learners motivation when it is integrated in learning context. In this paper we focus on the influence of structural and content gamification on students' intrisic motivation when is intergrated in e-courses whose design is based on the core components of ARCS model of motivational design. According to the data that were derived from the modified Instructional Materials Motivation Scale (IMMS) questionnaire this gamified e-course improves students' motivation and engagement.*

Keywords: *E-Learning, Distance learning, online, Gamification, Education, Intrinsic motivation, ARCS model, Engagement, Motivational design*

1. INTRODUCTION

Nowadays, learners are called digital natives as they are very familiar with new technologies. As a result, they have different attitude and higher requirements for teaching and learning process. Because of this familiarity with digital technology, e-learning courses are totally preffered as they also constitute a solution to surmount the barriers of time and place in learning. However, a variety of researches that have focused on the phenomenon of e-courses, have shown that despite the advantages there is a great number of drop out. The most frequent factor that have proven to be the cause, is the lack of motivation. Because of the higher requirements of learners, educators have to deal with new challenges in order to adapt learning process to suit students' needs, preferences and requirements so as to be motivated.

A new method that is proven to be effective on students' motivation is Gamification. This new approach implements active learning and leads learners to be active participants with strong motivation and engagement to their own learning. Moreover, as far as concerns Gamification, many studies have focused on the intergation of Gamification in motivational models or learning theories in order to be more efficient the learning process.

The aim of this study is to indicate the influence of Gamification on students' motivation in an e-course based on ARCS model of motivational design and furthermore to prove the reinforcement of ARCS model via the asssociation of gamified elements and core components of ARCS model of motivational design.

2. ARCS MODEL & GAMIFICATION

ARCS Model

Motivation concerns the continual effort that is directed toward a goal and plays a vital role in the learning process so it should constantly be kept at high levels and also be improved. Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, on the other hand, extrinsic motivation refers to doing something because it leads to a separable outcome.

A gamified system that aims to increase motivation should focus on both intrinsic and extrinsic motivation. More specifically, structural gamification that will be analyzed below increase extrinsic motivation and content gamification increase intrinsic motivation(Kapp, 2014). However, the cultivation of intrinsic motivation is a complex process and in order to be achieved, motivational theories or models should be used suportively to any educational method or technique of teaching. Such an example is ARCS model of motivational design that was created by John Keller (1979) in his effort to explain

motivation. ARCS model is based on Vroom's expectancy-value theory as it is described in the writings of E,C. Tolman and K. Lewin. Additionally, Keller combine four theories in his model; Bandura's theory of Self- Efficasy, Berlyne's theory of Curiosity adn Arousal, Maslow's Needs Hierarchy and Rotter's Locus of Control. The ARCS model consists of four core components; Attention, Relevance, Confidence and Satisfaction.

Analyzing the core components, **Attention** refers to the stimulation and preservation of interest and curiosity of the learners throughout the educational process. Keller distinguish three factors of Attention;

1. **Perceptual Arousal** that means the use of surprise or uncertainly to gain interest
2. **Inquiry Arousal** that means stimulation of curiosity by posing challenging questions or problems
3. **Variability** that means the variety of elements of instruction

Relevance refers to the association of educational content with the needs, the past experiences, the goals, the interests, the learning preferences and generally with whatever is meaningful for the learners. Keller distinguish three factors of Relevance;

1. **Goal Orientation** that means the use of concepts that are related to the learner's experiences and values
2. **Motive Matching** that means the presenation of objectives and utility of the instruction
3. **Familiarity** that means the use of teaching strategies that match the motive profiles of the learners

Confidence refers to the establishment of positive expectations in order learners to achieve success. The level of confidence concerns the percentage of effort and motivation in order the goals to be achieved. Keller distinguish three factors of Confidence;

1. **Learning Requirements** that means that learner is aware of performance requirements
2. **Success Opportunities** that means that multiple achievement levels are provided so as learners be able to set personal goals
3. **Personal Control** that means that feedback is provided in order to support students' recognition of their abilities

Satisfaction is the last core component of ARCS model and refers to the positive feelings that are created by the sense of success, the praise or simply the entertainment. Keller distinguish three factors of Satisfaction;

1. **Intrinsic Reinforcements** that means the use of newly acquired knowledge or skill in a real or simulated setting
2. **Extrinsic Rewards** that means the provision of feedback and reinforcement that will sustain the desired behaviour
3. **Equity** that means the maintenance of consistence standards and consequences for task accomplisment.

Moreover, ARCS model of motivational design is characterised by a designing process that is described below.

Gamification

Gamification is defined as the use of **game elements** and **game-design techniques** in **non-game contexts.** According to the definition, the **game elements** are found while we analyze games. They are the small elements that constitute them. Werbach and Hunter (2012) organise those elements into three categories; **Game Dynamics**, **Game Mechanics** and **Game Components**.

Figure 1: Gamification Elements Pyramid

Game Dynamics are in the highest level of pyramid and construct the whole game. In other words, they are the hidden structure that make games coherent. Game Mechanics are the basic process that promote participation and action. Game Components refer to more specific characteristics of games that are used in order to support Game Dynamics and Game Mechanics. Additionally, there are connections between all the Game Elements.

Game-design techniques concern the detailed design and the strategies that should be followed over the proper use of game elements and the offer of experience, aesthetics and fun (Werbach& Hunter, 2012).

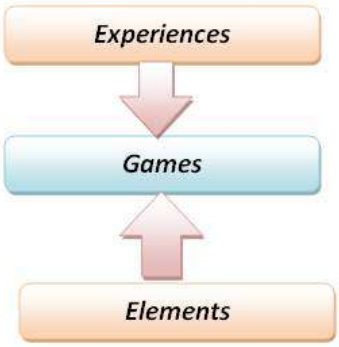


Figure 2: Structure of Games

Games are not a result of random combination of game elements. On the contrary, in the middle of the structure is located the game as a whole of rules, components and aesthetics. On the above, there is the experience that someone feels in the game. The lowest level refers to the elements that can be used for game's creation.

The definition of **non-game contexts** means the incorporation of game elements and their effective application in the real world (Werbach& Hunter, 2012). Thus, this context refers to the incorporation of gamefication into anything that is not a game (work, company, website, education) in order to engage users and enrich the interactivity.

Moreover, Gamification is divided into two types; **Structural Gamification** and **Content Gamification**. Structure Gamification is the application of game elements without any changes or alterations to the content. So, the content does not become game-like in contrast with the structure around the content. A common implementation of this type of gamification adopts the scoring elements of video games, such as points, levels, badges, leaderboards, achievements and progress bars and applies them to an educational context. On the other hand, Content Gamification is the application of game elements and game thinking to alter content in order to be more game-like. This type adds either story elements or challenges without turning the content into a game (Kapp et al., 2014). According to Kapp (2014), both of these types are mutually exclusive to each other, meaning that both can be used at the same time without being affected by the presence of the other.

Finally, in order a gamified system to be constructed, then characteristics of Gamification should be taken into consideration. The first characteristic is the existance of engagement. Engagement consists of four stages that are called "**Engagement loop"**. The first stage is the motive that user has and drives him into action and consequently engagement. When user successfully complete the actions, receive feedback or rewards and the engagement loop may be continued.

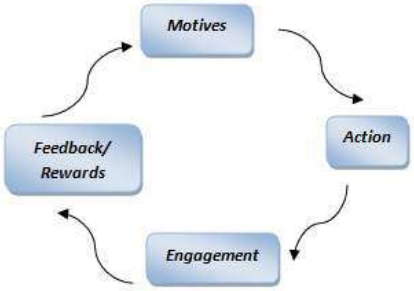


Figure 3: Engagement Loop

An other characteristic of Gamification is the **flow**. This characteristic is one of the most important as it helps at the maintenance of interest and at the alertness of the user for as much time is possible. Csikszentmihalyi (1970) describes the process with the use of the elements that are depicted below.

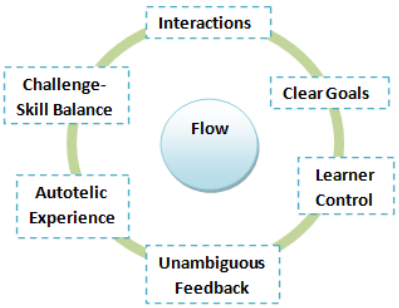


Figure 4: Process of flow

The last characteristic of Gamification is the "**Progression Loop**". This characteristic represents the progression of user through the gamified system. More specifically, user tries to reach the final goal via small steps.

Figure 5: Progression Loop

3. COURSE DESIGN

Due to our research objectives we design and actualize a gamified e-course ("Play to learn English") based on ARCS model of motivational design that aims to increase learners' motivation during the learning of English as a second language. First of all, we apply the ten step model of motivational design that is defined by Keller (2008) and we incorporate in it the "6 D" design framework (Werbach & Hunter 2012) as it is shown in the table below.

Table 1: Process of design

Ten Step Model of Motivational Design		Gamification Design Framework 6 D
Phase	Step	Step
Analyse	**1.** Obtain Course Information **2.** Obtain Audience Information **3.** Analyze Audience **4.** Analyze Existing Materials **5.** List Objectives & Assesments	Define business objectives Delineate target behaviors Describe your players
Design	**6.** List Potential Tactics **7.** Select & Design Tactics **8.** Intergate with Instruction	Devise activity loops Don't forget the fun!
Development	**9.** Select & Develop Materials	Deploy the appropriate tools
Evaluation	**10.** Evaluate & Revise	

The first phase concerns the collection of information about the learners and the learning environment. We identified learners' previous experiences on English and e-courses. Subsequently, we took into consideration the learning conditions and we decided about the material, the learning objectives and the evaluation system. Of course, as we created a gamified e-course we had to describe the participants as players, so we focused on Bartle's categorization and we embodied gamified elements that satisfy all the players' categories.

Figure 6: Players' Categorization

The second phase concerns the incorporation of appropriate strategies that increase learners' motivation. Moreover, the whole process should be charectirised by fun and engagement and progress loops.

Finally, development and evaluatiuon phase concern the selection of apprpriate tools and the evaluation of the process in order to examine if the initial objectives have been satisfied.

After taking into account the findings of the process of design we structure the e-course on Moodle platform. The procedure flow is described in the figure below.

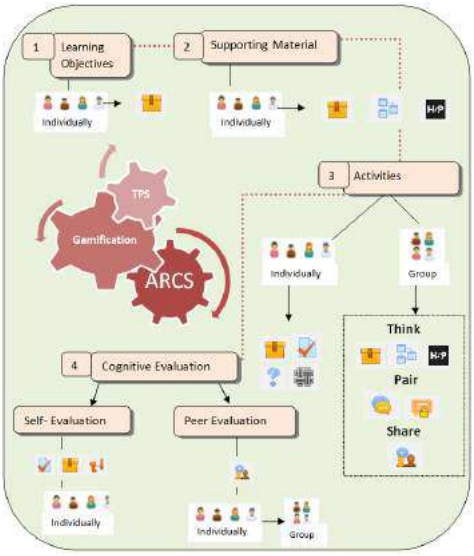
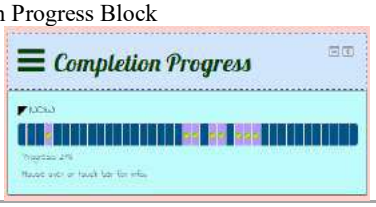


Figure 7: Procedure Flow

More specifically, we use a senario which is an element of game dynamics. This senario illustates a journey in London. Travellers should read the objectives of each journey and the supporting material, they should overcome challenges that has the form of quiz and should cooperate in order to reach the terminal station and get the certification. The educational senario is consised of three phases. In the first phase they meet the course's objectives and they navigate in the platform. In the second phase they have to deal with the educational material. Finally, in the third phase they evaluate the whole process.

As far as concerns the choosen LMS environment, Moodle platform can support both Structural and Content Gamification. The use of badges, points, leaderboards, progress bars and certifications achieve Structural Gamification.

Moodle Activities and Resources used for the gamified e-course (Structural Gamification)
Level up Block 
Ranking Block 
Completion Progress Block 
Quiz Results Block 

Badges

Certification Plugin

Figure 8: Gamified Activities and Resources list for Structural Gamification

On the other hand, the use of story elements and other game mechanisms such as cooperation, activity completion, restrict access, challenges and feedback refer to Content Gamification.

Moodle Activities and Resources used for the gamified e-course (Content Gamification)

Activity Completion

Quiz

Feedback

Avatars

Stash Block

Workshop Activity

Figure 9: Gamified Activities and Resources list for Content Gamification

Moreover, so as the effectiveness of gamification on learners' motivation to be measured, we match Game Dynamics, Game Mechanisms and Game Components with the core components of ARCS model of motivational design in order to be measured.

Table 2: Matching of Game Elements with core components of ARCS model

Game Components	Game Mechanisms	Game Dynamics	A	R	C	S
Avatar		Narrative/ Senario	✓		✓	✓
Levels (Level up Block)		Progress (Progress Bar)	✓		✓	✓
Content Unocking		Constraints	✓			
Leaderboards	Competition	Relationships			✓	
Teams	Cooperation		✓	✓	✓	✓
Badges	Rewards					✓
Points			✓		✓	✓
Collections			✓			✓
	Challenges		✓		✓	✓
	Feedback				✓	✓

As a result, since the core components of ARCS model have been satisfied by the framework of our gamified e-course on Moodle, then it is proven that our gamified e-course is well structured for the purpose of increasing motivation and engagement during the learning process.

Moreover, our structure proved that Gamification is reinforced regarding learners' motivation via the use of strategies as they are defined by the core components of ARCS model.

4. CONCLUSIONS AND FUTURE WORK

The purpose of the study is to examine the influence of gamification on learners' motivation in an e-course based on core components of ARCS model of motivational

design. Moreover, we incorporate game elements into ARCS model in order to achieve the gamification of learning and the enrichment of ARCS model so as to motive students during the learning experience.

In order to improve intrinsic motivation we construct an e-course based on ARCS model and we selected game elements that satisfy the four core components of ARCS model of motivational design.

The data of the study that gathered from IMMS questionnaire which was modified with the use of another parameterization of the same questionnaire (ARCS gaming scale) prove that there was an improvement of learners' motivation (Mean Post 3,6867). More specifically, the factor of Attention has been increased (Mean Post 3,2963), the factor of Relevance has also been greatly increased (Mean Post 4,2407), the factor of Confidence has been increased (Mean Post 3,0864) and finally the factor of Satisfaction has been also greatly increased (Mean Post 4, 5370). To sum up, the factors of Relevance and Satisfaction were influenced more by the use of gamification in the learning process of teaching English as a second language. Furthermore, those two factors seem to be the most important factors in the educational process of teaching English as a second language according to the findings of many studies (Bahous,2011). Our next step is to prepare a paper that will indicate how effective is this instructional design in learning English as a second language.

In conclusion, this study concerns the design of a gamified e-course that succeeded to increase learners' intrinsic motiavtion via the implementation of game elements into the core components of ARCS model of motivational design.

Further studies may be also focused on Personalized Motivation or different learning styles in order to be figured out which game elements or game techniques conform to learners' needs.

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FACTORS AFFECTING INSTRUCTORS' USE OF E-LEARNING AT THE UNIVERSITY OF JORDAN

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Abstract: *This paper investigates the current issues related to the e-Learning utilization at the University of Jordan (UoJ) as perceived by faculty members. Moreover, this article identifies factors that may affect instructors' use of e-Learning in teaching and learning processes at this Jordanian higher education institution. A web-based questionnaire was employed and distributed to all faculty members for the Spring Semester 2016/2017. A total of 124 participants from a wide variety of departments at UoJ in Jordan have responded and completed the survey. The results of the analysis revealed that the major factors that prevent or affect instructors' use of e-Learning at UoJ are lack of instructor ICT/e-Learning skills; lack of instructor confidence; lack of pedagogical instructor training; lack of suitable educational software; limited access to e-Learning tools; rigid structure of traditional education systems; restrictive curricula, etc. The article concluded that knowing the extent to which these factors and barriers affect individuals and institution may help in taking a decision on how to tackle them.*

Keywords: *E-Learning, Educational Technology, ICT, Higher Education, Jordan*

1. INTRODUCTION

Recently, information technology has been viewed as a solution to universities' cost and quality problems. Information technology in teaching and learning has created a need to transform how university students learn by using more modern, efficient, and effective alternative such as e-Learning. E-Learning concept has been around for decades and is one of the most significant recent developments in the information systems industry [1]. E-Learning can be viewed as the delivery of course content via electronic media; it typically means using a computer to deliver part, or all of a course whether it is in an educational institution, part of a mandatory business training, or a full distance learning course [2].

E-Learning is one of the new learning trends that challenge the traditional "bucket theory" or the banking concept of education [3]. The banking concept of education assumes that the instructor owns the knowledge and deposits it into the passive students who attend the class. E-Learning has been viewed as synonymous with web-based learning (WBL), Internet-based training (IBT), advanced distributed learning (ADL), web-based instruction (WBI), online learning (OL), content-based instruction (CBI), and open/flexible learning (OFL) [4].

E-Learning, one of the tools emerged from information technology, has been integrated in many university programs. There are several factors that need to be considered while developing or implementing university curriculum that offer e-Learning based courses. This paper is intended to specify major factors that may prevent the use of e-Learning as perceived by university instructors.

The acceptance and use of e-Learning by instructors and learners plays an essential and important role in higher education institutions. Worldwide, especially in developed countries, most students and learners are able to use e-Learning in their learning activities; but this is not the same among faculty members and instructors. Numerous universities in developing countries are greatly concerned about e-Learning use and acceptance among instructors [5].

E-Learning facilities and services are provided in developing countries' universities in order to enable learners to efficiently use Web-based resources and have the ability to utilize various applications of the Internet within their classroom instruction [6]. Thus, there is a need to investigate the issue of acceptance and use of e-Learning, and examine factors that influence and predict acceptance and use of e-Learning among faculty members and instructors at higher education institutions.

2. RELATED WORK

In spite of growing amount of information and communication technologies (ICT) and e-Learning tools provided to the instructors to use in their classrooms and teaching, respectively, instructors' e-Learning utilization is not still as predicted; research shows many barriers influencing instructors' utilization of e-Learning. Moreover, many researchers have identified a number of factors to describe why instructors do not feel ready to use e-Learning in their classroom instruction; they also investigated the key obstacles that prevent instructors to utilize e-Learning in teaching and learning process.

The literature showed that the key factors affecting the utilization of e-Learning in education are lack of enough training, lack of suitable software and hardware, lack of knowledge and skills, lack of ICT leadership support, lack of time, and lack of self-efficacy. Therefore, understanding the amount to which these obstacles affect e-Learning users

and institutes can support decision-making on how to equip them [7].

Numerous researchers have classified obstacles into two categories: the external and internal obstacles. The external obstacles include: lack of operational education and technological difficulties, technical problem, lack of enough time, inadequate technical support, and incomplete resources or lack of contact to quality multiplying resources. Internal obstacles relate to the educators' approaches to use e-Learning such as resistance to change, lack of self-confidence, instructors' negative attitudes, and lack of awareness about advantage of using e-Learning [8]. However, Mirzajani, Mahmud, Ayub, and Luan [9] reviewed the obstacles to the use of technology and e-Learning in higher education institutions; as well as organized the barriers into several categories that include: (a) resource-related obstacles (b) institutional obstacles, and (c) attitudinal obstacles.

In general, e-Learning integration into instruction is beneficial for learners' achievement and learning and, in an ideal world, would be fully assimilated into the curriculum. Unfortunately, there are often significant barriers to the successful integration of e-Learning in teaching and learning environments in institutions of higher education.

According to the reviewed literature, the major factors influencing integration of e-Learning and the key challenges and barriers to integrating e-Learning in higher education from the instructors perspectives are lack of infrastructure, lack of resources, lack of technology, lack of access to technology, lack of time, inadequate technical support, lack of knowledge and skills, lack of appropriate administrative support, user's attitudes, lack of technical support, lack of competence, lack of access to resources, resistance to change, lack of ICT equipment in classrooms, rigid structure of traditional education systems, users' beliefs and practices, lack of incentives and motivations, lack of sharing best practices, disbelieving ICT benefits, lack of confidence, lack of technical staff, low speed internet, restrictive curricula, lack of timely feedback from instructors, lack of awareness, Internet usage, language barriers, teaching workload, and lack of e-Learning policy [10].

In short, e-Learning utilization in higher education continues to be critical all around the world; low level of use of e-Learning into teaching and learning environment is critical issue in higher education. According to reviewed literature, it is observable that utilization of e-Learning in higher education is affected by numerous obstacles. A diversity of activity plans have been established to an efficient utilization of e-Learning in teaching and learning process, but numerous obstacles still happen in preparation. To facilitate these activities, obstacles are necessary to be recognized so that they might be solved. Hence, it is suggested that understanding the amount to which these obstacles affect e-Learning users and institutes can support decision-making on how to overcome and equip them.

3. METHODOLOGY

The methodology used in this study employed quantitative data collection procedures. However, descriptive research was used as a methodology to answer the research questions. The majority of the survey questions took the form of an attitude scale similar to a Likert-type scale. Respondents addressed each statement using a five-point Likert-type response set: 1= strongly disagree, 2=disagree, 3=neutral, 4=agree, 5= strongly agree; in addition to some statements took the form of closed-ended questions, or what is called dichotomous or two-point questions, (e.g. 'Yes' or 'No').

The study was conducted during the Spring Semester of the academic year 2016/2017; a total of 124 surveys were completed and returned. Thus, the sample size of the study was 124 respondents/instructors from all academic disciplines from this Jordanian university (UoJ). Figure 1 shows the participants' representation with regard to the academic disciplines.

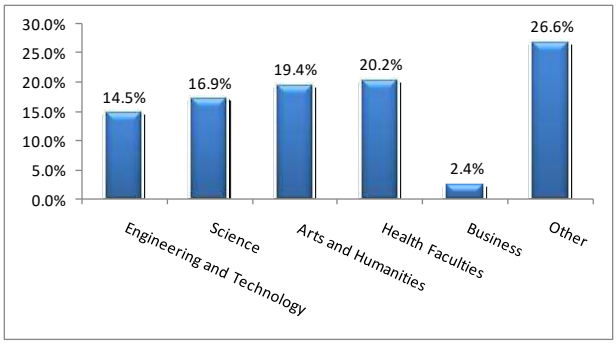

Figure 1: The participants' representation with regard to the academic disciplines

Following data collection, descriptive statistics were used in the study; statistical analyses were performed on the data collected from the surveys. Data analysis included the use of frequencies, percentages, means, and standard deviation. Data analysis and computations for all statistical techniques were performed using the Statistical Package for Social Science (SPSS), version 20.0, to analyze the data in light of the research questions. Then, the results were reported based on the analyzed data; however, the results from the analyses assisted the researcher in reaching conclusions on the instructors' perceptions towards the utilization of e-Learning in higher education in Jordan, as well as on the potential factors/barriers that might prevent the effective use of e-Learning in higher education in Jordan.

4. FINDINGS

In a question about the type of e-Learning delivery tools faculty members are currently using or previously have used, the respondents indicated that they are currently using or previously have used most is Blackboard. Fifty-one instructors indicated that they are using or have used this type of e-Learning tool (25.1%). Forty-one instructors indicated that they are using or have used Moodle as e-Learning delivery tool (20.2%). Thirty-six instructors indicated that they are using or have used Mobile Learning (Twitter/Facebook/WhatsApp). Twenty-five instructors indicated that they are using or have used Self-created Webpage as e-Learning delivery tool (12.3%). Fourteen instructors indicated that they are using or have used WebCT as e-Learning delivery tool (6.9%). Seven

instructors indicated that they are using or have used Webboard for delivery of their classroom instructions (3.4%). However, 29 instructors indicated that they have used other e-Learning tools (14.3%). Figure 2 illustrates the type of e-Learning delivery tools that the respondents at UoJ are currently using or previously have used most.

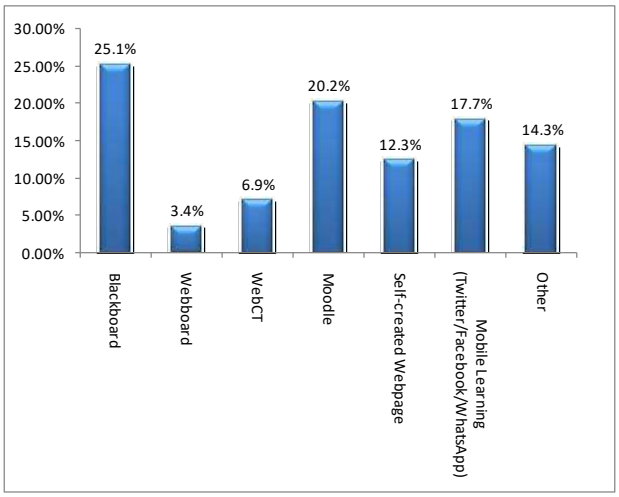

Figure 2: Type of ICT delivery tools are currently using or previously have used most by the respondents

In a question about instructors' plans regarding using e-Learning tools (ICT) in education, 17 instructors indicated that they have no plans to teach a course using e-Learning tools (11.3%). Sixty-eight instructors indicated that they plan to teach a course utilizing best practices in e-Learning in education in the coming year (45%). Thirty-six instructors indicated that they have taught a course utilized best practices in e-Learning in education (23.8%). Thirty instructors indicated that they currently teach a course utilizing best practices in e-Learning in education (19.9%); as shown in Figure 3.

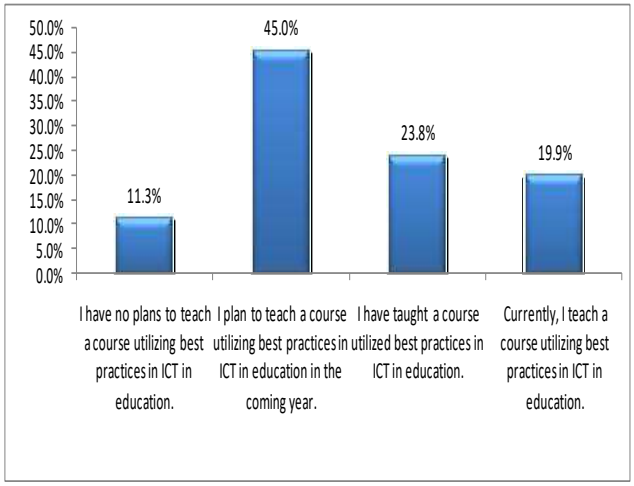

Figure 3: Instructors' plans regardingu e-Learning tools in education

The results indicated that a very large number of respondents (45.0%) plan or have the intention to use e-Learning in education in the coming year. About (43.7%) are currently teaching a course utilizing best practices in e-Learning in education or previously had taught a course utilized best practices in e-Learning in education.

In a question asked if faculty members have attended a training session about e-Learning use. Thirty-seven instructors indicated that they have attended a training session about e-Learning use (31.1%). Eighty-two instructors indicated that they have not attended a training session regarding e-Learning use (68.9%) as shown in Figure 4.

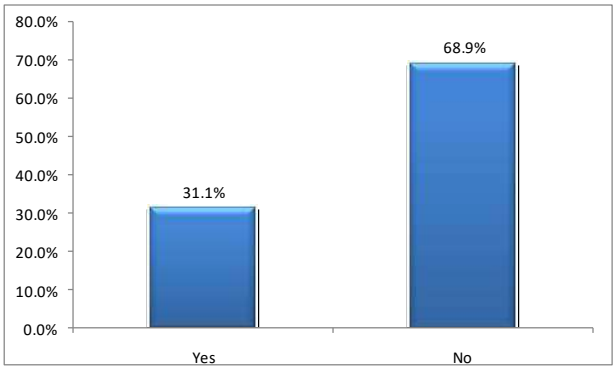

Figure 4: Attend a training session about e-Learning use

The results indicated that two thirds of the respondents have not attended e-Learning training sessions; hence, those who did not attended e-Learning training sessions may had used other resources to learn e-Learning best practices.

In a question asked about the classification of the e-Learning users, e-Learning faculty users versus e-Learning faculty non-users. Seventy-three faculty members (the majority) classified themselves as e-Learning faculty users (62.9%), whereas 43 faculty members classified themselves as e-Learning faculty non-users (37.1%) as shown in Figure 5.

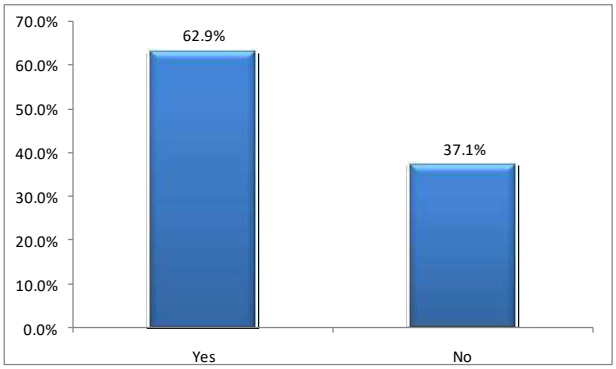

Figure 5: Faculty users and non-users of e-Learning

Figure 6 corresponds to a question of the survey about e-Learning faculty non-users only, asking whether they would be interested in receiving training (in both pedagogy and technology) about the use of e-Learning tools in the future. This result validates that (97.7%) of the e-Learning faculty non-users are interested in receiving training (in both pedagogy and technology) about the use of e-Learning in the future; whereas, (5.3%) of the e-Learning faculty non-users are not interested in receiving training about the use of e-Learning in the future.

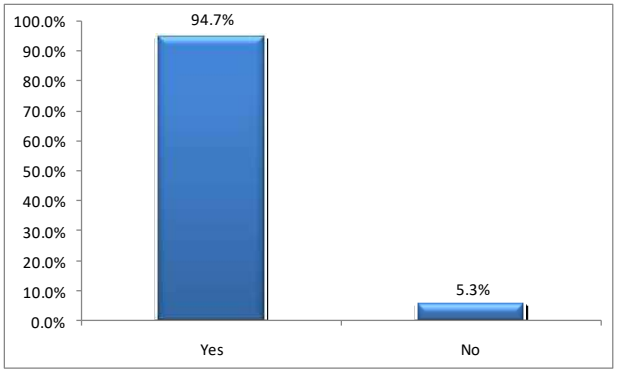

Figure 6: E-Learning faculty non-users' interest in receiving training about the use of e-Learning in the future

Figure 7 corresponds to a question of the survey which was for e-Learning faculty non-users only; asking what would the major deterrent to their decision to teach a course that utilizes e-Learning tools (ICT) in the future. In this question of the survey, respondents addressed each statement using a five-point Likert-type response set: 1=Strongly Disagree, 2=Disagree, 3=Do Not Know (neither disagree nor agree), 4=Agree, 5=Strongly Agree. For the data analysis purposes, the interpretation of mean score as follows: (1-2.33) low, (2.34-3.67) moderate, (3.68-5) high.

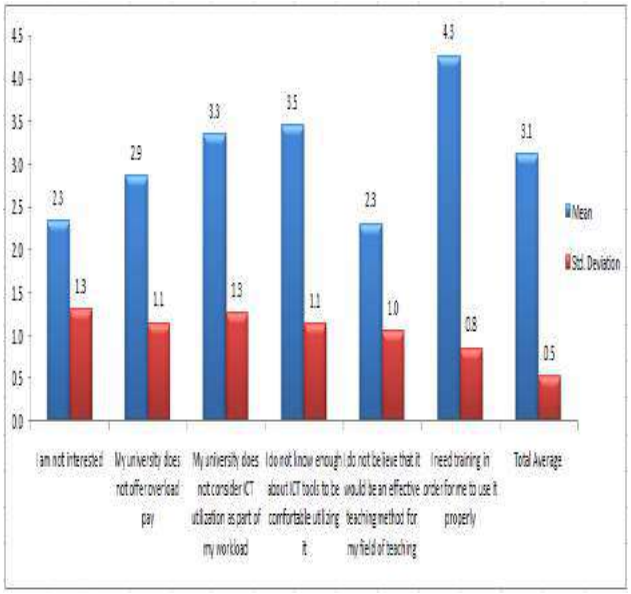

Figure 7: E-Learning faculty non-users' major deterrent to teach a course utilizing e-Learning tools in the future

As shown in Figure 7 above, the overall mean (total average) of these six statements is (3.1) with a moderate degree. This indicates that e-Learning faculty non-users rate those major deterrents to their teaching a course utilizing e-Learning tools in the future to a moderate level; which implies that these obstacles or barriers can be overcome.

Also from the figure above, it can be concluded that statement one (I am not interested), and statement five (I do not believe that it would be an effective teaching method for my field of teaching) with the same mean (2.3) have low degrees. But statement two (My university does not offer overload pay), statement three (My university does not consider e-Learning utilization as part of my workload), and statement four (I do not know enough about e-Learning tools to be comfortable utilizing it) with means of (2.9, 3.3, 3.5) respectively have moderate degrees. While statement six (I need training in order for me to use it properly) with mean of (4.3) has a high degree.

Referring to Figure 7 above, it can be concluded that the order of the major deterrent, as perceived by e-Learning faculty non-users, ranking in descending order according to the mean, is shown in Table 1.

Table 1: Major deterrent, as perceived by e-Learning faculty non-users, ranking in descending order according to the mean score

Statement No.	Ranking	Mean	Degree
6	1	4.3	High
4	2	3.5	Moderate
3	3	3.3	Moderate
2	4	2.9	Moderate
1	5	2.3	Low
5	5	2.3	Low
Total Average		**3.1**	**Moderate**

Nevertheless, most participants, e-Learning faculty users and non-users (*N*=124), were generally positive in their perceptions of e-Learning at this Jordanian academic institution (53.1% of the respondents are supportive towards the use of e-Learning at a personal level). Figure 8 corresponds to a question of the survey which asked about how instructors, overall, perceive the use of e-Learning tools.

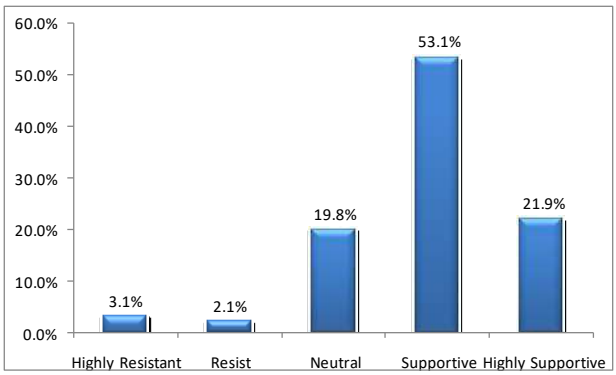

Figure 8: E-Learning faculty users and non-users' perceptions of the use of e-Learning

In a question asked about if the nature of the courses that instructors are teaching influences their decisions about whether or not to use e-Learning tools, ten instructors (10.4%) indicated they (strongly agree) that the nature of the courses they are teaching influences their decision about whether or not to use e-Learning tools; fifty-two instructors (54.2%) indicated they (agree) that the nature of the courses they are teaching influences their decision about whether or not to use e-Learning tools; ten instructors (10.4%) indicated they (do not know) that the

nature of the courses they are teaching influences their decision about whether or not to use e-Learning tools; twenty instructors (20.8%) indicated they (disagree) that the nature of the courses they are teaching influences their decision about whether or not to use e-Learning tools; and four instructors (4.2%) indicated they (strongly disagree) that the nature of the courses they are teaching influences their decision about whether or not to use e-Learning tools as shown in Figure 9.

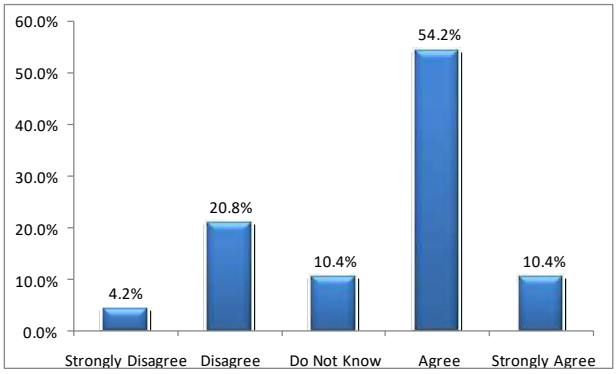

Figure 9: Does the nature of the courses that instructors are teaching influence their decisions about whether or not to use e-Learning tools?

Therefore, the results indicated that most of the respondents (54.2%) believe that the nature of the subject is a key factor to decide to use e-Learning tools in teaching and learning process.

In a question asked about what are or would be the major incentives for using e-Learning tools, the respondents (e-Learning faculty users and non-users) addressed each statement using a five-point Likert-type response set: 1=Strongly Disagree, 2=Disagree, 3=Do Not Know (neither disagree nor agree), 4=Agree, 5=Strongly Agree. For the data analysis purposes, the interpretation of mean score as follows: (1-2.33) low, (2.34-3.67) moderate, (3.68-5) high.

As shown in Figure 10 below, the overall mean (total average) of these six statements is (3.7) with a high degree. This indicates that e-Learning faculty users and non-users rate those major incentives for utilizing e-Learning tools in education to a high level; which implies that these incentives will help in increase the utilization level of e-Learning in the teaching and learning process.

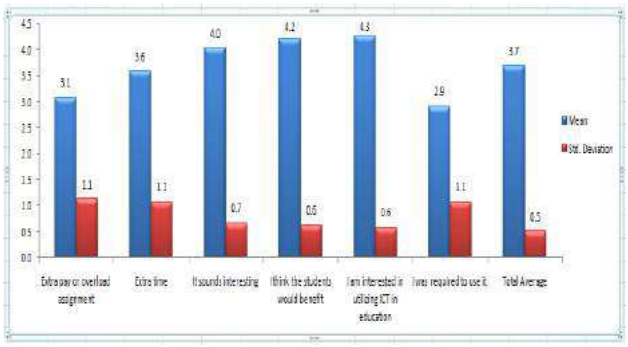

Figure 10: E-Learning faculty users and non-users' major incentives for utilizing e-Learning in education

Also referring to the figure 10, it can be concluded that statement one (extra pay or overload assignment) with a mean (3.1), statement two (extra time) with a mean (3.6), and statement six (I was required to use it) with a mean (2.9) are having moderate degrees. While statement three (it sounds interesting), statement four (I think students would benefit), and statement five (I am interested in utilizing e-Learning in education) with means of (4.0, 4.2, 4.3) respectively have high degrees.

Referring to Figure 10, it can be concluded that the order of the major incentives, as perceived by e-Learning faculty users and non-users, ranking in descending order according to the mean score, is shown in Table 2.

Table 2: Major incentives, as perceived by e-Learning faculty users and non-users, ranking in descending order according to the mean score

Statement No.	Ranking	Mean	Degree
5	1	4.3	High
4	2	4.2	High
3	3	4.0	High
2	4	3.6	Moderate
1	5	3.1	Moderate
5	6	2.9	Moderate
Total Average		**3.7**	**High**

In an open-ended question about the major factors for integrating e-Learning in education, the respondents stated that the followings are major barriers of e-Learning: lack of smart rooms and infrastructure; logistics and time; students' skills; no incentives; training availability on the use of e-Learning tools; the number of students enrolled in the class; lack of training and time; lack of equipment, technical expertise and interest; lack of user-friendly software; lack of internet security; teaching overload; the limited budget for using e-Learning at UoJ; lack of facilities, laboratories, and equipment; limited recourses; the traditional methods of teaching; the detailed nature of the course; and no previous experience on using the e-Learning tools.

In a question of the survey, the participants were asked to rate the extent to which they agree with nine statements using a five-point Likert-type response set: 1=Strongly Disagree, 2=Disagree, 3=Do Not Know (neither disagree nor agree), 4=Agree, 5=Strongly Agree. For the data analysis purposes, the interpretation of mean score as follows: (1-2.33) low, (2.34-3.67) moderate, (3.68-5) high.

As shown in Figure 11, the overall mean (total average) of these nine statements is (3.7) with a high degree. Also from the indicated figure, it can be concluded that statement six (Traditional classroom-based courses and e-Learning based courses are given the same Recognition) with a mean (2.7), statement eight (e-Learning instruction is at least as effective as face-to-face instruction) with a mean (3.1), and statement nine (Teacher-student interaction is difficult when using e-Learning tools to deliver instruction) with a

mean (3.0) are having moderate degrees. While statement one (Faculty members need more time available for implementing e-Learning) with a mean (3.9), statement two (e-Learning is positively related to the learning process) with a mean (4.0), statement three (e-Learning could effectively serve students with different backgrounds) with a mean (4.1), statement four (e-Learning could be a useful tool for supporting traditional methods of teaching) with a mean (4.0), statement five (e-Learning can be a more stimulating method of teaching than traditional instruction) with a mean (4.1), and statement seven (Lack of technical knowledge prevents the use of e-Learning tools) with a mean (4.1), are all having high degrees.

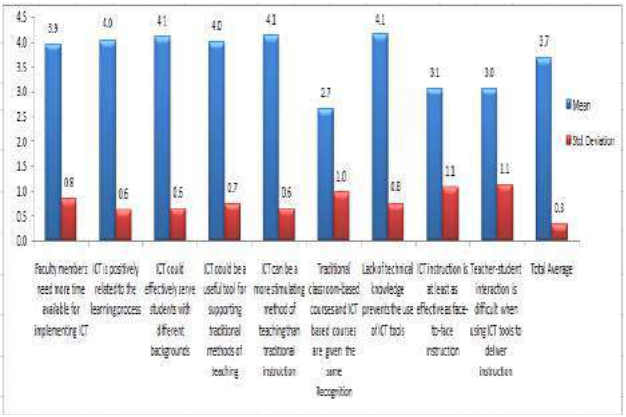

Figure 11: Participants rating the extent to which they agree with the provided nine specific statements

Referring to Figure 11, it can be concluded that the order of the comparison between e-Learning tools method of teaching and traditional teaching method, ranking in descending order according to the mean score, is shown in Table 3.

Table 3: Comparison between e-Learning tools method of teaching and traditional teaching method, ranking in descending order according to the mean score

Statement No.	Ranking	Mean	Degree
7	1	4.1	High
5	1	4.1	High
3	1	4.1	High
4	4	4.0	High
2	4	4.0	High
1	6	3.9	High
8	7	3.1	Moderate
9	8	3.0	Moderate
6	9	2.7	Moderate
Total Average		**3.7**	**High**

In an open-ended question asking the participants to make any additional comments they would like to add or anything else they would like to mention about the use of e-Learning, the followings are some of those comments as stated by the respondents:

"I would like to see a training center for e-Learning at the University of Jordan which can provide help and support to the faculty members to adopt e-Learning in the courses which they are teaching, also, I would like to see some smart class rooms; e-Learning has a great influence on teaching; I am concerned about the scarce resources at the disposal of my university and the impact of e-Learning on the fair evaluation of students' achievements; I'm very much interested in using e-Learning to explore it and see the impact on my students and their feedback, after that I may consider using it for all my courses or to forget it at all; training for instructors to use this method is essential to make its use with confidence, and more time/course load for the preparation of the learning material taught; the use of e-Learning is not supposed to be a replacement of the face-to-face meetings, there should be at least 25% of face-to-face meetings with students; infrastructural and handy technical support are very important if e-Learning "in the way I see it" to make a difference; next time, please write your survey in Arabic in order to make the question clear and understandable by all faculty members; and integrating e-Learning in teaching and learning process is necessary".

5. CONCLUSION AND RECOMMENDATIONS

Analysis of the data and the questionnaire indicated that most participants were generally positive in their perceptions of e-Learning at this Jordanian academic institution (UoJ). Also, Data from the completed surveys revealed that the majority of the e-Learning non-user participants would be (a) interested in using e-Learning in the future, (b) willing to or interested in teaching a course that utilizes e-Learning tools in the future, and (c) interested in receiving training about the use of e-Learning tools in the future. Furthermore, e-Learning non-user participants indicated that the most major deterrents to their teaching a course that utilizes e-Learning tools in the future are they need training in order for them to use it properly, they do not know enough about e-Learning tools to be comfortable utilizing it, and their university (UoJ) does not consider e-Learning utilization as part of their workload.

Overall, this paper reviews and investigates factors that influence instructors' decisions to use e-Learning in their instruction. It found that the major factors affecting instructors' use of e-Learning are: (a) Instructors' characteristics: (e.g. individual's educational level, age, gender, educational experience, experience with the e-Learning for educational purposes, and faculty rank) can influence the adoption of an innovation [11]. (b) Availability of vision and plan about the contribution of e-Learning to education: instructors need to know exactly how e-Learning is used as a teaching and learning tool; instructors must have opportunities to study, observe, reflect, and discuss their practice, including their use of e-Learning, in order to develop a sound pedagogy that incorporates technology [12].

(c) Level of and accessibility to the e-Learning Infrastructure: using up-to-date hardware and software resources is a key feature to diffusion of technology [13].

(d) Availability of time, to experiment, reflect and interact: according to Mumtaz [14], lack of time is a factor that hinders technology integration in schools and universities. (e) Available support to e-Learning-using instructor in the workplace: the lack of technical support reported as one of the major barriers that resulted in e-Learning being underutilized in the classes [15]. (f) Level and quality of training for instructors: professional development of instructors sits at the heart of any successful technology and education program [16].

(g) Attitude towards e-Learning: instructors' attitudes have been found to be major predictors of the use of new technologies in instructional settings [17]. (h) Computer competence: according to Pelgrum [18], the success of educational innovations depends largely on the skills and knowledge of instructors. And (j) Instructor workload: many studies have revealed that the workloads of instructors influence their acceptance of technology in classrooms [19].

In summary, the systematic review of the literature identified important issues which need to be in place for e-Learning to effectively take place. The factors, barriers, and potential solutions identified are useful for those designing e-Learning tools in any professional context. However, in the present study, the population sample that responded to the surveys came from one university located in urban area; hence, future research should collect a larger population sample including a broader range of respondents from both urban and rural areas.

Last but not least, the results from this study suggest several areas for future research: (a) Conduct a follow-up study with a selected sample of the original respondents using a qualitative data collection method to verify the findings of this study. (b) Conduct a study to investigate the barriers to utilizing e-Learning in higher education in Jordan from the perspective of the decision makers at both the Jordanian universities and the Ministry of Higher Education and Scientific Research.

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COMPUTER-ASSISTED LANGUAGE LEARNING PROGRAMMES: EVOLUTION & EVALUATION

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Abstract: *Technology and information technology in particular have shaped modern society and, consequently, the teaching and learning processes. Language learning has also been affected by these changes, following the trends in other scientific areas of education. Computer-assisted language learning has adopted many names, but it is now a reality that needs to be assessed and evaluated in the same manner that any other programmes are. In fact, this evaluation may prove invaluable in determining the courses' quality and therefore confer credibility to it. This evaluation can be performed using different methodologies, according to the purpose it serves and from different perspectives, depending on who is interested in it.*

Keywords: *CALL, evolution, e-learning, evaluation*

1. INTRODUCTION

Technlogy has had an impact on almost every aspect of society and education is no exception. Accordingly, language teaching approaches have sought to integrate the successive technological revolutions seeking to keep pace with them, offering new educational opportunities, modifying the processes, approaches and methodologies. Thus, the democratisation of computer technology, both in the personal sphere and in educational institutions, opened the door to new ways of learning and new learning contexts. The potential of information and communication technologies was harnessed to implement distance language learning courses, whose number has increased exponentially in recent decades, particularly in the context of adult education. These offer the possibility to study anywhere and anytime, presenting itself as an opportunity to all those whose professional lives do not allow them to attend face-to-face classes.

There are several CALL systems, each suited to a distinct reality: integrated in the context of a physical classroom; as a complement to the lessons that combines classroom learning and distance learning (blended learning); and as self-study, at a distance, with or without a facilitator, based or not on e-learning. The focus of this paper is on CALL courses at a distance, that is, e-learning courses for language learning.

2. DEFINITIONS OF CALL

In the 1960s, the use of technology in the language classroom, in the form of cassettes and projectors, among others, was considered revolutionary, even though it was welcomed (Shafaei, 2012) [1]. In fact, a teacher who would use ICT a few decades ago was seen as being innovative, whereas nowadays, if he does not do so, he will probably be perceived as being outdated (Chapelle, 2008) [2].

The acronym CALL seems to have been first used in 1981 by Davies and Steel at a symposium at the University of Leeds, according to Davies himself (Davies, n.d.) [3]. The use of the expression was formalized in the Teachers of English to Speakers of Other Languages (TESOL) convention in Toronto in 1983 (Chapelle, 2001) [4]. There was a succession of acronyms to name the use of computers in the process of teaching and learning languages. CALI (Computer Assisted Language Instruction), created by the Computer-Assisted Language Instruction Consortium (CALICO), was widely in use in the USA until the emergence of the term CALL (Davies, n.d.) [3]. The fact that it focused on the teacher (instruction), as opposed to learning, and was thus associated with the behaviourist approach dictated its end. ICALL (Intelligent Computer-Assisted Language Learning), CELL (Computer-Enhanced Language Learning) and TELL (Technology-Enhanced Language Learning) are other acronyms that also fell into disuse. Some of the terms adopted in the area of languages actually consisted of an extension of the existing acronyms in the field of education. The various acronyms point to "the means (computer, technology, network, web, mobile technologies), the role (to assist, to enhance, to provide a base) and the focus (instruction, learning, teaching)" (Levy, 2007) [5], each label having its limitations, since it is a reality that is becoming increasingly multifaceted due to the different media, modes of distribution and channels of communication and interaction used (Levy, 2007) [5].

The term CALL has persisted to the present day, and can be defined as "the search for and study of applications of the computer in language teaching and learning" (Levy, 1997, p. 1) [6]. Although the acronym in fact only refers to the word "computer" and does not include, for example, the Internet, it is a concept that covers ICT in general, since, according to Levy and Hubbard (2005) [7], it would be confusing to use a different term each time a technological innovation emerged. To reinforce this idea, Egbert & Petrie (2005, p.4) [8] define CALL as learning a language "with, through, and around computer technologies". Shafaei (2012) [1] believes that technology is not a method, but a tool that allows teachers to facilitate the process of learning

a language. Blake (2008) [9] also argues that technology itself is neutral from a theoretical and methodological point of view; it is the way it is used that is not neutral. This perspective is in line with the paradigm shift that has occurred with the proliferation of personal computers, in which the computer has gone from tutor to tool (Levy, 1997) [6].

Amaral (2011) [10] completes the definitions above considering CALL to be an integral part of something greater: "Computer Assisted Language Learning (CALL) is a multidisciplinary area of research that encompasses the study of computer applications in language teaching and learning "(p.1). Amaral argues that this multidisciplinary approach to a common problem has been the trend in research in the last 30 years. Psychology, technology and instructional design, artificial intelligence, human-computer interaction, computational linguistics, and applied linguistics are some of the major subjects involved in CALL (Levy, 1997, p. 72) [6]. Levy (1997, p. xii) [6] adds that, since CALL is interdisciplinary, it is necessary to study the developments in the subjects that are related to it. It is also a field of research that is constantly changing, because, as Beatty (2010) [11] states, computers themselves are constantly evolving. Levy (1997) [6] stresses the importance of creating mechanisms to deal with the rapid rate of change in technology, while noting that it is imperative that there be immutable qualities in CALL, so that it can be considered a field of investigation in its own right.

3. CALL EVOLUTION

In the same way that e-learning in general passed through a succession of phases, computer-assisted language learning was also marked by generations. Thus, with regard to language learning, White (2003) [12] claims that there are only three generations of e-learning systems: correspondence systems, followed by multimedia systems and, finally, online systems. As pointed out in this brief description of the evolution of distance education in languages, the nomenclature chosen by White (2003) [12] reveals that the division of generations is established based on the technologies used, unlike Anderson and Dron (2011) [13] who, at the same time that they recognize the impact of technology on the definition of distinct moments, emphasize, in addition, the pedagogy used.

Warschauer (2000) [14] and Bax (2003) [15] state that the selection and design of materials to be used with ICT generally obey certain pedagogical theories and methodologies, and there are therefore some principles that have guided changes over time. Warschauer (2000) [14] distinguished three phases in the evolution of computer-assisted language learning: structural CALL, dubbed behaviourist, and in existence between the 1970s and 1980s, communicative CALL (between the 1980s and 1990s) and integrative CALL (XXI century). The first phase was based on a paradigm similar to textbooks, essentially linear, grammar-centred, based on drill-and-practice, translation and the audiolingual method, aiming at the accuracy of the answers. Learning was based on an approach focused on behavioural stimulus / response, exposure to information and subsequent testing of knowledge, in a sequence of closed independent activities. One of the pioneering programmes of this sort was PLATO (Programmed Logic for Automatic Teaching Operations). The second phase was based on communicative tasks that aimed at improving fluency and the ability to negotiate meanings, with the acceptance of error as an integral part of the evolutionary process of learning. The teacher ceased to occupy the central place in the learning process as the sole provider of knowledge, "sage on the stage" (King, 1993) [16], to assume the role of facilitator of the learning process as the "guide on the side" (King, 1993) [16]. The communicative phase coincided with the widespread use of computers, which contributed to the expansion of CALL, although many of the existing courses did not reflect the new theoretical approach to language learning, according to McDonnell and Connolly (2008) [17]. As for the third phase, it covers the most positive aspects of the communicative phase, the learner being the agent of his or her own learning, with a special emphasis on the content and the authenticity of the context, common characteristics in English for specific or academic purposes. Bax (2003) [15], however, preferred to refer to three approaches rather than phases: restricted CALL, which does not differ much from behavioural CALL, but which he feels to be a more appropriate terminology to describe its constraints in terms of interaction and technological limitations; open CALL, which contains a greater openness to feedback and to software, with a more open-minded attitude towards computers; and integrated CALL (and not integrative as in Warschauer's model), which is to be achieved in the future. In Bax's view, the approach that is currently being used is open CALL, the aim being to achieve a state of standardization where technology is fully integrated, as in the third approach, thus becoming invisible. Bax gives the example of the book, which is so integrated into everyday life that it would make no sense to speak of book-assisted learning.

4. EVALUATION OF E-LEARNING PROGRAMMES

The potential of e-learning to provide access to education and training to those who would otherwise not have the opportunity to follow a course is widely recognized. However, in spite of this added value, it is often faced with some suspicion, which makes it important to demonstrate its quality in order to confer credibility to it. Lee (2005) [18] even asserts that there is a climate of scepticism and disbelief on the part of the academic community and the business community regarding the effectiveness of e-learning. In addition, from the perspective of Herrington et al. (2001) [19], the existing literature on e-learning suggests that the quality of courses is often compromised. In response to these allegations, a number of experts and e-learning enthusiasts have built or adapted from face-to-face models a set of guidelines and models to measure and promote the quality of online initiatives in order to set quality standards. At the same time, these initiatives have enabled course providers to become aware of the innovations and existing good practices, guiding future course developments.

Evaluating training, however, is not an easy task, starting with the fact that its product, the knowledge to be acquired

by the trainees, is not tangible and evaluating whether the learning took place can therefore prove difficult.

The word "evaluation" has a strong negative connotation of judgment, when in fact it should be taken as an opportunity for reflection, review and consequent improvement. It would be more fruitful for evaluation to be seen as an assessment for the purpose of guiding rather than as control or monitoring (Warwick Learning and Development Center, 2006) [20]. It is a term repeatedly used "to measure results and to use these in a frequently discriminatory and punitive way. One of the concerns on the part of those who are subject to an evaluation process is what the evaluator will do with the results of the evaluation" (Valente & Escudeiro, 2008, p.149) [21].

According to Scriven (cited in Baumgartner & Payr, 1997) [22], evaluation consists of the process of determining "the merit, worth and value of things, and evaluations are the products of that process" (p.2). The options for performing the evaluation are diverse; however, the main difficulty lies in the diversity of quality standards mechanisms, which vary with context and with the quality concept itself (Rubio, 2003) [23]. The most used expression in the international literature for this context is, in the words of Rubio (2003) [23], "quality assurance".

Jung (2010) [24] presents some aspects to be taken into account when evaluating e-learning: if, on the one hand, there are some general principles that can be applied both to face-to-face teaching and to online teaching, there are certain e-learning specificities that need different approaches. The same author also warns that e-learning depends, in a much more pronounced way than face-to-face teaching, on the level of motivation and commitment of the students, and these factors might interfere in the rigorous measurement of the quality of e-courses. In addition, Pawlowski (2003) [25] states that the quality of e-learning is not associated with a well-defined measure, varying in scope, perspective and dimension. However, on the most essential issues, face-to-face and distance education models share many common points, such as issues related to the purpose of the assessment, aspects to be valued, how to assess and by whom.

Establishing quality in e-earning courses is a complex and multifaceted problem (Jung, 2010) [24]. Regarding the task of defining an ideal online course, Carr-Chellman and Duchastel (2001) [26] even state that it is "a highly adventurous and risky one." The assessment of the quality of e-learning is thus difficult to implement, because it depends on human intervention, so it should not be based on a single methodology. There are several perspectives from which to evaluate an online course and there is therefore a considerable variety and a growing number of studies that identify quality dimensions, guidelines, good practices and benchmarks for e-learning, many of which describe the evaluation tools and mechanisms to be applied. In this context, the present research presents and discusses different guidelines, approaches, criteria and evaluation models of e-learning.

The assessment can be done in a summative or formative way, and the first occurs during the course with the possibility of reviewing and improving it with the continuous feedback that is obtained and the second, at the end of it. Evaluating whether or not a course achieves conclusively the proposed objectives implies assessing the students' knowledge before starting the course and when the course ends. It is also possible to evaluate the effectiveness of the course, to some extent, based on the instructional design. However, it is difficult to isolate the factors that lead to the success of e-learning, since there is no consensus on what constitutes a success factor. Course evaluation dimensions are defined by diverse concepts and theories.

For Jung (2010) [24], evaluation has different purposes and approaches, depending on the entity that is evaluating the e-course, since each stakeholder has different interests and requirements. In the case of an evaluation requested by the institution that provides the course, the focus will be on the quality of management, costs, student satisfaction and success rates. In the case of teachers, for instance, the concern will be more focused on aspects related to the quality of teaching.

5. CALL EVALUATION

CALL suffered a constant technological evolution, associated with some practical and conceptual problems. While a good textbook can be maintained over a long period of time as long as it proves to be effective, CALL materials are more easily discarded as a new technology emerges (Levy, 1997, p.2) [6].

As in other areas of applied linguistics, CALL research has adopted its perspectives and methodologies from multidisciplinary sources. The predominant approach to CALL evaluation is post-positivist, which implies an evaluation made from one of three perspectives: the teacher, the student or the course developer. However, according to Hamburger and Hubbard (cited in Villada, 2009) [27], these unilateral perspectives are insufficient to analyse a phenomenon with this degree of complexity. Thus, the interpretive approach emerges, which intends to integrate the various perspectives involved in the process. According to Willis et al. and Levy (cited in Villada, 2009) [27], it is the purpose of the evaluation that distinguishes the post-positivist paradigm from the interpretivist one, since the former seeks to achieve the "truth", while the latter seeks to understand. The designation itself is one of the three elements that make up interpretivism, since meaning is constructed from interpretation, which draws guidelines rather than rules, and through the contribution of the researcher and those who use CALL. Other elements of interpretivism are multivocality, in that it allows multiple voices to be heard, and contextualisation, because the context is taken into account. It ends up being a more complete and comprehensive approach, since it takes into account both teaching and learning in the real context.

There is a multitude of formats for CALL courses, and, due to their specificities, each model requires a differentiated evaluation. According to Blake (2008) [9], CALL assessment can analyse design, procedures, approaches, or even a combination of these factors. Chapelle (2008) [2] suggests that various research methods be used for this purpose. She refers the checklists methodology, stating that it should not be used on its own, and one should also

include the perspectives of teachers, students, researchers, course developers and the context in which the materials are used. The website "Information and Communications Technology for Language Teachers" (ICT4LT) [28], a project funded by the European Commission and EUROCALL, contains a checklist covering interface, navigation, multimedia (such as videos, photographs, images, animations and sounds), interactivity, help, feedback and student evaluation. In a different evaluative perspective, without the use of checklists or questionnaires, the CALICO journal contains a section on critical software analysis, which examines the main properties of CALL materials, with a particular focus on pedagogical validity, adaptability to different learning environments, efficiency, effectiveness (as measured by student outcomes) and innovation (Blake, 2008) [9].

6. CONCLUSION

Technological revolutions have marked different educational stages both in e-learning in general and in CALL. Continued progress over time in CALL has allowed for greater diversity, greater control over the learning process for the learner (White, 2003, p. 13) [12], increased interactivity, more communicative opportunities, and more timely feedback. Several evaluation methodologies and models can be applied to assess the quality of e-learning and CALL. These approaches may be based on existing and proven models previously applied on traditional face-to-face courses, while taking the opportunity to innovate and adapt the models to the context in question with some adaptations or the models may be built specifically for these courses.

The advantages of CALL will never be fully realized if its evaluation is not performed in a systematic way to ensure that it meets the specific needs of learners.

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AUDIO AND VIDEO ADAPTATION INSIDE 3D VIRTUAL LEARNING ENVIRONMENTS

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Abstract: *The use of 3D Virtual Environments is gaining interest in the context of academic discussions on e-learning technologies, as it provides several advantages over classical learning material. However, the use of multimedia resources such as videos and audio inside 3D Virtual Learning Environments (3D VLE) also has drawbacks, especially usability and the effectiveness issues may cause problems. One way to overcome such drawbacks is by providing an adaptive 3D Virtual Learning Environment i.e. an environment that dynamically adapts to the learner characteristics and his activities inside the environment. In general, providing different adaptation techniques inside 3D VLE is not simple and should be supported with care. Therefore, this research is conducted to investigate the different adaptation techniques that can be applied to the audio and video learning resources which are considered as one of the important components of 3D VLE. The proposed adaptation techniques can be used to improve the learning outcomes from a 3D Virtual Learning Environment.*

Keywords: *Adaptive 3D Virtual Learning Environment, E-learning, Multimedia Learning Resources*

1. INTRODUCTION

In general, 3D Virtual Environments or Virtual Reality (VR) are defined as three-dimensional (3D), multisensory, immersive, real time, and interactive simulations of a space that can be experienced by users via three dimensional input and output devices [1]. Another definition by [2] is "a computer-generated simulation of the real or imagined environment or world.". Evolutions in technology in the last two decades have helped researchers to explore the use of three-dimensional Virtual Environments (3D VE). As a result, more and more, 3D VEs are exploited in different domains such as training and simulation [3], [4], e-commerce [5], e-learning [6], educational games [7], [8].

Increasing attention is currently paid to the use of the 3D technology for educational purposes. For instance, Based on reviewed work [6], [9], [10] the use of 3D technology is considered as added value for anatomical education and the students attitude towards the use of this technology is positive and it is considered as an added value to the learning process.

Nevertheless the fact that 3D Virtual Enviornments are considered as an advantage in educational contexts, researchers exposed some obstacles related to the usabilty, learning process, efficiency [11]. Others claimed that the richness of such a 3D VLE could also be its weakness [12]. In general, adaptive 3D VLE is a new emerging trend and still under development. However, one of the possible solutions for diminishing different drawbacks and obstacles is to exploit adaptation techniques for 3D VLEs. Some approaches and frameworks have already been proposed in this context. For instance, researchers in [13]–[15] proposed approaches to adapt user interaction according to the user's different activities inside the 3D VLE or to adapt the 3D content based on the user profile. Other researchers proposed adaptation techniques based on the defined anatomy of the 3D VLE [16]. However, applying adaptation techniques to multimedia learning resources inside the 3D VLE is still an open issue. Based on our knowledge, there is no or limited research that was conducted to explore possible adaptation techniques for audio and video learning resources inside the adaptive 3D VLE.

As a starting point to explore adaptation techniques for video and sound in the context of 3D VLE, it is important to understand the different adaptation techniques that have been proposed for multimedia learning resources in the context of classical elearning applications (like educational hypermedia, moocs, etc.,). For instance, researchers in [17] proposed some guidelines for providing videos in elearning applications. Moreover, researcher in [18] suggested a new methodology for jumping to specific place in videos based on machine learning model (Factorization Machine Model). Other research work [19], [20] proposed the notion of dynamic fragmentation of multimedia resources based on instructor responds to student's questions. Furthermore, authors in [21] propose to increase the playback speed of

the video to shorten the watching time in acceptable way. This lead us to provide a systematic overview of adaptation techniques by investigating how can multimedia resources potentially be adapted inside a 3D VLE. Such approaches are considered as a background for the proposed adaptation techniques for the multimedia resources inside the 3D VLE. Furthermore, the findings of our research work can be applied by 3D VLE engineers and developers to apply adaptation techniques to multimedia learning resources inside the 3D VLE.

This paper is structured as follow: Section 2 gives a brief description about the proposed architecture, Section 3 describe the prototype that has been developed to demonstrate and validate the proposed solution, Section 4 concludes the paper and discussion of future work is presented.

2. ARCHITECTURE

The system architecture is basically based on web-based architcture. Different components of the architecture are depicted in Figure 1.

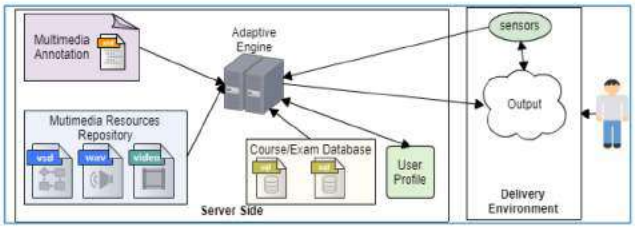

Figure 1: Proposed Architecture

The learner will interact with the 3D models and view video or audio files inside the delivery environment. The delivery environment integrates a specific canvas for playing video or audio files along with 3D models. With the recent web technologies such as HTML5, a wide range of video and audio formats can be embedded. Furthermore, a 3D VLE can be displayed in a web browser using some applications such as WebGL, Three.js, etc.,

During learner interaction with the system, predefined sensors will record data and send requests to the server (such as a request for new learning resource video or audio file, update learner profile, etc.,). Sensors will be also responsible for getting event from the server side (such as get information about the learner, synchronize between 3D models and video or audio file, apply adaptation techniques to 3D models, apply adaptation techniques to learning resources, etc.,).

The server side includes multimedia resources repository, multimedia annotation, annotation for multimedia resources, course information, exam information, user profile and the adaptive engine. A description about each part is as follow:

- Multimedia resources repository and multimedia resources annotations are related to each other. For instance, the repository is used to store all video and audio learning resources which will be sent by the adaptive engine to the client side. The annotation is used to provide closed caption learning resources, metadata, holding textual information about timeframes of each video or audio file, tags, etc. Furthermore, with video and audio annotations, the adaptive engine will specify the video or audio fragment that should be reviewed by the learner.

- Course information stores data that are related to the course model such as learning topics to be covered and relationships between the learning topics. Relationships can be prerequisite, example of, etc. Such relationships are important for generating the learning path by the adaptive engine.

- Exam information holds different level of exams for each learning topic. The exam is used as an assessment tool to determine if the learner can move to the next level or re-learn the same topic again but with the help of adaptation techniques to specify which part of the video or audio should be viewed.

- User profile is used to keep the data about the learner. Data can be static data or dynamic data. Static data are related to gender, learning style, etc., dynamic data are related to learner knowledge level, background, preferences, etc.. Both type of data can be used to formulate the adaptation rules which will be realized by the adaptive engine.

- Adaptive engine is the core of the architecture, which is responsible for compiling the different adaptation rules and perform the reasoning process for selecting learning resources, updating the learner profile. For instance, to enable the adaptive engine to select a learning resource, adaptation rules and annotation for learning resources are required. For instance, if the learner start learning a specific topic, then the adaptive engine will realize the adaptation rules that are associated for learning this topic. In more details, the adaptive engine will get the learner's knowledge level (from the user profile) about the topic and it will send video or audio file that fits his current knowledge level. Furthermore, the adaptive engine will apply adaptation techniques that are specified for the 3D models.

It is important to mention that adaptation rules holds two parts: condition and action. Condition part is mainly depending on the information about the learner like his knowledge, background, gender, learning style, etc. On the other hand, the action part is responsible for updating the learning environment based on the realization of the condition part. Updating the learning environment can be one of the following three states: insert new learning resources to the delivery environment, apply adaptation techniques to learning resources, apply adaptation

techniques to the 3D models inside the delivery environment.

Possible adaptation techniques for the 3D models can be found in [12], [16], [22]. For instance, *highlight* adaptation techniques is used to draw a wired box around 3D model. Normally, it is used to specify the part of the body that will be learned. Another adaptation techniques is *spotlight* which is used to mark a 3D model by using specific lighting colour to draw a learner attention to the highlighted part of the 3D model. A list of possible adaptation techniques can be found in [12] and [16].

Adaptation techniques for learning resources are AddVideo, AddAudio, playFrame, pauseFrame, repeatFrame, skipFrame, stop, showCaption, hideCaption. Such adaptation techniques are inspired from reviewing related work [17], [18]. The mentioned adaptation techniques can be applied to video or audio learning resources inside the 3D VLE. It is important to mention that proposed adaptation techniques for 3D models and learning resources can be applied in a synchronous manner.

Next, we explain the proposed approach using an early prototype.

3. PROTOTYPE

To validate our approach for integrated video and audio with 3D VLE, we have developed a web-based prototype using PHP[1] and WebGL[2] running on Apache Tomcat. A server stores and manipulates the different learning resources such as 3D models, video and audio files using MySQL[3]. Furthermore, the database is responsible for holding information about the user profile, course domain and learning resources, and adaptation techniques for learning resources (video and audio files) and 3D models. Each video and audio file has been annotated manually using Adobe Premier[4] to explicitly identify the topics that are presented during the timeline of the video or audio. For the adaptive engine, a Java servlet running on Apache Tomcat[5] is used not only to send requested files but also to realize hardcoded adaptation rules. The rules are defined in XML file format. This will enable us to reuse as much as possible of the prototype code in the final implementation of the proposed solution.

As mentioned earlier, the kernel (Adaptive Engine) will decide which learning contents will be displayed to the learner according to his level of knowledge about the topics covered in the course. The learning contents should be sent to the client side via HTTP requests and responses. The adaptive engine can also recommend videos or audio files uploaded by educators for the same topic depending on relevance of current learner knowledge about the topic and the suitability of the learning resource. This is achievable by using metadata associated to each video and audio file.

To try out the prototype, an example of adaptive course was developed. The course is about the human body anatomy. It integrates 3D VLE and video files (see Figure 2) where a specific canvas is used to display the video once it is received from the server side. To investigate scientifically the issue related to the providing a synchronous adaptation and integration between different learning resources, the course has 3D contents displays 3D human body, video and audio as learning resources to explain each part of the human body in the course.

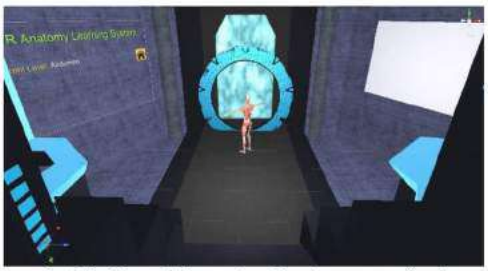

Figure 2: 3D Virtual Learning Environment for learning Anatomy course

The course is divided to 86 learning topics based on classical anatomy 1 and anatomy 2 courses given in our university. Each learning topic has three learning resources labelled with different levels (beginner, intermediate, advanced). Learning resources has been mapped manually, by two experts in the anatomy domain, with corresponding 3D parts of the human body. Furthermore, a third expert cooperating with the previous experts was responsible for defining the adaptation rules.

The course starts with Thorax as learning topic. Therefore, the Thorax part of the 3D human body will be highlighted by green colour (See Figure 3). The course will prevent he learner from learning other learning topics till he passes an exam for the current learning topic. Therefore, visual and auditory feedback are used to direct the learner to follow the specified sequence of the learning path.

Figure 3: Highlighted part of the 3D human body to be learned

Once the learner clicked on the green highlighted part of the body, the learner will be directed to see related video or audio depending on learner preferences. During the running of the learning resource and based on the textual annotation of the video or audio segment, the adaptive engine will apply adaptation techniques such as highlighting corresponding part of the human body, rotating corresponding organs, etc. Upon the completion of the current learning topic (Thorax), which is evaluated by providing an exam to the learner as Figure 4 depicts, an Abdomen learning topic will be displayed to the learner by highlighting the Abdomen part of the 3D human body in

[1] https://secure.php.net
[2] https://www.khronos.org/webgl/
[3] https://www.mysql.com
[4] http://www.adobe.com/products/premiere.html
[5] http://tomcat.apache.org

green colour. The same sequence of steps in the thorax learning process will be also applied to the Abdomen and the rest of learning topics. It is important to mention that the learner is still able to interact with the 3D human body, pause or stop video so that the learner has the control on playing, rewinding, stop, etc.

Figure 4: Provided Exam to the learner.

In the case of the learner fail to satisfy a predefined threshold of the Thorax learning topic, the adaptive engine will replay parts of the video or audio files which are related to the questions that had a low score.

Finally, the learning path is displayed in a new technique. It uses the 3D human body with textual information to show the sequence of learning topics to be covered during the course. This is done by using a specified learning path button on the screen. It is more like a navigation map but represented in the 3D model. In more details, completed part of the 3D human body are given a grey highlighted colour along with the word "completed". The parts, which are currently learned, are highlighted with green colour along with the "on progress" textual annotation. Finally, other parts, which will be learned after acquiring the required knowledge, will be highlighted with red colour along with "to be completed" text. Furthermore, the sequence of the learning path is represented by numbering the different 3D human body parts.

This porotype has a limited functionality because only a couple of adaptation techniques have been implemented. However, this prototype has provided us insight in how to integrate video and audio inside the 3D VLE, apply a limited number of adaptation techniques to video and audio, and provide us feedback on earlier design phases.

4. CONCLUSION AND FUTURE WORK

This paper describes an approach to support adaptation not only for 3D models inside the 3D VLE but also multimedia resources such as video and audio. The approach is innovative from different aspects. First, it is learner-oriented approach so that the learner will be supported to view specified part of video and audio files. Second, the learner will be able to view a corresponding 3D models visualizing the content of the running part of the video or video. Third, a number of possible adaptation techniques for multimedia resources have been explained.

A prototype has been built and an example of adaptive course has been elaborated with an example. Currently, an evaluation phase has been started to perform both qualitative and quantitative feedback about aspects such as easy to use, usefulness, leaner's attitudes, easy to learn for adaptation techniques, synchronization between 3D models adaptation and multimedia resources adaptation.

Future work for our research work will follow several directions. First, we will investigate how to map video or audio fragments to corresponding 3D models automatically using some sort of data mining [23] so that there will be no need for expert labelling. Another direction is that of usability issues related to integration between 3D models and multimedia resources. This still needs to be considered further in research. For instance, video styles such as the instructor and the board, writing pen without instructor face, and hybrid videos, need to be cooperated well with the instructional design.

Finally, the findings of this research work can be used for further research like investigate adaptation techniques in different contexts such as e-commerce and mobile applications.

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MEASURING THE NEWCOMERS' PERCEPTION OF VIRTUAL SERVICESCAPE FOR E-LEARNING SERVICE

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Abstract: *This paper presents the study of the perception of virtual servicescape in Moodle e-learning platform from the aspect of new users. The transition from physical service locations to virtual service processes has increased the research interest in virtual servicescape field, but no research so far has analysed the virtual servicescape in e-learning. This study analyses it through its perception of aesthetic appeal and layout and functionality. The research is conducted on e-learners participating for the first time in a one semester course at the university level. This paper offers an overview of the servicescape in the virtual environment and presents the factors that are important for measuring the perception of a virtual servicescape in e-learning. Using the PLS-SEM method, the research results point out that the Originality of design as a first-order indicator has no statistically significant effect and the Layout and functionality, as a third-order construct, has major influence on the perception of the virtual servicescape.*

Keywords: *E-Learning, Virtual servicescape, newcomers*

1. INTRODUCTION

Technological developments and Internet growth have provided new channels for services and products, with wide space for electronic services like electronic learning service. E-learning enriches the teaching and learning experiences because it meets the needs of a modern and freely-interactive relationship between the service provider (teacher and lecturer) and the consumer (learners) [1]. The Internet offers many advantages for organizations interested in promoting and selling their services, and in the era of e-commerce, consumers have to deal with huge amount of information. In the services marketing literature, the "servicescape" is one of the leading factors in customers' perception of value in physical settings [2], [3]. The research field of the online servicescape is designated as one of the leading emergent areas for future researches [4]. The transition of physical servicescape to virtual servicescape has been researched in the context of online shopping and e-commerce [5]–[9], but the area of learning services such as e-learning has been comparatively neglected, especially considering the growing importance of the Internet as a channel for numerous teachers in the online enhancing knowledge. This study examines the perception of the virtual servicescapes in the context of e-learning for the perspective of newcomers.

This paper is divided into five parts: after this introduction, the second part provides the literature review regarding the constructs of e-learning as a service and virtual servicescape. The methodology of the research is then explained, followed by the results. Concluding remarks make up the fifth part.

2. LITERATURE REVIEW

E-learning, defined as the use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance [10] is a tool which deliver information for higher education and businesses. According to the definition of service: application of competencies (knowledge and skills) by one entity for the benefit of another where value is created collaboratively [11], [12], e-learning is seen as a service of application of knowledge [13]. The service-oriented approach for e-learning has many advantages [14]. In this way, e-learning system needs to implement the service-dominant logic (S-D logic) which is extensively describe in the marketing service literature. The central premise of S-D logic is that marketing inherited a model of exchange from economics, which had a dominant logic based on the exchange of goods [15], [16] where knowledge and skills are key resources for competitive advantage [11].

In the context of services, the total configuration of environmental dimensions where the service is offered is defined as servicescape [17]–[19]. The servicescape in an offline setting is defined as a set of tangible, physical cues that represent an organization to its clients [20], which can affect customers impersonally [21].

The servicescape in an online environment can be referred as a "cyberscape" [22], "e-scape" [23], "online servicescape" [9], "e-servicescape" [24] and "virtual servicescape" [4], [25], [26]. The importance of the servicescape in an online environment lies in the customers' encounter which can create positive effects in users in order to increase favorable consumer responses [27]. According to the authors [28] the design of the virtual site that Internet web pages as electronic servicescape have marked their significant presence in the business world. The prediction of its growing popularity is confirmed by previous studies in the area of e-commerce where the web cues can influence the trust and relationship building [7], the trust and purchase intention [9], loyalty [18], customers' cognitive and affective responses as well as approach and avoidance outcomes [29].

Given the proven importance of the virtual servicescape for online commerce, there is a need for its further analysis in the context of e-learning systems. The perception of the

virtual servicescape is seen from the perspective of the new user, because the success of e-learning depends on its continued use or continuance after initial use [30]. In this way, the participants which have used the e-learning platform for the first time can present the best set of impressions after the first impact with the virtual servicescape of the e-learning system.

4. METHODOLOGY

The research is based on a quantitative approach, using a questionnaire-based survey as a method of data collection. The sample was made up from the population of new users of the Loomen Carnet e-learning platform introduced during the academic year 2016/2017 on the Faculty of Tourism and Hospitality Management in Opatija, University of Rijeka, Croatia. These courses were on different academic years on bachelor and master degree programs for students and one course for teaching staff that never used e-learning system in the higher education. Invitations were sent by e-mail, containing a URL leading to the web site hosting the survey. All subjects were asked to respond to the questionnaire and their responses were guaranteed confidentiality. The response rate is 29% of fully completed questionnaires collected throughout August and September 2017.

The questionnaire was designed using 6 closed questions collecting demographic data and 42 items on a 7-point Likert scale from 1- "strongly disagree" to 7- "strongly agree". The scale for the e-learning attitude are adapted from authors [31], while the conceptualization of virtual servicescape for online shopping is presented by the authors [9] as comprising three dimensions: aesthetic appeal, online layout and functionality, and financial security. It is tested and adapted to measure the perceived value for the virtual servicescape for online purchase, but no research yet applied the multidimensional scale of virtual servicescape for investigating its perception in online service domain and specifically the e-learning context. Comparing these measures to the specific system of e-learning, the dimension of financial security cannot be taken into exam. Therefore, these two measures have 7 scales: "aesthetic appeal" is formed by visual appeal, originality of design, and entertainment value; where "layout and functionality" include usability, and the relevance of information, customization/personalization, and interactivity.

Descriptive statistics were computed using IBM SPSS Statistics 22, while the PLS-SEM analysis was conducted using Smart PLS 3.0.

4. RESULTS

The characteristics of the sample are presented in Table 1. The newcomers are predominantly participants/learners (85%) in the course with the e-learning system implemented in the teaching process. Of the total number of respondents, the majority, 72,5% are between 21 and 30 with higher education qualifications/ master's qualifications (42,5%), while 22,5% of respondents hold MBAs, MScs, and PhDs. Concerning total weekly spending time for the course on the e-learning platform, 80% of respondents have spent from 1-4 hours. These results are accordant with the system of blended course because the majority of the courses take into exam had more physical experience than virtual one (70%).

Table 1: Sample characteristics

Measure and item		Percent
Age	18-21	10
	21-30	72,5
	31-40	10
	41-50	7.5
Educational level	Secondary qualifications	22,5
	Two-year post-secondary/bachelor's qualifications	12,5
	Higher education /master's qualifications	42,5
	MBAs, MScs, PhDs	22,5
Role during the course	Participant/Learner	85
	Assistant	10
	Instructor	5
System of blended course	Pure virtual classroom experience	17,5
	Virtual experience more than physical experience	12,5
	Physical experience more than virtual experience	70
Spending time for the course on weekly basis	< 1 h	7,5
	1-2 h	55
	3-4 h	25
	> 4 h	2,5

Table 2 presents the descriptive analysis results of the perception of the virtual servicescape items, as well as the outer loadings of items after the recoding for negative items.

The formative model is used because the indicators cause the construct. The latent construct is "Perception of virtual servicescape", which is conceptualized as a third-order factor. It has two second-order formative dimensions: "Aesthetic appeal" and "Layout and functionality". The second-order dimension "Aesthetic appeal" has three first-order dimensions: "Visual appeal" (VSA), "Originality of design" (ORD), and "Entertainment value" (ENV). The second-order dimension "Layout and functionality" has four first-order dimensions: "Usability" (US), "Relevance of information" (ROF), "Customization/personalization" (CSP), and "Interactivity" (INT).

Ten indicator variables, with outer loadings smaller than 0.4, were eliminated from further analysis. Two of the rejected indicators referred to the dimension of Originality, three of Usability, one of Relevance of information, two of Customisation/Personalization, and two of Interactivity.

Table 2: Results of descriptive statistics and outer loading of first-order indicators

2nd order	1st order	Item's code	Mean	SD	Outer loadings
Aesthetic appeal	Visual appeal	VSA1	4,59	1,29	0,916
		VSA2	4,71	1,63	0,786
		VSA3	4,28	1,16	0,916
		VSA4	4,48	1,21	0,887
		VSA5	4,30	1,45	0,935
	Originality of design	ORD1	4,30	1,43	0,829
		ORD4	4,20	1,54	0,922
	Entertainment value	ENV1	3,94	1,45	0,889
		ENV2	3,20	1,52	0,900
		ENV3	3,23	1,51	0937
		ENV4	3,38	1,35	0,926
		ENV5	2,61	1,38	0,616
Layout and functionality	Usability	US1	4,71	1,27	0,718
		US2	4,69	1,34	0,854
		US4	4,30	1,41	0,863
		US5	4,33	1,23	0,862
		US6	4,89	1,57	0,909
		US7	3,82	1,80	0,766
		US8	4,82	1,80	0,936
		US9	4,84	1,49	0,887
		US11	4,82	1,73	0,955
	Relevance of information	ROF1	4,79	1,30	0,895
		ROF2	4,84	1,47	0,959
		ROF3	4,94	1,45	0,948
		ROF5	4,74	1,35	0,777
	Customization/ Personalization	CSP1	4,30	1,74	0,874
		CSP3	3,43	1,77	0,857
		CSP4	3,48	1,50	0,894
		CSP7	3,94	1,35	0,800
	Interactivit	INT1	5,02	1,51	0,822
		INT2	4,38	1,42	0,929
		INT3	4,17	1,41	0,916

The results of measurement model analysis suggest that all formative measurement constructs possess a satisfactory level of internal consistency reliability and convergent validity. All manifest variables were checked for outliers, but no item has values greater than +/-3 of the standard deviation from the arithmetic mean of a variable. The outer loadings of most of the variables exceed the recommended level of 0.7, and the indicator variables with outer loadings ranging from 0.4 to 0.6 were retained because C.R. values and Cronbach's alpha coefficient were above the recommended level of 0.7. A bootstrap analysis was performed with 500 subsamples and all the t-values are considered adequate.

In order to evaluate internal consistency of reliability and convergent validity, outer loadings, composite reliability indicator (C.R.), Cronbach's alpha coefficient and average variance extracted indicator (AVE) were calculated. These results are presented in Table 3.

Table 3: Model evaluation of second- and third-order formative indicators

	Cronbach's alpha	C.R.	AVE
Visual appeal	0,933	0,935	0,744
Originality of design	0,707	0,730	0,583
Entertainment value	0,909	0,915	0,692
Usability	0,957	0,958	0,717
Relevance of information	0,918	0,924	0,757
Customization/ Personalization	0,936	0,939	0,569
Interactivity	0,869	0,875	0,704
Aesthetic value	0,879	0,939	0,569
Layout and functionality	0,970	0,971	0,633

The Cronbach alpha coefficients of all constructs are higher that the acceptance level of 0,7, with very high scores, except for the "Originality of design" indicator which has the lowers level (0,707). The composite reliability (C.R.) indicators are higher than 0,7, while the average variance extracted (AVE) are above the 0,5 recommended value.

Using to the repeated indicator approach [32], the third-order construct was formulated. Paths to the second-order constructs represent the contributions of the first-order constructs, while the second-order constructs represent the contribution for the third-order construct.

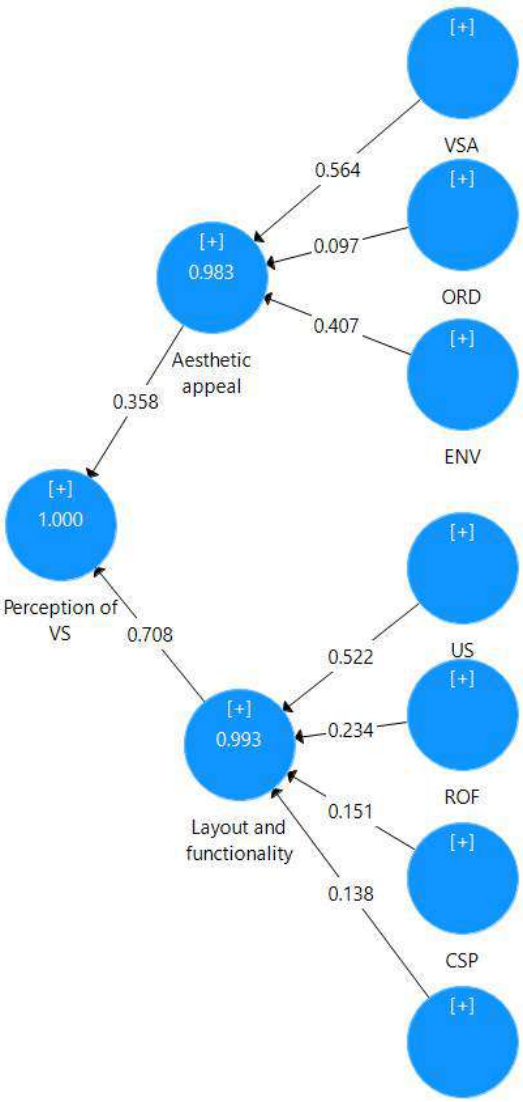

Image 1: PLS-SEM model with structural coefficients

According to the results, the first-order constructs that have a statistically significant effect on the second-order construct of Aesthetic appeal are: Visual appeal (β=0.564; t-value= 9,943), ($p<0.01$) and Entertainment value (β=0.407; t-value= 7,512), ($p<0.01$). Originality of design (β=0.097; t-value=1,367), $p<0.05$) is not statistically significant at the level of 0,1%. Usability (β=0.522; t-value= 7,940), Relevance of information (β=0.234; t-value= 3,576), Customization/Personalization (β=0.151; t-value= 4,635), and Interactivity (β=0.138; t-value= 3,808), have all a statistically significant effect on Layout and functionality (R square= 0,993).

The construct of Layout and functionality (β=0.708; t-value= 17,924), ($p<0.01$) has a greater effect on the construct of Perception of virtual servicescape than the construct of Aesthetic appeal (β=0.358; t-value= 11,018).

5. CONCLUSION

This study investigated the perception of virtual servicescape for new users of the Loomen Carnet e-learning platform. The usage of e-learning systems yields many advantages: independence of time and location as well as availability of content in remote areas [14]. In service marketing literature, the importance of virtual servicescape can be the factor which influences the consumer satisfaction and loyalty [9], [33].

The results of the empirical research support that the e-learning platform has a satisfactory level of layout and functionality, but from the perspective of Aesthetic appeal, the Originality of design is uncreative and has no statistically significance.

The Visual appeal and the Entertainment value have been evaluated by the respondents as important in building the Aesthetic appeal, with positive impact of likeability of the site and enthusiasm and entertainments of offered services.

The main influence on the perception of virtual servicescape as a second-order indicator has the Layout and functionality. Users consider that e-learning offers high Usability functions which they supported with high ratings on the aspects of navigational aids, links, intuitiveness and easiness.

This study has found that the design, innovativeness and creativity of e-learning is needed, in order to maintain the interest and return intention of consumers.

The limitation of study can be seen in the fact that it was conducted only on newcomers in the field of e-learning service, as well as on a non-representative sample. Therefore, the results cannot be generalized on repetitive and loyal users. More thorough researches about learners' behaviour and perception of e-learning virtual presentation and service processes should be conducted, since the topic represents the future of knowledge transmission and key competitive advantages on the education market.

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PROVIDING HINTS BASED ON DISCOVERED FREQUENT HIGH-UTILITY PATTERNS IN A WEB-BASED ITS

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Abstract: *This paper presents an exploratory data mining methodology for discovering frequent high-utility learning patterns and using them to provide hints in a web-based intelligent tutoring system (ITS). This is achieved through several phases, namely: obtaining and evaluating learning traces of each student; transforming and encoding these traces in order to create a set of paths that led to a learning unit ("prefix" paths) and a set of paths a student took after learning a unit ("suffix" paths); combining the paths of all students for each learning unit into a final dataset, performing high-utility sequential pattern mining and finally storing the discovered frequent patterns in the systems database. This enables the final goal of the system – offering hints to students using our ITS. We present and discuss the results obtained by applying this methodology on interaction data from two different knowledge domains.*

Keywords: *Sequence mining, providing hints, high-utility paths, student guidance*

1. INTRODUCTION

Intelligent Tutoring Systems (ITSs) are usually created for teaching well-defined domains (e.g., mathematics). Their objective is to guide the student towards a predefined goal such as completing a lesson, task, or mastering a skill. Guiding students is more complex in ill-defined domains [1] where the expert defines the model of the knowledge domain and the students have freedom to follow their own path through it. One such web-based ITS has been developed at our institution to serve as an additional learning platform in a blended learning approach applied in a number of courses. The process presented in this paper focuses on the sequential pattern discovery module of the new infrastructure of our ITS developed with the goal of improving the adaptivity of our system [2]. This architecture also consists of a communication module that enables the system to invoke DM tools (SPMF and Weka), and a clustering module [3] that groups students by their learning activities. This architecture is our attempt towards achieving the objectives put forth in [4].

While attempting to master a knowledge domain presented in our system, the student performs a large number of actions which are saved by our logging system as learning traces. These can be presented as a single (very long) sequence from the moment the student starts using the system until he/she completes the domain but it is usually more useful to analyze them on a smaller timeframe e.g. student's sessions, or even by each learning "run" (which may consist of learning multiple connected units). Most of the students will need multiple interactions with a unit until it is mastered/completed, e.g., after a failed attempt they realize they need to learn some other (lower-level) units and then they come back to complete the first unit.

Our goal is to offer hints on which unit to select ("I think you should learn X before this) or which unit to learn next ("I think it would be best to learn Y next"). To offer those hints we devised a process (and implemented it as a module of our web-based ITS) to discover productive frequent patterns leading to, and following after, each unit. By "productive" we mean paths that resulted in highest rate of learning i.e. covering the unit(s). Sequential pattern mining (SPM) algorithms [5] discover frequent patterns from a sequences database. The problem is that they do not discriminate between patterns or reasons why a pattern is frequent. We are interested in providing hints based on frequent patterns that were productive. A frequent pattern may originate from a number of sequences; those created by students struggling to complete a unit (or a group of units) or those created by students making fast progress on a number of units. To discriminate between productive and unproductive frequent patterns we decided to use a high-utility SPM algorithm called USPAN [6]. High-utility SPM algorithms require that each item set in each sequence in the dataset contains their "profit". For this purpose we developed an expression that calculates each path's learning "productivity". Finally, we can run the algorithm on each of the created datasets and store them in the database where they can be used by the tutoring model to offer hints.

We tested this exploratory data mining methodology in our system in two different knowledge domains, with 31 and 69 learning units, used by 30 and 20 students, respectively.

The rest of this paper is organized as follows. Section 2 presents a brief review of sequence mining methods that have been employed to derive and analyze students learning behaviors in various learning environments. Section 3 describes the algorithms developed for frequent

productive paths discovery as well as the hint selection algorithm. In Section 4 we present and discuss the results. Finally, Section 5 offers conclusions and outlines directions for further research.

2. RELATED WORK

In order to better understand learning, researchers have applied clustering and SPM, to a variety of computer-based learning systems. In [7] authors propose SPM of students' paths in a web-based environment followed by a clustering step, to build better student models. In [8] authors proposed a method for creating personalized activity trees to be used in a Sharable Content Object Reference Model (SCORM) e-learning system. They used SPM to extract frequent learning patterns as part of a larger process that creates a decision tree to predict the group/category for a new student. In [9] authors investigated trace data from mirroring and feedback tools that support effective teamwork among students collaborating on software development using an open source professional development environment (TRAC). In their approach, they help all groups improve their work by observing and emulating the behaviors of the strong groups. Similarly, in [10] authors discovered which frequent sequences of actions characterize high-achieving and low-achieving learners. They collect electronic traces from groups of students collaborating around a shared tabletop to answer an open question posed as a mystery problem. They then apply a clustering algorithm to group similar patterns to aid in analyzing the pattern distribution across the groups. Employing SPM allows them to identify differences between the higher- and lower-achieving groups in their manner of information gathering to solve the problem. Examples of more recent approaches that employ SPM algorithms to improve the results of desktop ITSs can be found in [11] where authors developed new algorithm to discover effective patterns in learning to use the international space station's robotic arm. In [12] authors compare patterns derived from groups of student activity sequences. They developed a differential sequence mining algorithm that directly incorporates comparisons between groups in identifying interesting patterns, rather than manually performing researcher-directed comparisons after data mining. In our system, the results are automatically evaluated and used by the tutoring module to offer hints adapted to the current students' overlay model status (number of units completed) as well as the number of hints previously presented. Our system also prepares features and performs clustering analysis before performing SPM similar to [13] in order to improve the student model. Performing cluster analysis before SPM analysis enables us to discover high-utility patterns per cluster which both lowers the chances of highly productive paths "drowning" in a larger number of unproductive paths, and provides finer adaptation of hints.

3. CALCULATING PATH PRODUCTIVITY

To prepare the datasets for high-utility SPM raw time-ordered learning traces must first be preprocessed, raising the level of abstraction. The first step is calculating the "profit/productivity" of each learning interaction. This is done before transforming the "vertical" list of learning traces (as written to relational database) into two "horizontal" datasets containing "prefix" and "suffix" sequences surrounding each unit the student has learned, because the same traces will appear in multiple paths. Our ITS offers two main functionalities (learning activities): a) LEARN (TUTORING) - presenting learning materials followed by one specific question about some fact presented in the learning unit, followed by an "initial" (a broader type question aimed at testing the students understanding of a unit) question about each of the connected underlying units (units below the selected one in the domain hierarchy – see Figure 1 below). If the student answers all the questions correctly the path is considered optimal (highly productive) and the change in the students overlay model is calculated. If the student offers an incorrect answer to some of the initial questions, the system will transfer the student to learn the underlying unit, and the whole process is repeated recursively, but on a longer path (less productive, or unproductive). Therefore, one learning "run" can consist of a number of learning units and a number of questions answered, b) REPETITION - answering a series of questions about one selected unit without presenting any learning materials. A visualization of different path lengths/profits is presented in Figure 1.

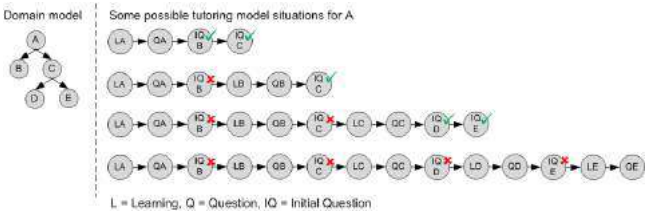

Figure 1: Possible variations in learning path lengths

It is important to note that students complete a unit by gaining points (cq) from answering question correctly (they lose points when answering incorrectly). Also, "initial" questions gains (ciq) are much smaller as their main function is to guide the tutoring process.

The basic components for productivity calculation are presented in Table 1. The profit is calculated for both types of activities. Each knowledge unit (KU) has a set threshold value (hKU). When reached, the student has completed/mastered this unit. Each question has a gain value (cq) which brings the students score closer or further from the threshold value. We calculate each paths productivity by considering the points gained, path length (PL = number of units/actions in path) which consists of learning actions (Ls), questions presented (Qs) and initial questions presented (IQs).
The following expression is used to calculate the productivity of a path x from a learn/tutoring activity:

$$PP_x = \left(\frac{\sum_{i=1}^{|KUi|} cq_i / h_{ku_i}}{|Q_s|} + \frac{\sum_{i=1}^{|KUi|} ciq_i / h_{ku_i}}{|IQ_s|} \right) * \frac{\min|PL|}{|PL|}$$

The expression used to calculate profits of the REPETITION activity is simpler as it contains questions for only one unit. Minimum path length (PLmin) is calculated based on the number of units added to the

Table 1: Path productivity calculation

ku	*A*	*B*	*C*	*D*	*E*	∑	*|ku|*	*PL*	*min PL*	*Qs*	*IQs*
h_{ku}	10	10	6	8	10						
ciq cq	+2	+0.2	+0.2			2.4	1	3	3	1	2
	+3	-0.1 +2	+0.2			5.1	2	4	3	2	2
	+2	-0.1 +2	-0.1 +2	+0.2	+0.2	6.2	3	7	3	3	4
	+1	-0.1 +1	-0.1 +1	-0.1 +2	-0.1 +2	6.6	5	9	3	5	4

learning structure at the time the learning activity took place. The tutoring model determines the number of items in the learning structure based on the students overlay model state, e.g. according to Figure 1, if the student starts the LEARN activity with unit A, having previously completed units B and C, the tutoring module will not add any units to the learning structure (except for A, making the minimum path length = 1)

4. PREPARING THE SEQUENCE DATABASE

After the learning traces have been evaluated, they can be transformed. The transformation algorithm traverses the list of learning traces looking for each units applying a FIFO principle to add a set of "prefix" units until the first interaction trace of the current units is found. After that, the following units are added to the "suffix" set. Both sets can have a maximum count of 6 (units). This arbitrary limit was set based on the assumption that longer paths become less likely to have a significant impact on learning the current unit. If the next occurrence of the current unit appears before the suffix set count reaches 6, the set is regarded as a "prefix" path as we are more interested in productive paths leading up to the current unit. This process is repeated for each unit, for each student in the cluster, for each students' session.

One step of this process is visualized by Figure 2 for a unit with ID=189.

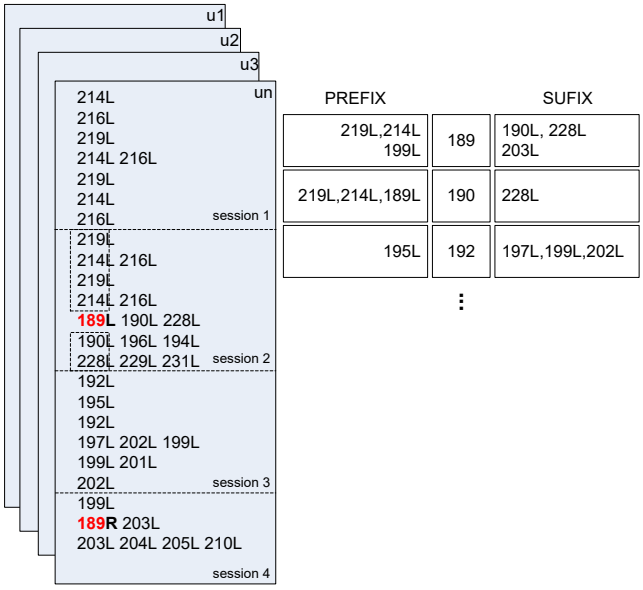

Figure 2: Paths to sequences transformation

Finally both datasets for each unit are converted to the correct format of the USPAN algorithm implementation in SPMF [14]. The next phase performs the HUSPM on each dataset under the condition that a unit has been learned by at least 5 students, i.e. we must have a minimum of 5 paths in the dataset, although there can be much more if the students have been struggling with the unit. Our system relies on a communication layer that is responsible for writing datasets to disk, generating API calls towards SPMF and parsing the output (either from stdout or text file). This decouples the system from specific algorithm implementation, and simplifies the application of other algorithms in the future. This process takes around 15-20 seconds and is run automatically (from crontab, after a set number of new learning traces have been created by students). The USPAN algorithm is run with the minimum profit of 5 and maximum frequent pattern length of 6 (same as the maximum length of our paths).

When the process is completed all the discovered high-utility frequent paths (HUFPs) are added to the database.

5. PROVIDING HINTS

Once the system has updated the database, the ITSs tutoring module can display hints to students. As mentioned in the Introduction, the process presented in this paper is coupled with the clustering process which discovers groups of students that use the system in a similar way and also grades/orders the clusters based on the activity and efficiency levels of each cluster members. This enables the tutoring module to offer hints from two sources – the HUFPs of the cluster the current student belongs to, and the cluster graded on level above. In this way the tutoring module can have a more pedagogical function, and guide the students towards most profitable paths created by members of the current students cluster, or by even more profitable paths created by the members of cluster that is graded on level above (populated by more active/efficient students).

The hint selection algorithm considers: a) the current state of the student's overlay models (list of completed, partially completed and uncompleted units), b) has the current unit been already suggested and/or followed by this student, c) which suggested unit was most followed by other students. Finally if the system couldn't find a hint, it will analyze the ratio of LEARN and REPETITION functionalities usage by this student for the selected unit. Students use the LEARN functionality much more than the REPETITION although this functionality enables them to advance

through the domain much faster (provided they analyzed from the learning materials). If that is the case, the hint selection algorithm will suggest to try the REPETITION functionality for the selected unit.

6. RESULTS

This methodology was implemented in our web-based intelligent tutoring system and was tested on two different knowledge domains – Web technologies (D1) and Operating systems (D2). Some basic usage statistics are presented in Table 2.

Table 2: Domain usage statistic

Domains	Units	Students	Active	Avg. complete	Duration
D1	31	30	28	76%	4 days
D2	69	21	13	35%	7 days

Students in D1 had to complete the domain to get course points, while students in D2 used the domain voluntarily, hence the lower numbers in "Students", "Active" and "Average complete" columns. The "Students" column presents the number of students initially assigned to the domain group. The "Active" column presents the number of students that had any activities after the study was completed. The "Average complete" column presents the percentage of the domain the students completed (on average) at the moment the study was completed. Both domains were used by undergraduate students (3rd and 2nd year, respectively).

The results from D1, presented in Table 3, show the number of times the clustering and HUSPM processes have been executed while the students were using the system. The "TRACES" column contains the number of learning traces in the system at the time the process was executed (as mentioned earlier, the process is started automatically when the limit of 400 new interactions is reached, the system checks the limit every 30 minutes so the number of interactions is not exactly 400). The "HOURS" column contains the total number of hours of the time allowed to students to complete the domain. The "CLUSTERS" column contains the number of clusters the students were grouped into at the time of execution. This can have a significant impact on the number of discovered HUFPs. If the clustering process selects a model with a high number

Table 3: Results for D1

No	TRACES	HOURS	CLUSTERS	HUFPs	PREFIX	SUFIX	UNITS	HINTS PRES.	UWHP	FOLLOWED
0	800	0								
1	1206	12	2	21	5	16	7	12	5	5
2	1616	28	4	35	20	15	15	83	24	39
3	2068	35	2	115	65	50	22	204	15	36
4	2504	46	4	121	79	42	18	225	15	12
5	2912	62	4	89	52	37	21	47	12	13
6	3314	71	2	418	227	191	31	417	23	35
7	3604	84	2	538	289	249	31	332	24	22
	3894	96								

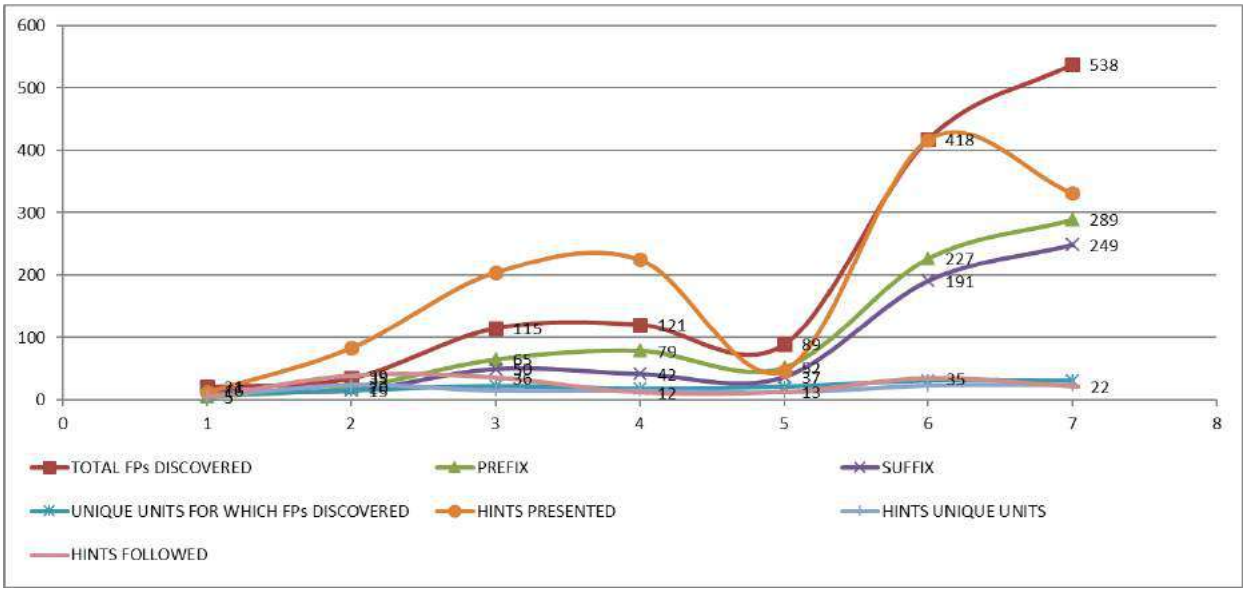

Figure 3: Visualization of results per iteration

of clusters, the number of students in each cluster will probably be lower which reduces the interactions dataset from which we discover HUFPs. In this case, this was not an issue because our clustering evaluation algorithm "leans" towards a smaller number of clusters. The total number of HUFPs discovered at each execution (divided in "PREFIX" and "SUFFIX" types) is presented in the next three columns. The number of "prefix" and "suffix" path is balanced, although the "prefix" paths are, on average, shorter than "suffix" paths which almost always contain 6 units per path.

We don't expect to discover frequent paths for each unit in the knowledge domain, as some units are well known to students and are completed quickly. Also, some units have a lower threshold value, so the students can complete them by answering a smaller number of questions. Thus, we discover HUFPs for all units in the domain later on in the experiment (UNITS column, 6th and 7th iteration). We are most interested in discovering HUFPs for the units many students are struggling with so the system can offer hints and help streamline the learning process. This is the reason we are performing HUSPM per each cluster.

The number of HINTS PRESENTED to students and the number of UNITS for which the hints were presented (UWHP) are displayed in the next two columns. Finally, the last column presents the number of hints FOLLOWED (clicked) by students.

The percentage of followed versus total number of hints presented varied from 5 to 47 percent. The number of followed hints was decreasing towards the last day as the majority of the students have completed the domain. It rose during the last day (last two iterations) when a number of students rushed to complete the domain in the allotted time. The large "dip" in the fifth iteration of this process visible in Figure 3 happened because most of the new traces were created by a very small number of struggling students using the system at this time, so our process did not discover many new patterns. Also, it was not able to display many hints to such a small number of students.

Unfortunately, D2 had a much lower number of active users and a much lower average completion rate. This domain also has a much larger number of units which helped dissipate the learning traces. This made it impossible for the system to perform SPM as the condition for 5 or more students learning each unit was not satisfied.

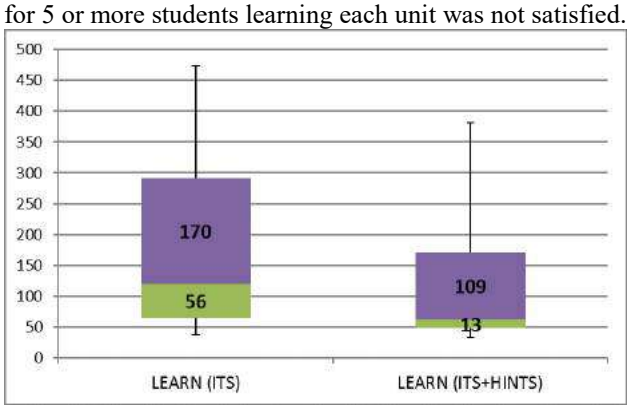

Figure 4: Difference in avg. number of LEARN actions

To test our new ITS architecture we performed an experiment. A total of 61 students enrolled in the course where divided into a control and a test group based on points collected in the course up to this point (most of the points in the course). A t-test showed that the groups weren't not statistically different. The control group used the ITS without the new DM architecture for providing hints, while the test group use the same system with hints provided.

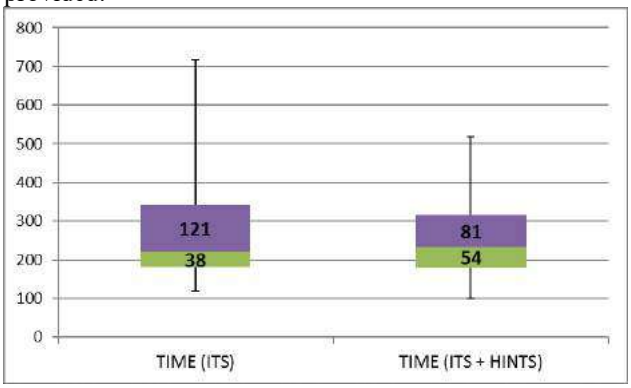

Figure 5: Difference in total time required to complete (minutes)

As previously stated, the main goal of hint generation is to streamline the learning process. After the experiment ended, the obtained results proved that this goal was reached. The test group completed the domain with less LEARN actions (Figure 4) and in less time (Figure 5).

To analyze the progress of each student of both groups we created the following charts that visualize the path of each student from 0% to 100% domain completion (blue horizontal line in Figures 6 and 7 below).

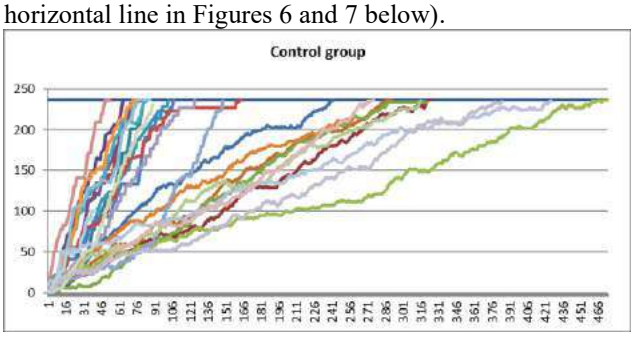

Figure 6: Control group learning rates

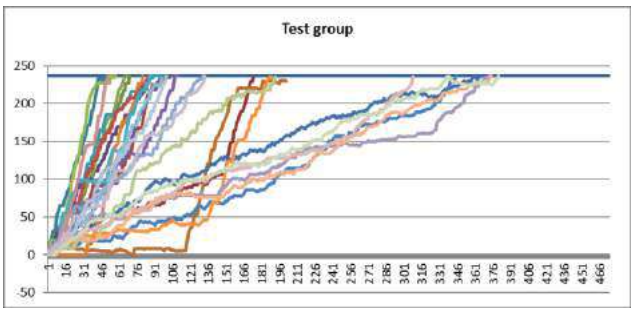

Figure 7: Test group learning rates

It is visible that the test group had less learning interactions overall, and that there are more students in the group with a steep learning rate (on the left). Some students in the test group ignored all the hints producing a slower learning rate.

In the last iterations the students were grouped in two clusters. Cluster A consisted of 22 students out of which 13 were presented with hints. Students in this cluster had an average of 51 learning interactions and a 16%

presented/followed ratio. Cluster B consisted of 6 students, out of which 4 were presented with hints. Students in this cluster had an average of 339 learning interactions, and a 9% presented/followed ratio. A Pearson correlation coefficient was calculated and it showed 0.39 for cluster A and -0.17 for cluster B. The test group also performed 10% better in post-test.

Questionnaire results showed that students welcomed a new functionality of the system aimed at helping them learn more efficiently, although the percentage of hint usage remained rather low.

6. CONCLUSION

In this paper, we presented an exploratory data mining methodology for identifying productive frequent paths and using those paths to offer hints to students in order to facilitate their learning process. The methodology was implemented in our web-based ITS and tested on two different domains. This module is autonomous and runs repeatedly in frequency related to the level of activity of the students (e.g. every 400 interactions traces) from the moment the students start using the system until they complete the knowledge domain or the allotted time expires. As expected, the performance of this system suffers in few users/large domain scenario (D2) because of the spread of learning interactions. However, the system will be used as an additional learning platform in a blended learning environment, where we expect the majority of students to start using the system on the same day and complete (most of) the domain which will reduce this problem. In such environment (D1) the system was able to start producing hints relatively early (20 out of 28 active students received hints, others completed the domain before the system had enough learning traces to identify high-utility frequent patterns. We believe that the main improvements to the system can be made in: a) the interaction-to-path transformation algorithm – by implementing additional logic to recognize branch/level changes in the domain hierarchy which can reflect student's strategy (need to learn another unit before current one), and b) the hint selection algorithm – by implementing additional logic to minimize repetition and optimize the unit selection process.

ACKNOWLEDGMENTS

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DESIRABLE CHARACTERISTICS FOR EMPLOYMENT OF PERSONS WITH DISABILITIES IN PRIVATE AND PUBLIC SECTOR

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Abstract: *Employers often have prejudices and negative stereotypical attitudes regarding the employment of persons with disabilities (PwD). This is a part of the conclusion of D1.1 Report - Identify and analyse the needs of Employers from School-to-Work Transition for Higher education students with disabilities in Serbia, Bosnia & Herzegovina and Montenegro (Trans2Work project). We wanted to know if there was a difference in attitude between employers in the public and employers in the private sector in separating the desirable characteristics of persons with disabilities in employment. In this piece of paper we were specially interested in characteristics that employers consider desirable in hiring persons with disabilities. This was the main aim of this research. We started from the hypothesis that there are differences between employers from the private and employers from the public sectors in separating the desirable characteristics of students with disabilities in employment. The data show that there are differences between employers in the selection of desirable characteristics in hiring persons with disabilities. As desirable characteristics employers from the public sector extracted: communication skills (23.3%), the accuracy and responsibility (21.7), team orientation and motivation (21.7%). As the most desirable characteristics employers in the private sector allocated: accuracy and responsibility (26.7), the effort (25%) and expert knowledge and skill to correspond to a position (16.7). Our hopes are that the results will contribute to the existing literature related to the employment of persons with disabilities and project Trans2Work at all.*

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Keywords: *Desirable characteristics for employment, private and public sector, persons with disabilities, Trans2Work.*

1. INTRODUCTION

Persons with disabilities in the labor market are faced with numerous obstacles and barriers in the both private and professional life. The lack of the opportunities for gaining work experience after completing education or training for a specific job represents a significant obstacle in the employment of persons with disabilities. Among the main reasons that affect (non)employment of the persons with disabilities are the opinions and the prejudices of the employers themselves and their stereotypes towards that group of people. Prejudice towards the people with disabilities have the roots in the lack of knowledge and the maintenance of negative stereotypes [1, 2]. Many employers share the opinion that persons with disabilities are not reliable in performing their duties and responsibilities, that they are unreliable, conflicting, that they are more often out of work than those who do not have disabilities, etc. An important component of the successful functioning of each person's life are beautiful and desirable characteristics that characterize the particular behavior of each individual. Suitable behavioral characteristics are a necessary factor for any successful and reticent work. Researches done in the world show that many people with disabilities can carry out their work assignments at about the same level as people without disabilities. Many of them also lose their job because they cannot integrate into the workplace [3]. Many people with disabilities have left the job because they cannot integrate into a particular social group. Especially in this paper we are particularly interested in the characteristics that private and public sector employers find desirable in the employment of the persons with disabilities, since it is known from the past time that the number of unemployed grows steadily. Finding ways how to help the unemployed persons with disabilities to get work becomes also political and public theme. Our goal is to examine what are the desirable qualities that employers consider most desirable, and whether there is a certain difference in opinion between private sector employers and public sector employers in that.

2. METHODOLOGY

There is a small number of surveys in our country dealing with the employment of people with disabilities. In this piece of paper we were specially interested in characteristics that employers consider desirable in hiring persons with disabilities. This was the main aim of this research. We started from the hypothesis that there are differences between employers from the private and the employers from the public sectors in separating the desirable characteristics of the persons with disabilities in employment.

During the research we used two scientific - research methods:

-Theoretical analysis method and
-Descriptive method

The method of theoretical analysis was used for theoretical processing of the research problem, where different sources were analyzed, as well as the researches that were done in this field. The descriptive method is suitable for examining differences among employers in selecting desirable behavioral traits and collecting empirical facts, as well as for analyzing, comparing, interpreting and performing certain conclusions.
A survey research technique was used to collect the necessary material**.**
In this research, we used a questionnaire about the employment of the persons with disabilities, which examines the attitude of employers towards the employment of the persons with disabilities. The questionnaire consists of 19 questions. The reliability of the instrument was checked using by Kronbach alpha coefficient and amounted the 0.89. We used the quantitative processing of the collected data in the study. The hi - square test was applied.. The study sample consisted of companies from the private and public sectors in one of two entities in Bosnia and Herzegovina – Republic of Srpska (60 companies in the private sector and 60 companies in the public sector). The selection of companies was not accidental, but was adapted to the possibilities, and therefore the sample had characteristics of convenience sample.

3. RESULTS OF RESEARCH WITH DISCUSSION

The main task of our research was to determine whether there are differences between the employers in the private and in the public sector in allocating desirable qualities in the employment of the persons with disabilities. Table 1.shows the differences between private sector employers and public sector employers in allocating preferences for employment the persons with disabilities.

Table 1. Differences between the private and the public sector in the allocation of desirable qualities in the employment of the persons with disabilities

What qualities do you consider the most important for people with disabilities to recruit?							Total
Employer	AAR	WD	CP	TPCP	TOMW	AKSP	
Private Sector	16 26.7 %	15 25.0 %	9 15.0 %	6 10.0 %	4 6.7%	10 16.7 %	60 100 %
Public Sector	13 21.7 %	4 6.7%	14 23.3 %	9 15.0 %	13 21.7 %	7 11.7 %	60 100 %
Total	29 24.2 %	19 15.8 %	23 19.2 %	15 12.5 %	17 14.2 %	17 14.2 %	120 100 %

Legend – aar Accuracy and responsibility, wd - Work diligence, cp - Communicative personality, tpcp - That person is not a conflicting person, tomw - Team orientation and motivation for work, aksp - Acquired knowledge and skills that match the position.

The obtained hi – square ($\times^2 = 13.660$), and its significance level ($p = 0.018$), tell us that there is a certain statistically significant difference between employers from the private and from the public sector in allocating desirable qualities in the employment of the persons with disabilities. Private sector employers highlighted accuracy and responsibility (26.7%), followed by work diligence (25.0%), third place were acquired knowledge and skills that correspond to employment positions (16, 7%), the communicative personality was selected as the fourth preferred feature (15%), then the person is not conflicting (10%), and ultimately team orientation and motivation for work (6.7%). Public sector employers highlighted communication as the most desirable feature in the employment of the persons with disabilities (23.3%), followed by accuracy and responsibility (21.7%), followed by team orientation and motivation for work (21.7%), after that the person is not conflicting (15.0%), and than they have allocated the acquired knowledge and skills that match the position (11.7%), and work diligence (6.7%).
Private sector employers primarily decide for the persons who are accurace and responsible in their work, who are diligent, have a certain level of knowledge in the area they are being elected, they have communicative personality and they are not conflicting and who are team-oriented for work and professional development. On the other hand, public sector employers distinguish communication as one of the most desirable qualities of the PwD in employment, then accuracy and responsibility in carrying out work as well as motivation for work, that a person is not conflicting and has knowledge in the given field. In the last place, they identify the diligence as a feature that on their opinion is the least desirable for employment.
According to the modern perspective, public sector employers are not only interested in whether a person with disabilities will be communicative, accurate, motivated to work, and so on, but also will integrate into the entire organization and the existing climate, the culture that operates in the company, while the private sector employers do not emphasize these qualities so much. Private sector employers will decide for a person who is ready to perform tasks on time, accurately and precisely, to be diligent in fulfilling their obligations, and then only in the last place are they involved in the team and organization of the work.

We can say that sometimes the emphasis was on the person being admitted to be able to perform work tasks, while today the emphasis is on the person being able to work in cooperation with the others. Many persons with disabilities can perform different tasks at approximately the same level as people without disabilities. It is known in the literature that most persons with disabilities lose their jobs because they are difficult or poorly integrated into a particular social environment. Also, the most common reason for the unemployment of this group of people is the misconception of employers that people with disabilities are not able to work and therefore they reluctant to provide employment opportunities [4].

The first known research about that what employers are looking for with employees, was carried out in the US in 1991. by the Department of Labor [5]. At that time, the desirable competences were grouped into the five categories:

1.Resources - the ability to use time, money,

2.Interpersonal skills - skills of cooperation with other people, such as team work, training others, etc.,

,

3.Information - the ability to adopt and use information,

4.Systems - the ability to understand social, organizational and technological systems,

5.Technology - ability to work with various technologies [5].

When making a decision as to which qualities employers prefer when employing the persons, they mostly rely on three desirable characteristics: good interpersonal skills, learning and work skills, as well as high motivation and desire to work. We can conclude that interpersonal relations are one of the important features for the employment of persons with disabilities and in general. The question is why special attention is paid to interpersonal relations in the public sector. One of the answers to the given question could also be that jobs today become less formal, structured, routine, and require the mutual cooperation of all employees with different educational, cultural, technical and other experiences.

4.CONCLUSION

The role of employers in the employment of persons with disabilities is important and of great importance. The greatest obstacle in the employment of persons with disabilities is reduced ability to work, which is conditioned by the kind of damage that an individual encounters.
In relate with the many social changes in recent years in our country, employers are not enough informed about the needs of persons with disabilities. Thus would be desirable to develop programs to help employers integrate into the process of hiring this group of people. Employability depends not only on employment policy, but also a range of other factors such as the relations between employers and persons with disabilities, changes in the labor market, measures to encourage employment, demographic characteristics, and the similar (Uršić, Vidmar, Bilić, 2002). In this paper, we tried to answer the question about the characteristics that employers consider desirable in hiring persons with disabilities in the private and public sector.

The results of this research have shown that there are certain differences, and that private sector employers are most likely to evaluate as desirable qualities - accuracy and responsibility to work, work diligence, possession of certain level of knowledge from the area for which an employee is being sought, communicative and non-conflicting skills, as well as readiness for teamwork and professional development. Public sector employers believe that persons should be preferably communicative, accurate and responsible in carrying out their tasks, to be motivated to work in teams, not conflicting and ready for professional training and acquiring new knowledge. On the basis of the obtained results we can conclude that the obtained results can serve to improve the strategy for employment of persons with disabilities. The conclusion of this paper is that persons with disabilities should be notified that the possession of additional skills, traits and abilities is an important factor in finding a job and it is necessary to motivate them to work on their activation on. Our hopes are that the results will contribute to the existing literature related to the employment of persons with disabilities and project Trans2Work at all.

ACKNOWLEDGMENTS

One of the objectives of Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina project (project no. 561847-2015) is to identify and to analyse the needs of employers and of the students with disabilities. The goal of this paper– Desirable characteristics for employment of persons with disabilities in private and public sector–is to examine whether there is a certain difference in opinion between private sector employers and public sector employers for employment of the persons with disabilities what can be used for the purposes of Trans2Work project.

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ELEARNING SYSTEM BASED ON ODOO

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Abstract: *Development of an eLearning platform for the PT&SCHE project, which is a part of the EU programme. The paper focuses on the features of the LMS system, its functionalities that meet the demands of a modern student. Furthermore, it describes the architecture and main characteristics of the eLearning solution from the perspective of the users of the system.*

Keywords: *eLearning, ODOO, LMS*

1. INTRODUCTION

This paper presents an implementation of the eLearning platform based on the ODOO [1] open-source platform. Implementation is done for the "Introduction of part-time and short cycle studies in Serbia" (PT&SCHE) project [2], which is a part of the EU programme Capacity Building in the field of higher education. In the introductory part of the paper, the features and characteristics of the LMS system are discussed with an emphasis on essential functionalities that meet the demands of a modern student. The rest of the paper presents the architecture and main characteristics of the solution from the perspective of the users of the system, students and the author of the content.

1.1 LMS

The term LMS is not completely clearly defined. Several slightly different terms are used for the same concept. The most commonly used are: CMS - course management system), VLE - Virtual Learning Environment, LCMS - learning content management system), VLS - virtual learning system, learning portal, or e-learning platform (e-learning portal). Each of these terms has a slightly different meaning depending on the specific interpretation. Maybe this system should be called "instructional management system", since instructors and not students determine the parameters for learning. However, for the purposes of this document, the term LMS will be used in the context of complex integrated software that supports the development, delivery, testing knowledge and and administration of traditional F2F courses, "blended" or online learning systems.

Educational institutions use LMS software for planning, organization, evaluation and monitoring of the learning process. With this software they centralize: the preparation of courses, content and resources; content administrators and educators from various perspectives.

Today there are over 500 different LMS's that are in use [3]. Each LMS is unique. Some of them allow users to implement different scenarios and approaches, such as predominant orientation to the content (content-centric), to the connection (network-centric), to activities (activity-centric), or to a linear or branched approach. Some systems are better at delivering asynchronous instruction, while others are better at synchronous mode of instruction delivery. Some LMS systems deliver content to students and allow the assessment using mobile devices, while others do not have that option. Therefore, instructors should identify available possibilities and use them adequately in their instructions. It is necessary to carefully analyze available tools and their functionality in order to be implemented adequately. Selecting the right LMS depends on many factors, including the age of students, the type of teaching and learning methods, experience of lecturers, as well as the objectives of the educational institutions.

1.2 LMS SELECTION AND CHARACTERISTICS

A modern approach to the LMS selection should be based on the answer to the following question:
What are the real chances for its application in the real learning process?
A positive answer to this question has the greatest weight. But the answer to this question can not be given without a systematic approach in the evaluation of individual criteria.
Criterion 1: The time required for implementation.
Criterion 2: Is it possible to adapt to the specific needs of the institution?
Criterion 3: How reliable and secure is it?
Criterion 4: Functionality LMS is a mission critical APP. Its reliable and safe operation is a prerequisite for successful use. What does this actually mean?

4.1 Support for Learning Analytics
4.2 LOR Support
4.3 Graphical reports
4.4 The integrated audio / video recorder
4.5 Integrated learning outcomes
4.6 Automatic tasks
4.7 Choosing the notification type and manner
4.8 Easy to use
4.9 IOS and Android
4.10 Customized navigation
4.11 File Download and Upload
4.12 SpeedGrader
4.13. Profile
4.14. Audio and Video messages
4.15. Integration with multimedia content
4.16. Stronger support for group work
4.17. Students as creators of content
4.18. Web Conferencing
4.19. Open API
4.20. Support for web browsers
4.21. LTI Integration
4.22. Modern Web Standards

2. ODOO CHARACTERISTICS

Based on previous discussions it was clear that we should choose a platform that has the following characteristics:

- Open source [4]
- Matured (graduated)
- Suitable and very open for developing broad spectrum innovative applications that are easy to integrate with other modern application and meet expectations that students have.

After a detailed analysis, we decided to choose the ODOO platform. Several key arguments for the selection:

- From Wiki: “Odoo is an all-in-one business software capable of covering all business needs, including CRM, Website/e-Commerce, billing, accounting, manufacturing, warehouse- and project management, and inventory, all seamlessly integrated”
- 12 years of continuous development of the open source community that counts more than 2000 developers led by the Brussels' company Odoo S.A Odoo S.A is recognized as an example of innovation, potential, growth and success in the Belgian economy, Odoo has been chosen by the European Commission and the European Investment Bank (EIB) to illustrate the 315 billion euro investment plan jointly launched by the two institutions to foster business competitiveness
- One of the Top 10 Open Source software [5].
  1. LibreOffice
  2. FlatPak
  3. Rocket.Chat
  4. Mattermost
  5. Odoo
  6. iDempiere
  7. SuiteCRM
  8. Alfresco
  9. Camunda BPM
  10. Talend Open Studio

- Odoo is built upon a Model-View-Controller (MVC) architecture. One of the primary goals of this architecture is to separate the visual display of the information from the business rules and management of the underlying data.

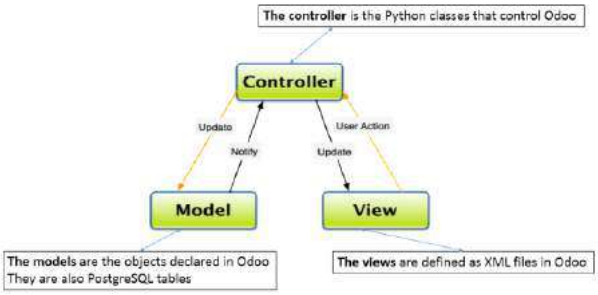

Image 1: MVC architecture

- Odoo system is formed from three main components:
  a. PostgreSQL database server: which contains all of the databases, each of which contains all data and most elements of the Odoo system configuration.
  b. Odoo application server: which contains all the enterprise logic and ensures that Odoo runs optimally.One layer of the server is dedicated to communicate and interface with the PostgreSQL database, the ORM engine. Another layer allows communications between the server and a web browser, the Web layer.
  c. Web client: Which provides user interface, it is running in a web browser as Javascript application. The client issues a request to the server, gets data back and display the result (e.g. a list of customers) in different ways (as forms, lists, calendars, …). Upon user actions, it sends queries to modify data to the server.

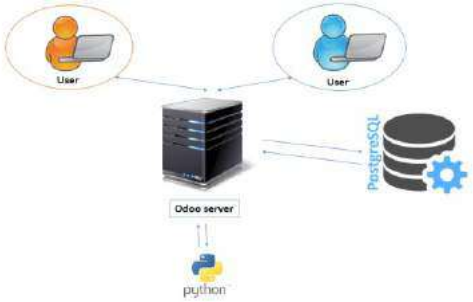

Image 2: ODOO components

Scalability - ODOO is very flexible and scalable. It can be used in systems with only a few concurrent users, but it can easily be extended to a system that can be used by a few thousand users, as is the case with the installation in the Portuguese Ministry of Education. The following Image shows such physical architecture.

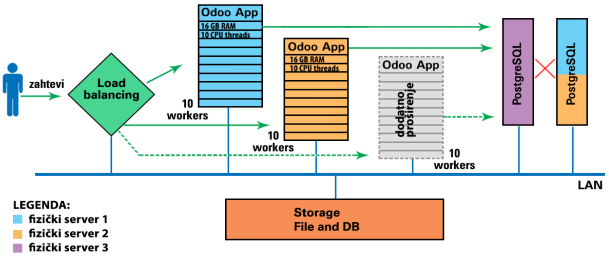

Image 3: ODOO scalability

3. eLearning architecture for PT&SCHE

Image 3 represents a global vision of the architecture of the eLearning platform of an one HE institution. The platform consists of 3 interconnected units:

- Odoo platform itself
- Beckend application for PT@SCHE program administration
- Students Portal

The student portal is realized as a standard website, and it enables easy connection to the existing web site of a HE institution. This ensures consistent expansion of the existing websites of HE institutions which will organize PT&SCHE education.

This architecture should provide the automation of the complete education process within PT&SCHE program, starting with enrollment for a particular program, through the delivery of study materials to the examination.

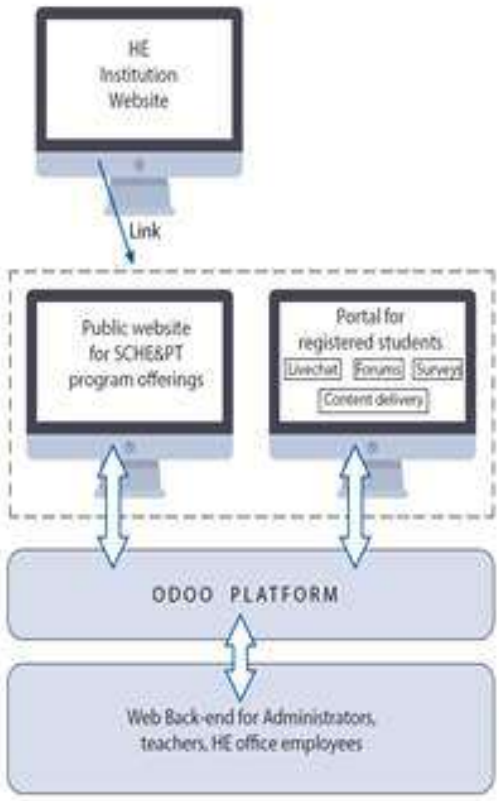

Image 4: eLearning platform architecture

3.1 BACK-END

The Back-end component provides authorized access to the eLearning platform users, and through certain access rights and roles in the system of PT&SCHE education it provides access to individual modules. The following Image shows a dashboard with all the available Back-end modules, which are used by HE staff and employees.

Image 5: Back-end

Discuss is a module for exchanging messages between all users of the platform, through email, or chat.

LMS Management is the key module for the organization of the structure of PT&SCHE program.

Admissions is a module that supports the whole student enrollment process through a previously defined workflow.

Faculties is the module intended for teaching staff and their activities.

Students is a module for managing tasks that a student needs to do during a program attendance. The module enables the definition of tasks, their publication and acceptance of student's works.

Tests is a module for the management of tests a student has to complete during the program attendance.

Surveys is a module that provides data for the analysis of the program's quality. It enables the creation of ad hoc questionnaires, their forwarding to student's personal pages, and the analysis of the answers.

Live Chat is a module for creating and managing information from chat rooms. The following image shows how to configure a chat channel. When an operator joins a channel, an appropriate message appears on the student's page and the student can enter into direct communication with the operator.

3.2 STUDENTS PORTAL

Public website for PT&SCHE programs is an informative, responsive website, the primary purpose of which is to provide potential students with information about available programs and terms and conditions for PT&SCHE. It contains a powerful editor for easy maintenance of the web content.

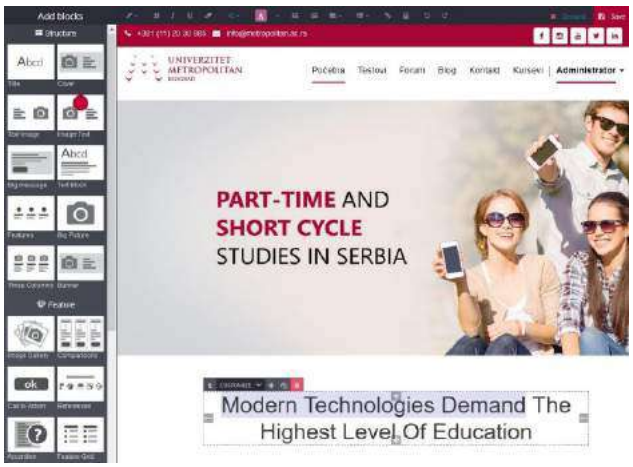

Image 6: Website management

Website is visually divided into several sections:

- Top horizontal area with contact info and social media links
- Horizontal menu area with logo
- Central section for showing page content
- Footer area

Another important informative page is the list of available courses, where visitor can select a desired course and see all available information regarding the program. A typical course details page has the following areas:

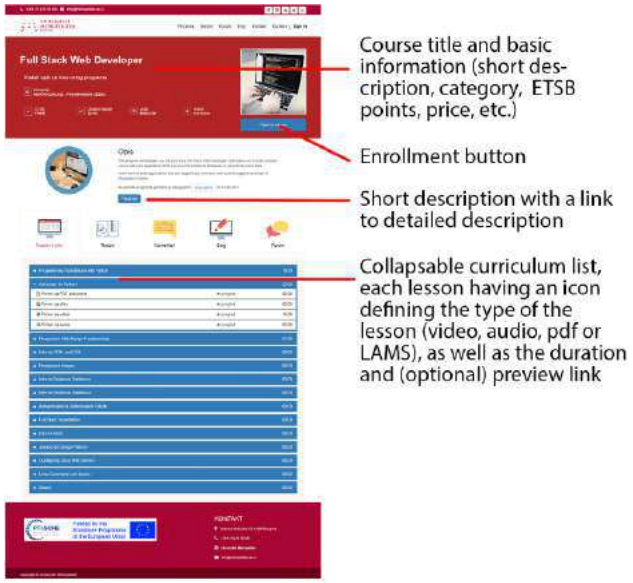

Image 7: Course details page

Links to Tests, Comments, Blogs and Forum are enabled only for enrolled students.

For the content delivery of the PT&SCHE program the portal for students uses the channel concept. The Image 8 depicts this concept in more details.

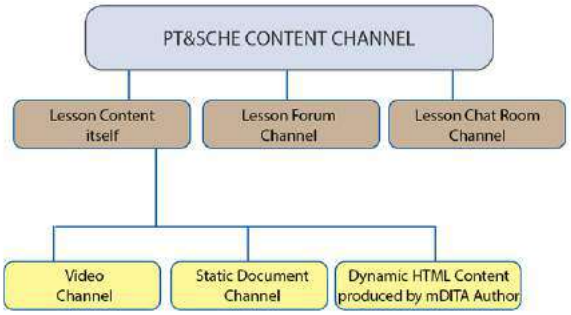

Image 8: The Channel concept

In order this concept could deliver maximum effects, the contents of the PT&SCHE program should be prepared and structured in an appropriate way. The rules for content organization are as follows:

1. One PT&SCHE program consists of the following components:
   a. One or more courses, some of which are mandatory and some elective
   b. Two or more surveys. One before, and the other at the end of the course
   c. One or more assignments
   d. One or more exams.
2. Each course consists of one or more Learning Objects in the form of lessons, which can be prepared as video material, a static document (Pdf or PPT) or a Dynamic XHTML document (LAMS seq.) which can contain links to other multimedia content generated by mDITA authoring Tool.
3. Each course has its own Forum for collaboration with other students on that course and teaching staff.
4. Each course has its own Chat Room for scheduled online consultation with the teaching staff.

The screenshots below show the front-end screens of the learning content delivery:

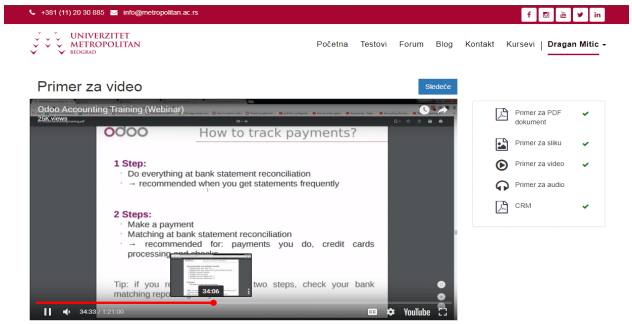

Image 9: Video content delivery

Image 10: mDita content delivery

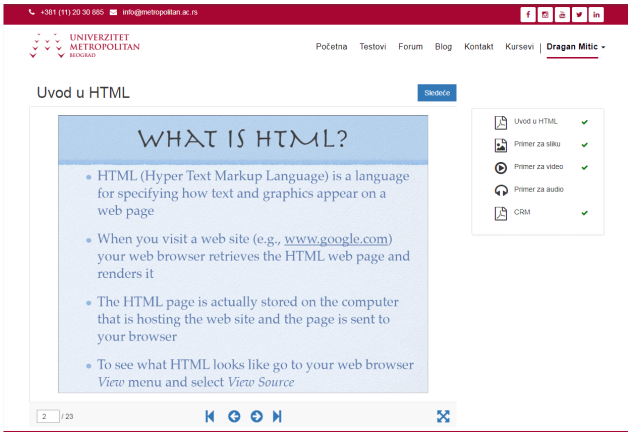

Image 11: PDF content delivery

For the purpose of collaboration of students and professors within a single subject, channels for Forum, Blog, Comments and Live Chat are provided. These systems enable the students and the teachers to make learning process better and interesting by enabling free flow of information and improved sharing techniques.

4. COURSE CREATION PROCESS

The Course module efficiently manages courses, subjects and sessions for the educational institution. Course creation is performed in the back-end area, where administrators have at their disposal all the necessary forms necessary for defining and creating courses.

Before creating a new course, it is necessary to have prepared the following information:

- Course title
- Course code
- ETSB number
- Short description of the course
- Detailed description of the course
- A photography that illustrates the course
- List of the course materials
- List of instructors (faculty) with short description and email addresses
- A blog for each course
- A forum for each course

Furthermore, it is necessary to prepare the following information related to the short program curriculum:

- Subject title
- Subject code
- ETSB number
- A short description of each subject
- Titles of each lesson
- Lesson material in one of the following format:
  - PDF document
  - Video file (from YouTube or some other server)
  - Audio file
  - mDita document
  - iFrame (link to the content located on another server)
- Total time for learning a lesson
- A short description for each lesson

After the preparation phase has been finished, the first step in creating a course would be to insert teaching materials in the appropriate back-end module.

Image 12: Inserting teaching material

Creating the course itself is very intuitive through user-friendly forms of the course creation module.

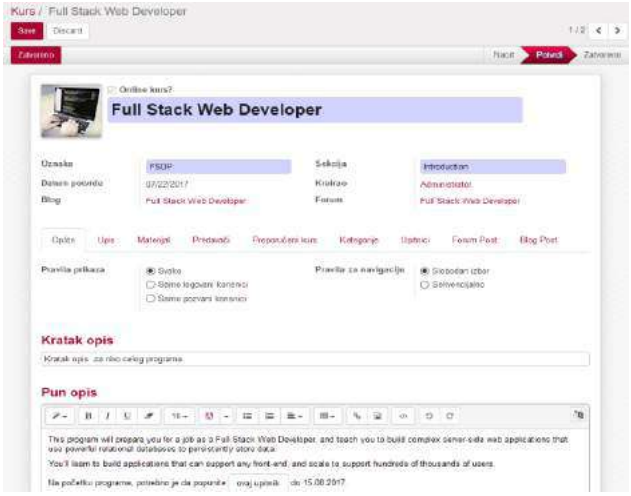

Image 13: The course creation module

5. TESTS

An interesting, easy and effective way to evaluate all the participants in a learning system is through the use of online tests. The eLearning platform allows the instructors to create tests as per their need and then make them worth attending by randomizing the questions and options.

Instructors can configure the following options for a test:

- Test title
- Test description
- Duration
- Number of questions per page
- Number of attempts
- Grade for each question
- Total grade
- Result message based on total grade, etc.

Test questions can be:

- Multiple choice questions
- Fill in the blank questions

Questions are entered into a WYSIWYG editor, meaning that they can contain images, source code, and formulas and equations.

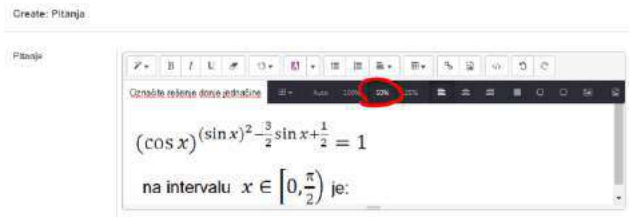

Image 14: WYSIWYG editor

During the test the following information is available for students all the time:

- Number of question
- Remaining time
- Percentage of the answered questions

At the end of a test, students have insight into detailed statistics of the test:

- Total number of questions
- Total number of correct answers
- Total number of wrong answers
- Total available marks
- Received marks
- Test result in percentage
- Questions with correct answers
- Questions with wrong answers
- Not attempted questions

Instructors also have both group test statistics for all students, and detailed statistics for each student.

6. SURVEYS

Instructors can have instant feedback on various activities with surveys which can be created in the built-in survey system. Similar to tests, surveys can have one or more pages, each of them may contain one or more questions.

The following types of questions are available:

- Multiple Lines Text Box
- Single Line Text Box
- Numerical Value
- Date and Time
- Multiple choice: only one answer
- Multiple choice: multiple answers allowed
- Matrix

Image 15: Creation of a survey question

Created survey can be available to students via a public web link, via email notification, or via private invitation.

Instructors can access the detailed statistics of the submitted answers, including pie charts and numeric data.

7. CONCLUSION

Based on the requirements and conclusions of the document for the selection of LMS platform, Odoo is selected as the platform of choice.

Odoo is built upon a Model-View-Controller (MVC) architecture, and is formed from three main components:

- PostgreSQL database server
- Odoo application server
- Web client

A global vision of the architecture of the eLearning platform contains 3 interconnected units:

- Odoo platform itself
- Beckend application for PT@SCHE program administration
- Students Portal

The student portal is realized as a standard website, and it enables easy connection to the existing web site of a HE institution.

This architecture should provide the automation of the complete education process within PT&SCHE program.

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TECHNOLOGY ENABLED FLIPPED CLASSROOM TOOLS AND METHODOLOGIES

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***Abstract**: The transformation of teaching and learning in higher education is inevitable with the use of Web-based and mobile communications technologies. Fundamental redesign based on blended approaches to teaching and learning represent the means to address the challenges associated with providing a quality learning experience. Although the catalyst for change in teaching and learning has been technology, the need to enhance quality standards is drawing attention to the potential of blended approaches. Because blended learning is an approach and design that merges the best of traditional, Web-based or mobile learning experiences to create and sustain vital communities of inquiry, many higher education institutions are quietly positioning themselves to harness its transformational potential. The transformational potential leads to creating a model called flipped classroom where lectures goes under control of the students: they can watch, rewind, and fast-forward as needed.*

***Keywords:** E-Learning, Distance learning, Flipped Classroom, video presentations*

1. INTRODUCTION

Higher education institutions must address changing expectations associated with the quality of the learning experience and the wave of technological innovations. Participants in the higher education enterprise are questioning traditional approaches and whether they are achieving the high levels of learning promised. Those who have grown up with interactive technology are not always comfortable with the information transmission approach of large lectures. Students expect a relevant and engaging learning experience.

Administration, faculty, and students in higher education know there has to be change in how we design educational experiences. Most recognize that the convergence of the classroom and communications technology has the potential to transform higher education for the better. However, blended learning is more than enhancing lectures. It represents the transformation of how we approach teaching and learning. It is a complete rethinking and redesign of the educational environment and learning experience. Blended learning is a coherent design approach that openly assesses and integrates the strengths of face-to-face and online learning to address worthwhile educational goals.

2. CONCEPT OF THE FLIPPED CLASSROOM

There are two related movements that are combining to change the face of education. The first of these is a technological movement. This technological movement has enabled the amplification and duplication of information at an extremely low-cost. Most research on the flipped classroom employs group-based interactive learning activities inside the classroom, citing student-centered learning theories. There is wide variation in what is being assigned as "homework". The flipped classroom label is most often assigned to courses that use activities made up of asynchronous web-based video lectures and closed-ended problems or quizzes. In many traditional courses, this represents all the instruction students ever get. Thus, the flipped classroom actually represents an expansion of the curriculum, rather than a mere re-arrangement of activities. We define the flipped classroom as an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom.

An effective way to start the (re)design process is to reflect on a series of key questions about the course:

- What do you want your students to know when they have completed your blended learning course?
- What types of learning activities will you design that integrate face-to-face and online components?
- What means will you use to assess these integrated learning activities?
- How will information and communication technologies be used to support blended learning?

For most students, blended learning will be a new experience; therefore, it is important to provide them

with a proper orientation to the course. Our experience has shown that students who understand what the teacher plans for the course and why are in a much better position to engage positively in the learning activities and to achieve the course learning outcomes.
The theoretical foundations used for justifying the flipped classroom typically focus on reasons for not using classroom time to deliver lectures.

3. WEB – BASED TOOLS

In a study on course redesign, Twigg (2003) indicated that learning management systems, such as Blackboard and Moodle, can increase student opportunities for feedback and assessment, while decreasing the amount of time that faculty and teaching assistants spend preparing assessment activities, grading, recording, and posting results. Traditional assessment approaches in large introductory courses often involve only a midterm and final examination. But when a Web-based assessment tool is used, components of the assessment and feedback process can be automated to enable repetition and practice and frequent feedback. Research has consistently proven that repetition and feedback enhance learning. A Web-based tool can also significantly reduce faculty workload and increase free time for interaction with students.
Students can be regularly tested on assigned readings and homework with the use of online quizzes designed to probe their preparedness and conceptual understanding. These brief quizzes motivate students to keep current with the course material, as well as aid study structure and encourage more time spent on the task at hand. Using online quizzes encourages a “do it until you get it right” approach because students are allowed to take quizzes as many times as required to master the material. These types of online activities provide consistent, automated grading across sections and allow instant feedback for students when they are concentrating on the task. [1], [2], [3].

4. CASE STUDY IN THE CLASS ON SELECTED GROUP AND SUBJECT

In this paper, the examinations are specifically aimed at comparing the knowledge of students in the subject of Informatics from two faculties observed in two different study years 2015/2016 and 2016/2017. We will work with a sample of about 600 students from the Faculty of Medical Sciences at the University "Goce Delcev" - Shtip, of which 300 students have attended the Informatics course in the academic year 2015/2016, and 300 in the academic year 2016/2017.
In the paper, we start with the assumption that students in both study years come with approximately identical forewords from Informatics and we neglect all other facts that influence the acquisition of knowledge from various types of learning and gaining basic knowledge on the topics covered in the Informatics course. In the following given below are
In the study 2015/2016, the classes are realized with a classic method, using methods of lectures through presentations and minimal use of web technologies in this case, created e-course on the Moodle platform.

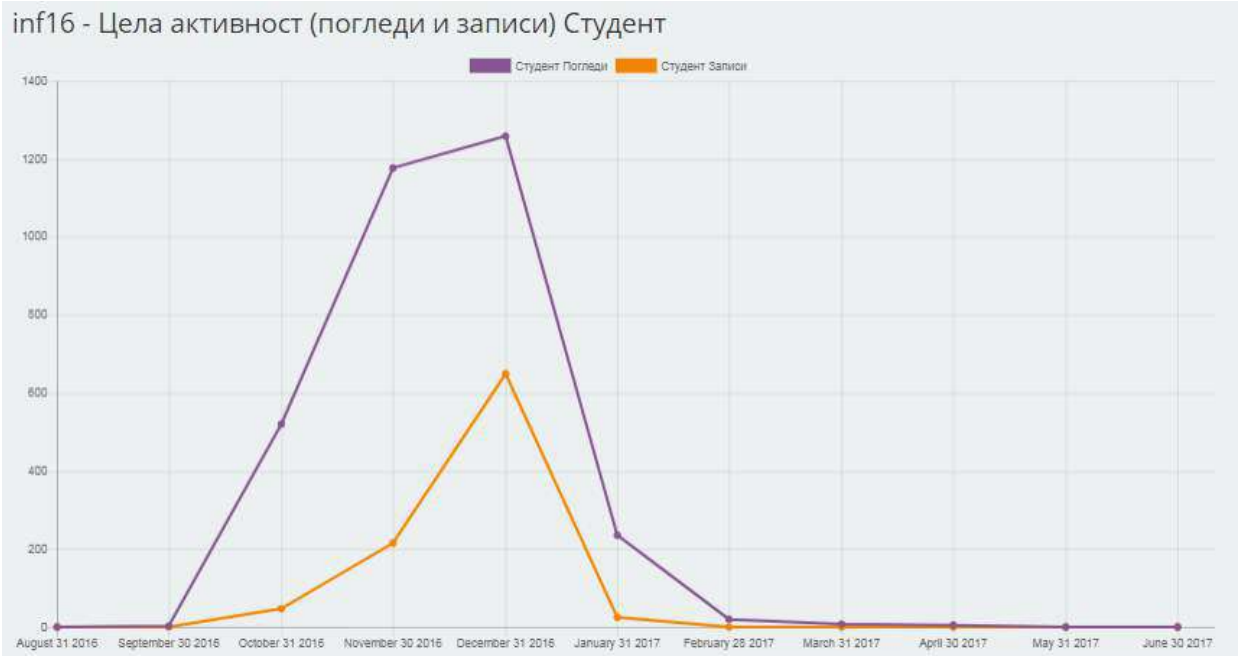

Figure 1. Course activities by students 2015-2016

Table 1. Course activities by students 2015-2016

The period ends (Month)	Student Views	Student Records	Reports
June 30 2016	**0**	**0**	**Reports**
May 31 2016	**1**	**0**	
April 30 2016	**4**	**0**	
March 31 2016	**7**	**0**	
February 28 2016	**20**	**0**	
January 31 2016	**236**	**25**	
December 31 2015	**1258**	**650**	
November 30 2015	**1178**	**215**	
October 31 2015	**520**	**47**	
September 30 2015	**2**	**0**	
August 31 2015	**1**	**0**	

In the 2016/2017 study, the teaching was realized in combination of the classical method using methods of lectures through presentations and using web technologies as an e-course in which besides presentations and standard forms of electronic testing of knowledge, they are complemented with activities in the form on: questionnaires, discussion groups, blogs, forums and video presentations. As advanced forms of activities such as granting privileges to the users themselves - students to be creators of discussions and forms of voting, or active on-line activity, which would actively develop joint projects with other colleagues on the course itself and evaluating final seminars or projects between each other. [4], [6], [7],[9] , [14], [18],[19], [21], [22].

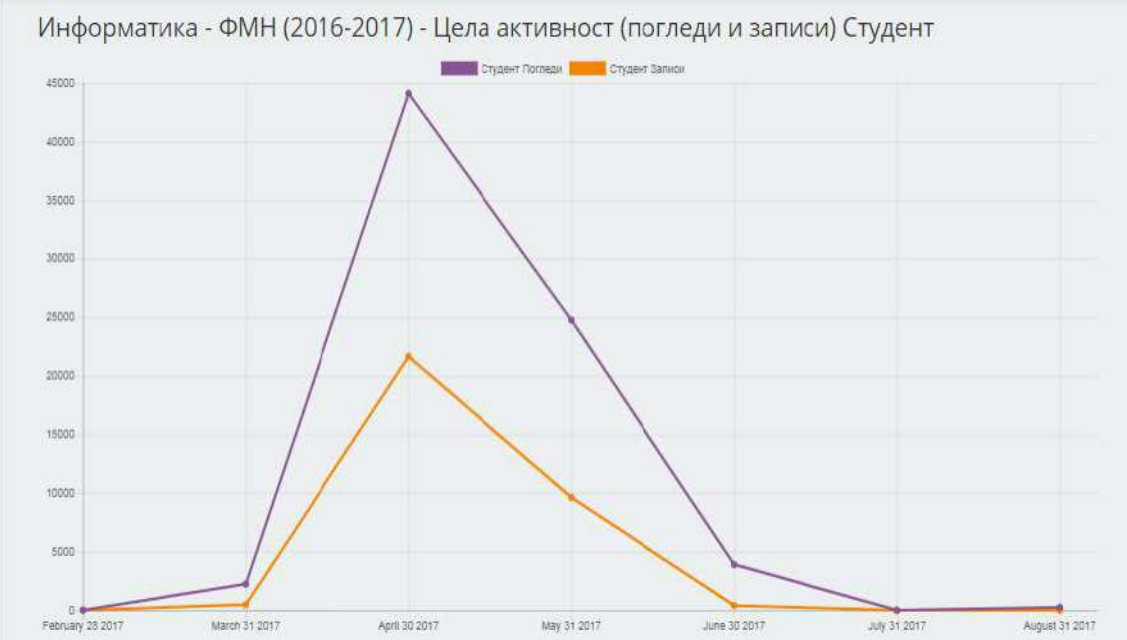

Figure 2. Course activities by students 2016-2017

Table 2. Course activities by students 2016-2017

The period ends (Month)	Student Views	Student Records	Reports
August 31 2017	**200**	**3**	Reports
July 31 2017	**18**	**2**	Reports
June 30 2017	**3869**	**387**	Reports
May 31 2017	**24808**	**9662**	
April 30 2017	**44105**	**21703**	
March 31 2017	**2220**	**503**	
February 28 2017	**20**	**1**	

The results were dramatically visible according to the results achieved after completing the course within a given period. In Table 1 and 2 are given results: Student Views and Student Records from the course in which is visible that in the student year 2016-/017 the views and records from the students are significantly higher than 2015/2016.

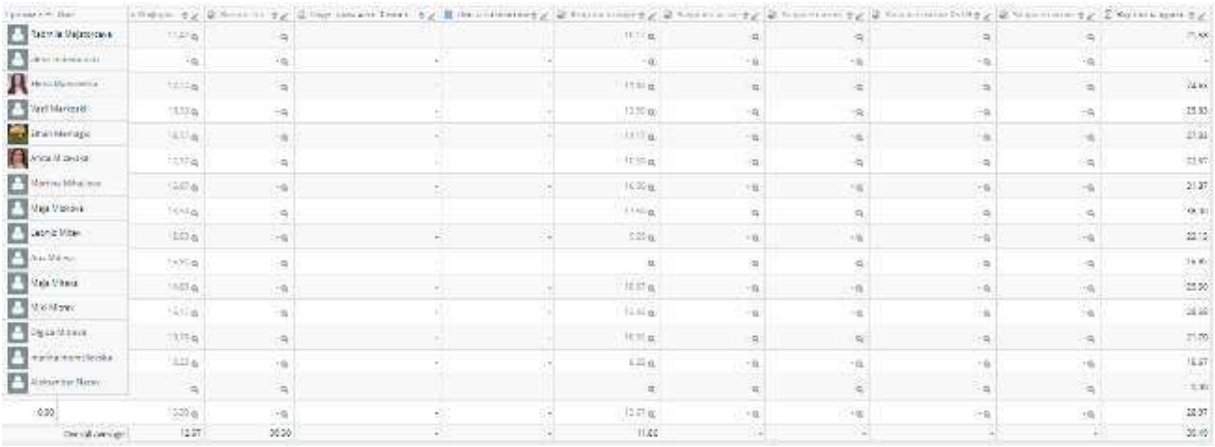

Figure 3. Achieved results after completing all activities for 2015-2016

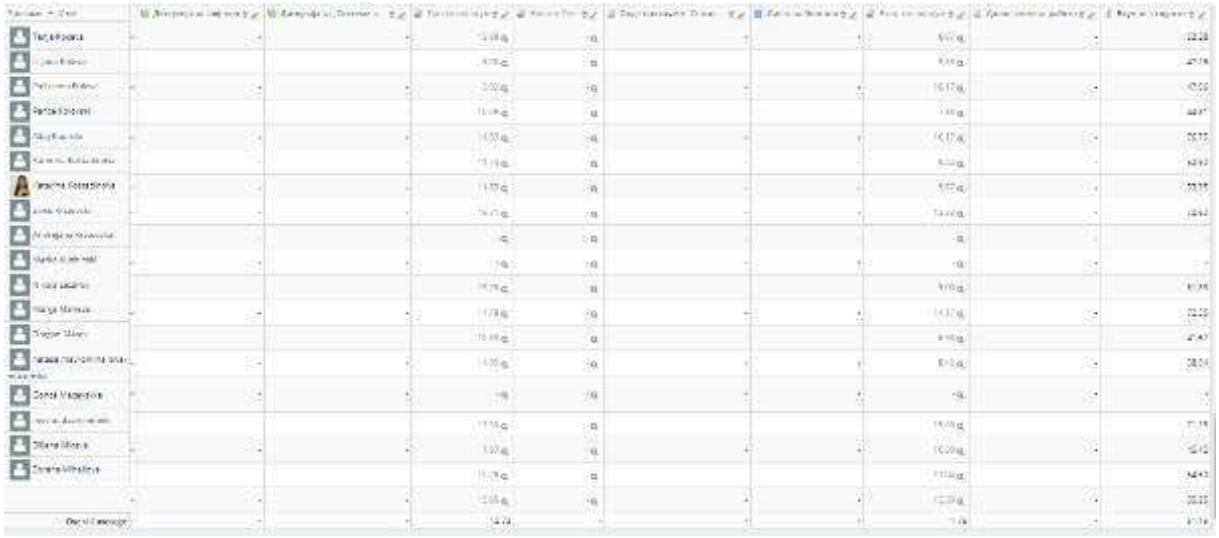

Figure 4. Achieved results after completing all activities for 2016-2017

Based on the overall results achieved by students, this is how the final table of success looked like for all examined students in both study programs with and without the use of the flipped classroom method:

Class 2015/2016 – Overall average = 30.49 points (out of 100 max)
Class 2016/2017 – Overall average = 61.15 points (out of 100 max)

5. CONCLUSION

We suggest that in order to ensure progress, future research on the flipped classroom should employ controlled studies that objectively examine student performance throughout a semester, with both traditional and concept-inventory style problems. Further, we recommend that researchers employing the flipped classroom leverage the existing research and theoretical frameworks to guide their use and design of in-class activities. The affordable state of recording technology and ubiquity web-based dissemination tools make research on the flipped classroom both timely and cost-effective. Even though the survey data and the grades cannot be used to make any substantial conclusions about differences between the flipped and non-flipped classroom, we think the difference between grades and student's results from the flipped classroom warrants further interest and research in its use in the higher education classroom. This study illustrates that using the Flipped classroom concept gives about fifty percent better results and it is a great help for the students in their overall success . Some students do not grasp the concept in the beginning but the Flipped instruction concept facilitates interaction among students, and between students and their Instructors. Flipped instruction leads to better learning results.

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INTRODUCING 360 DEGREE VR INTO GAME DEV EDUCATION AT BMU

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Abstract *Extension of educational flight simulation game at BMU by low cost VR technology is described in the paper. This game is result of a student team project, with the goal to motivate students in studies of advanced 3D game technology as well as to develop teamwork ability. The game is developed by spiral model, where each cycle represent individual or team project resulting in a playable functional extension. In the last cycle, described in the paper, the player is supplied with additional visual output - google VR cardboard using wireless network communication.*

Keywords: *E-Learning, Learning by doing, Virtual reality, Game based learning, Simulation game, Serious game,*

1. INTRODUCTION

This article is about adapting of digital game studies at BM to rapid advances in computer and game technology.

Game technology in this article refers to technology (hardware and software) exploited to build digital (or computer) games. We treat primarily 3D games.

Digital games (including games for entertainment and serious games) share common application domain with interactive simulations and Virtual Reality (VR) systems, limited by low cost technology. Game technology is used to develop low cost simulation (AKA light-weight simulators [1-3]) and VR systems and also, to prototype more complex (and expensive) systems. For this reason, game technology may be used to teach how to develop VR and simulation systems.

Rapid technology advances and decrease of its cost extends the limits of game technology and challenges the education to adapt curriculums to new and more sophisticated technological solutions.

Belgrade Metropolitan University (BMU) has opened computer game studies to educate qualified people for local game industry as well as for academic research in game technology based fields. Computer game related courses are taught at FIT (Faculty of Information Technology) and FDU (Faculty of Digital Arts) at basic, master and doctoral level.

BMU chose educational approach adapted to rapid computer and mobile technology development, which combines traditional teaching (at beginning of studies) with problem oriented learning (with advancing of studies), where student initiative and team work dominate [4]. For the students who have already mastered basic game development techniques, the focus is moved toward the goal "can I (and how to) exploit my knowledge in more complex realistic projects and real life like challenges".

In this context, flight simulator development project (or FlSim) is initiated at BMU to implement the "learning by doing" principle and let the students learn how to face and resolve challenges in developing low cost simulation and VR systems (also referred to as serious games or simulation games - Sims). The project involves the students of FIT and FDU of all levels of studies. It is organized as a series of subprojects, assigned either to individual student or student team. The teacher's role is primarily to supervise and participate in the evaluation of a subproject, and also to manage whole project using spiral development model [5]. More details on the FlSim project and initial results are reported in [6, 7].

Devices with a stereoscopic view are very attractive feature of VR since they give more realistic perception of 3D virtual world. However, in the past this technology was expensive and considered to be exclusive in academic context. Recently, new software solutions enabled stereoscopic view on smart phones at almost no cost and enabled this technology to take part massively in schools.

In this article we describe a result, adding stereoscopic viewer to flight simulator described in [6, 7]. The plan of paper is as follows.

- In the section Virtual reality and games we discuss inherent relation between 3D digital games and VR systems, and student project FlSim previous results.

- In the section BMU vr-flight simulator we describe extension of FlSim by low cost 360 deg stereoscopic viewer, and its implementation

- We close the article by concluding remarks.

2. VIRTUAL REALITY AND GAMES

VR means representing illusion of physical 3D reality by the means of computer IO and additional hardware. Virtual world or virtual environment is just a place where observer may be. If something happens in virtual world, then we are talking about simulation. Simulator which usually represents motion in 3D world with realistic audio/visual effects is a simplest form of VR system.

Adding a gameplay, goals, challenges and other elements one obtains a game (we are talking about 3D games), which may be for entertainment or other purposes (serious game).

A whole class of VR systems may contain special (usually costly) interaction devices, still representing some kind of simulator.

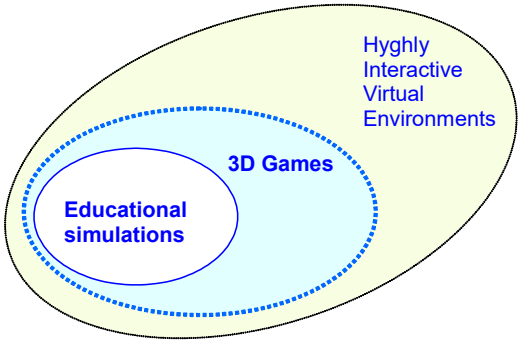


fig 1: VR, games and SIMs

In fact, a simulation game (or SIM) is a simplest game with realistic 3D world (focus is moved from playability to realism and fidelity) and thus an example of VR system.

Thus, as a representative for development VR technology to teach the students at BMU, a serious game (vehicle simulation game) project was chosen since it may demonstrate all (or majority at least) of basic aspects of VR system development as well as 3D.

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.

2.1 Vehicle simulator project

Educational game is most typical serious game, and close to academic people from application domain point of view.

Vehicle simulation game intended for learning (e.g. of car driving or piloting airplane) is a typical example of educational game. It is more effective form of learning than widely adopted reading, hearing and seeing (in the class) as it implements learning by doing principle. It is well proven concept, as it is based on experience of training simulators which serves to fulfill majority of education and training instead of real vehicle. That's why vehicle simulation educational games are sometimes called a light-weight simulators – simulators implemented in low cost (game) technology.

The project FlSim was started for 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).

FlSim learning objective is "How to make concept, develop and test an educational game".
The details of previous FlSim version are published in [6, 7].

Reference [6] covered the visual modelling of an Airport and cockpit of a plane. Afterwards, a simulation was created in Unity 3D (airport, planes, moving elements, primary scripts).

The airplane (Cessna 172) and airport modelled was that used by the national pilot academy for civil aviation at Vršac to train the cadets.

fig 2: First Cessna 172 simulator version

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.

3. BMU 360 DEG VR-FLIGHT SIMULATOR

Sufficiently large angle of view is important for training simulators and that's why they often have visual system composed of several screens (or projectors).
Recently, new software solutions enabled stereoscopic view on smart phones at almost no extra cost and enabled this technology to take part massively in schools.

Devices with a stereoscopic view are very attractive feature of VR since they give not only more realistic perception of 3D virtual world, but also enable 360 deg wide field of view.

Thus, in present FlSim version a stereoscopic viewer is introduced to study programming and implementation aspects, and also to test benefits (if any) of low cost VR technology.

3.1 Simulator Architecture

First issue was that airplane flight controls could not be (easily) implemented on mobile device and that best way to do was to keep original PC simulator and connect mobile device by network.

Fig 3 VR simulator architecture

As seen from above image, there are two main modules in this simulator: PC module and Mobile module. Both software modules are implemented in Unity3D. The two components run on client-server architecture, with server running on PC and client running on mobile device. All mathematical calculations needed for flight simulation, as well as flight control input are done on sever, and client only consumes final results of those calculations (position and orientation of airplane) to show to viewer. Simulation is generally built like network multiplayer game, where the two modules communicate via Unity Networking High Level API.

3.2 Google cardboard - VR glasses

Google cardboard provides an easy and low-cost way of entering VR development and is thus readily available to students.

3.3 Unity 3D VR support - Google VR SDK

Google provides SDK for developing VR applications for most of major platforms. These include: Android, iOS and Unity. As the simulator was developed in Unity and Google Cardboard was intended for use, Google VR SDK was chosen as the basis for VR development.

Google VR enables features like Stereo rendering, head tracking, VR input and so on.

Stereo rendering, as opposed to Mono Rendering, is a technique where game world is rendered with two images separately, one image for each eye, with an offset. This then mimics the picture human eyes see in the real world – where brain percepts depth based on how much object is offset on the images it gets from both eyes. Also, resulting rendered images are usually distorted to better match eye's spherical nature, distortion mostly used is barrel distortion.

Head tracking or gaze tracking is another technique that help immersion by tracking the movements of the user's head and then rendering part of the world that the user is looking at, thus enabling 360 deg view. Head movements are measured using built in mobile device sensors, like accelerometers and gyroscopes. Stereo camera inside the scene is then rotated according to the data from these sensors.

Input in a VR environment is inherently problematic, because VR devices enclose the user's eyes completely. The user cannot see their hands or any possible input devices, and in Google Cardboard, phone is completely encased in a box, so the primary mobile input device, the touch screen, is unavailable. So, in order to accomplish user interaction with in game world, cardboard provides a simple solution: on the side of the cardboard, there is a magnet, which is held in place by another magnet placed inside the cardboard. When the user wants to interact with the game, they can just pull on the outer magnet, and that would cause disruption in magnetic field. These disruptions can be detected by phone sensors, and SDK provides components to integrate this form of input into Unity's event system.

3.4 Unity3D Networking High Level API

Unity3D Networking High Level API (HLAPI) is a system for building multiplayer capabilities for Unity games. This system was used for implementing client-server architecture in BMU FlSim. It is focused on ease of use and iterative development and provides services useful for multiplayer games, such as:

- Message handlers;
- General purpose high performance serialization;
- Distributed object management;
- State synchronization;
- Network classes: Server, Client, Connection, etc.

State synchronization is a means of synchronizing game object's state over the network. All game objects we want to be synchronized in this fashion must have a NetworkIdentity component that enables HLAPI to identify game objects over the network.

There are two aspects of state synchronization in HLAPI that are implemented in FlSim:

- Transform synchronization;
- Variable synchronization.

Transform synchronization is achieved with NetworkTransform and NetworkTransformChild components. NetworkTransform is meant to be placed on the root object of an object hierarchy and it synchronizes its Transform component over network. Any other objects in that hierarchy that need to be synchronized should be synchronized with NetworkTransformChild. NetworkTransformChild component is also placed on the root of the hierarchy, and its *target* property is set to the Transform of the object within the hierarchy that we want to synchronize.

Variable synchronization is available to scripts, where public or private class member fields can be synchronized

over network. In order to make a class member synchronized, it should be marked with SyncVar attribute, and the class should inherit from NetworkBehaviour.

3.5 Implementation

Client and server are implemented in the same Unity game. Game behaves differently if it detects that it is run on mobile device (client mode) or a PC (server mode). For that a singleton class GlobalState was created, containing two read only Booleans, isServer and isClient. Other parts of the game can adapt to client or server in an *if* statement according to these two variables. Although this functionality is already provided by NetworkBehaviour script, the goal of this system is to be able to support a system of roles in the future, where it would be possible to distinguish roles in a finer grained manner than just server or client, with possible roles being *pilot, copilot, air traffic control operator etc*… This would enable development of a whole virtual flight ecosystem, making for interesting and highly educative collaborative student projects.

Game server

The two basic roles that game server has are input for controlling the airplane and the mathematical model for airplane flight simulation. These behaviors are implemented in a script named move_Flight (javascript class), where the main update loop looks like this:

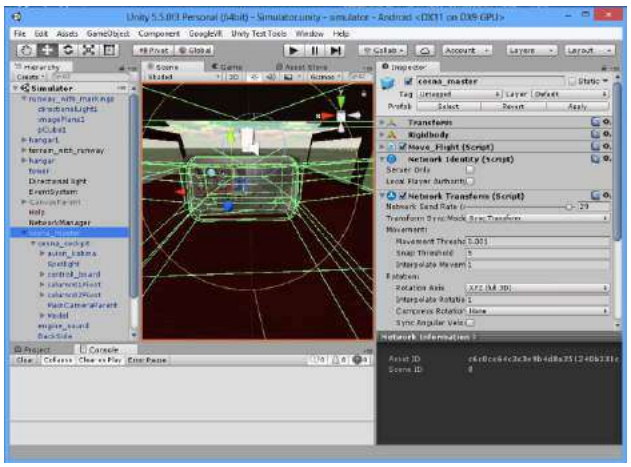
```
If not server mode then return;
Update input;
Check if we have entered or left ground mode;
Update airplane controls;
Update airplane position;
Update airplane rotation;
```

Also, there are other instruments in the airplane such as attitude indicator that are updated to reflect the current state of the airplane, using position and rotation calculated by move_Flight script. Since above mentioned update cycle is not executed on client side, results of the calculations are synchronized over the network.

Server and client communication

Network communication and synchronizing of state between server and client is provided by Unity High Level API (HLAPI).

We have cessna_master object that represents airplane. Its child objects represent various parts of the plane. We are using NetworkTransform to synchronize airplane translation and rotation and we use NetworkTransformChild components to synchronize position and rotation of control columns.

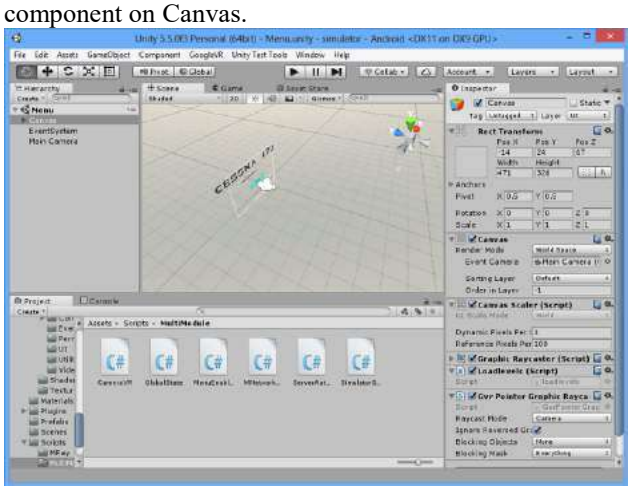


Our move_Flight script also calculates, among other things, speed and acceleration of the airplane. These two variables are used by individual scripts that update state of the flight instruments, and they are synchronized with client using SyncVar mechanism.

One final networking component that was implemented by hand was ServerAutoDiscovery, a script that enables client and server to automatically find each other in LAN and connect to each other. Implementation is based on UDP multicast, where server broadcasts a “beacon”, the predefined string that enables client to identify it. Client listens on designated UDP port and upon receiving and identifying the beacon, client connects to the server on IP address the beacon was received from. Managing connections between server and client is provided by MNetworkManager, our decorator class for HLAPIs NetworkManager class.

Client

First of all, we have a main menu scene. There we have the UI consisting of a single button which lets the player proceed to the airplane driving scene. UI is implemented with Unity’s Canvas system, and canvas is set to be rendered in world space. Also, in order for VR input to work, we must put GvrPointerGraphicRaycaster component on Canvas.



Now we must make the camera behave like stereoscopic view on client side. We must add following functionality:

- stereo rendering
- head tracking
- VR input

First two functionalities are managed by GvrViewer. Internally, it creates two more cameras (for left and right eye), and also sets the appropriate post processing effects so that each camera renders on its own half of the screen and applies distortion (this can be set on or off). Also, it adds additional scripts to camera, such as GvrHead, that tracks device rotation and makes camera object rotate according to that.

For VR input to work, we must enable Unity to recognize input from Cardboard magnets. SDK provides implementation of Unity's BaseInputModule, called GvrPointerInputModule, which enables cardboard magnet input to interact with Unity's EventSystem. We must add this script to the same game object containing EventSystem for our scene. We also add GvrPointerManager to this game object.

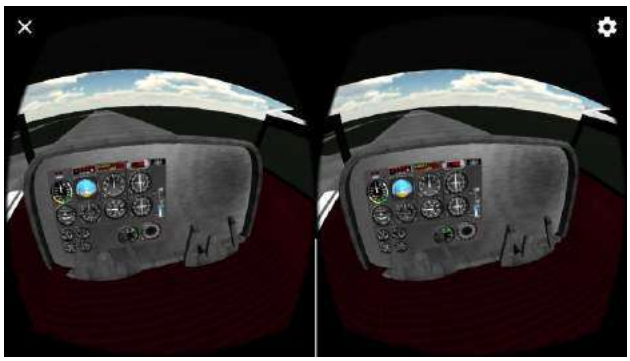
In order for user to have some sort of indication of what interactable UI elements he is looking at, we must create ReticlePointer. We create a prefab called *reticlePointer*, which needs mesh renderer, GvrReticlePointer script, and material with Reticle shader from Google VR SDK. This reticle is a pointer that represents cursor in VR applications, it is always centered in rendering, and when hovered over a selectable item like UI button, it expands, giving the user indication that they can interact with the object they are looking at.

Flight simulator scene

Flight simulator scene is where flight simulation takes place. Most importantly cessna_master game object, that is the root of hierarchy of game objects that represent various parts of the airplane. Part of that hierarchy is MainCamera that also has GvrViewer script. Here we do not use reticle pointer, as we have nothing to interact with in VR mode.

One of the problems encountered with stereo rendering was that sometimes objects looked too small, e.g. airplane instruments being unreadable, and upon camera closer to the dashboard caused users not being able to see properly out of the airplane. This prompted the need to appropriately zoom to an object the user is looking at so that the object would take up the appropriate fraction of the user's view area.

Hopefully, VR SDK already comes with a concept like this implemented, in the form of "center of interest" object. This concept in stereo rendering bears analogy with mono rendering cameras field of view. StereoController script from SDK enables setting center of interest game object, and SDK will move eye cameras to or away from it depending on distance of the object from the head. In Flight Sim center of interest object is moved on every scene update to be at the position where user's gaze intersects nearest object. This is accomplished using ray casting, and enables matching the field of view against objects user is looking at. In practice, this made VR experience much smoother and more pleasant.



3.6 Analysis of the results

Experience gained from the project is following.

Introducing stereoscopic viewer gives FlSim new functionality and provides new user experience. User can explore virtual world in new direction as well as evaluate viewer itself. This is attractive for those who may enjoy in virtual sight (passengers), but not suitable for those controlling airplane flight since pilot does not see controls nor his hands (professional flight simulators have physical cockpit and virtual out-of-cockpit world).

More important, FlSim has been proven useful as test bed for developing various innovative solutions (e.g. mobile technology based). Thanks to distributed architecture, a new module may be implemented on separate computer and added in the system using network communication. Thus, developer may pass concept, implementation and testing-evaluation phases, which is very important for students to gain experience and feel in developing new working solutions.

4. CONCLUSION

Student built simulator game at BMU has been successfully extended by low cost stereoscopic viewer. This enabled students to gain experience in prototyping, design, development and testing of VR and simulation systems.

The project also provide basis for introducing of stereoscopic viewing technology in game education classes at FIT and FDU.

The authors observed at BMU that students show interest to work in teams on the game projects whose goals go beyond the framework of standard school courses. This increases student motivation and helps them to gain more problem solving experience, acquire skill and better understand game industry projects.

The authors also believe that technology of serious games combined with e-learning really has future in higher education.

ACKNOWLEDGMENT

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USING E-LEARNING SYSTEMS FOR TEACHING GEOGRAPHY IN ELEMENTARY SCHOOLS

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Abstract: *Large number of e-learning systems indicates the existence of many users. However, with intensive development of Internet technologies, younger population of students who are highly IT trained have higher expectations of e-learning system in terms of interactivity and dynamism. In this paper, we analysed the needs of the elementary school in the subject Geography that existing platforms do not offer and which would greatly improve the quality of teaching and testing students. Interactivity with maps, map elements, coordinates and facilities has become an integral part of many educational sites on the Internet, but not part of e-learning systems used in a formal and informal education. The aim of this paper is to point out this specific need and to propose new types of questions and answers with the aim of mutual satisfaction of all parties in the teaching process.*

Keywords: *E-Learning, Distance learning, geography, online*

1. INTRODUCTION

Intensive development and large-scale implementation of the wide range of e-learning platform enables a high-quality way of learning and testing. Since these forms of instruction are available to students starting from elementary school, their constant change is required, given the length of the learning period. This change should be in two directions: change in design and new functionalities.

The change of design should ensure the students have appeal to the same platform for many years, and to provide innovation as well as the aesthetic moment. On the other hand, new functionalities should respond to the specific requirements of the subject and be in line with trends in IT. It has been shown that materials for different subjects can be presented, or students tested, in standard ways. This standardization refers to content types, their placing and organization within the website, the types of questions and answers. Observing from the students point of view, to whom such education is presented in a large number of subjects in a very similar way, it becomes monotonous. This can cause a decrease in interest and commitment, which should not happen.

From the perspective of teachers and specific requirements within the subject, standardized types of questions and answers makes student loses exploratory approach in learning.

In this paper, the application of the e-learning system for the specificity of subject Geography in elementary school is analysed. Fundamental approach to explaining many facts in this case is related to different types of maps and cartograms. Even with a rough analysis, the types of questions and answers without interactivity with map, region, city, relief, etc. cannot achieve the expected result. Such questions can always be reformulated by displaying a classic image with a labelled object, for example, radio buttons with offered answers. However, it turned out that students who use many free Internet services, interactive maps, web-oriented games, expect a higher level of dynamics when working with maps. From the teachers' perspective, questions that would allow interactivity with the map would be desirable also in the learning process, because clicking on the wrong country, continent, ocean, area, meridian, city, etc. would clearly point out the error, but also made it possible to explain what was clicked, and to give instructions for another attempt (for example, move for a certain number of degrees of longitude). Such implementations and specificities in the e-learning system do not exist in the generic form, and they would be highly desirable in these or similar applications.

The aim of this paper is to point out the benefits of the e-learning system, and on the other hand the needs of users and functionalities that would greatly increase the quality of the online learning platform with the mutual satisfaction of students and teachers.

The paper is organized through 4 chapters. After the introduction, in the second chapter, the overview of e-learning systems is presented with focus on their classification and possibilities. In the third chapter, the specificities of the Geography for primary school students are analysed, with an emphasis on those that would be desirable to be enabled through e-learning platforms, but for now they are not present in these forms. In the closing chapter, the Conclusions and further plans for future research are presented.

2. OVERVIEW OF E-LEARNING SYSTEMS

Important part of learning is to check whether the material has been learned. It can be used in the process of learning or for grading the student knowledge.

When e-learning system is used for grading, it helps teaching staff to relatively easy examine large number of students. In this way, it is possible to very effectively check the knowledge of students through questions. Note that in our pedagogical practice computer testing is not widely used, although this method of testing knowledge has many advantages over other methods [1]. The test conditions are the same for all students, the assessment is automatic, so this type of knowledge testing is completely unbiased [2].

Generally, tests can be divided into three basic categories. These are knowledge tests, ability tests, and personality tests [2]. The test is a kind of experiment consisting of tasks identical for all subjects, for which the mode of testing is determined and a precise way of assessing test results. Knowledge tests can be normative or criteria tests [2]. Both types of tests serve to test knowledge, but their purpose is different. In normative tests, the success of an individual is compared with the success of others, the norms are determined after a test by comparison, and the results show how much the respondent learned, and not what he learned. Criteria tests measure the extent to which educational goals have been achieved, or what the respondents learned from what they should know. For the examination of pre-knowledge, teaching efficiency and teaching methods, criteria tests are used for which it is necessary to determine in advance what is to be learned [3].

The basic classification of knowledge tests is according to the form of tasks appearing in the test [3]. There are reproductive tests (including supplementation tests and essay tests) and recognition tests (including bipartite test, multiple choice tests, and benchmarking and comparison tests).

Some of the advantages of using electronic testing in teaching are:

- Relevant tests provide information on which parts of the material are difficult for students to understand and what is incomprehensible. These data are important for professors [3].
- The student has an overview of how well he has mastered the material.
- Increasing the efficiency for the examiner: automatic processing of results, presentation of results and statistics (a comparative overview of the results of all students or a review of the results of a student's work on several tests ...)
- Possibility of remote testing via the Internet
- Creating a well-structured database with a defined number of points grouped into topics. From this database, various tests can be generated by automatically including a certain number of questions from each topic (what the program does) or the selection by the examiner itself.
- High quality display of questions and explanations enriched with multimedia content
- Compact and durable form of keeping test results
- Currently available results to the examiner and/or student
- Automatic time limitation
- Impartiality complemented by a reduction in error checking ability
- Possible generation of auxiliary questions during testing
- Support in creating and applying different kinds of impartial measurement, monitoring and evaluation

Contemporary e-learning systems do not cover speciality of the subject which is necessary to consider for improving learning and teaching process. E-learning platforms like Moodle [4], Oracle iLearning LMS [5], Sakai [6] are generic and usually allow only use of static material for learning material and multiple choice questions for testing purposes. This needs to be changed and improved, for learning process to be more attractive and efficient.

3. THE SPECIFICITY OF GEOGRAPHY SUBJECT

Given the complexity and number of different e-learning systems, their functionalities can be expected to be adjusted at least to the most common user needs. If it is known that in many of European countries priority is given to teaching elementary and secondary school students using interactive learning and learning with the possibility of using the Internet, it is obvious that various forms of e-learning systems intended for student education should be adapted for standardized subjects which are studied at these levels of education. Unfortunately, this is not the case with all subjects. Moreover, support was not done in a way to enable the realization of individual subjects in the way they defined in the official plans and programs, but generic support for the creation of teaching materials and testing was made. As this era of information society, and as new generations of children are born and grown up with electronic devices, it is necessary that all that obligatory primary education imposes as norms and outcomes of knowledge be supported in systems that are initially intended for education and e-learning

In this paper, we will point out the specificities that are being implemented in the Geography subject, which is a compulsory subject in all European countries and is being studied for at least 3-5 years in various forms of educational systems. In the Republic of Serbia, the subject is also included in the subject matter for which students are tested in the form of a final exam at the end of elementary education, which additionally shows the importance of the material to be learned and adopted.

The National Education Council of the Republic of Serbia has decided on the adoption of educational standards for the end of compulsory education. Educational standards include a series of statements describing the knowledge and skills that we expect the student to show at a certain level of achievement. In this sense, three levels of achievement are defined: basic, intermediate and advanced.

In the basic level of achievement for the subject Geography, in the fifth grade of elementary education, among other things, the following goals are defined that require the student to describe the method of representing the earth's surface and the ability to recognize and read the geographical and additional elements of the map. Additionally, in the intermediate level of knowledge, the student should be able to determine the position of places and points on the geographical map. According to the National Education Council's expectations, the number of children who need to reach the basic level of knowledge is more than 80% of students, while for the middle level this figure is about 50%.

Given this large number of students who need to master the intermediate level of education and the impact of this subject in the overall education, it would be very convenient if e-learning systems would allow teachers of these subjects to be able to create teaching materials and tests that are in accordance with the prescribed levels achievements.

In this sense, the legitimate use of a geographic map defines the students' orientation on the map. This implies knowledge of terms of latitude and longitude, determining the position of geographic objects, calculating the distance and using the map conditions. These competences must be checked by testing, and according to this matter, they require very specific forms of questions which as such do not exist in classical e-learning systems. For example, in such forms of testing, student interactivity with the software is very important. This is done in paper form in the form of blank or classical geographic maps and where a student should be able to find a geographic map element (e.g. city, settlement, mountain, river, mine, etc.) based on defined latitude and longitude. Similarly, the e-learning system should, in the testing process, allow the mouse to click on a map to get coordinates to suggest whether the student is well-positioned. In addition to being aware of whether it is true or correct, it is advisable to clearly indicate to each of the wrong clicks the location in terms of latitude and latitude that has been clicked for the interactive error process to have an exact answer. This would mean that a teacher can define a greater number of element positions, their coordinates, and predict the possibility of what the student will show when clinging to a particular surface on the web page where the map is displayed. Additionally, interactivity should be enabled in the selection of larger surfaces, such as globular parts, position on meridians and parallels, and the like. Special attention is paid to understanding the size of the map. In this sense, it would be desirable for the student to display maps with different sizes, and to test for calculating the distance between randomly defined geographical elements.

This is done in a paper format by giving to one group of students one scale, and the second group another scale, while in different groups cities or locations can be defined for calculating the distance between them.

Similarly, it is desirable to allow all other classic forms of interactivity with a map to select borders of states, to recognize the location of the state, the mountain, etc.

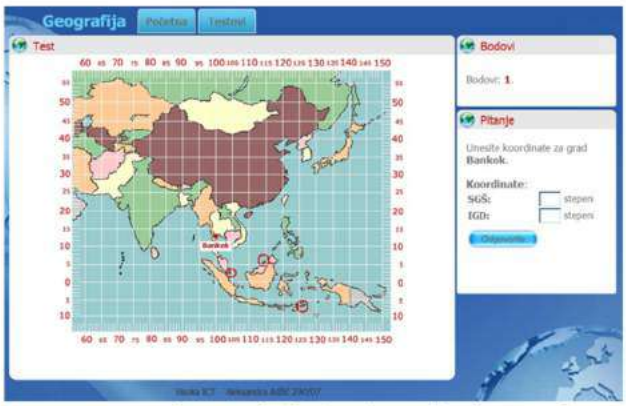

Image 1: Using specialised web application [7] for interactive discovery of position of map element

Although e-learning systems are very widespread in student education, and although these levels of achievement are foreseen for the largest student population, they cannot currently be implemented in classical e-learning systems.

Some of the solutions to this are the specialized and dedicated solutions of software and websites that offer these features [7]. The concrete solution presents the possibility of interactively defining the position of a city with a defined geographic length and width, to locate the area or parts of the map elements and the interactive exercise of the use of the scale, image 1 and image 2.

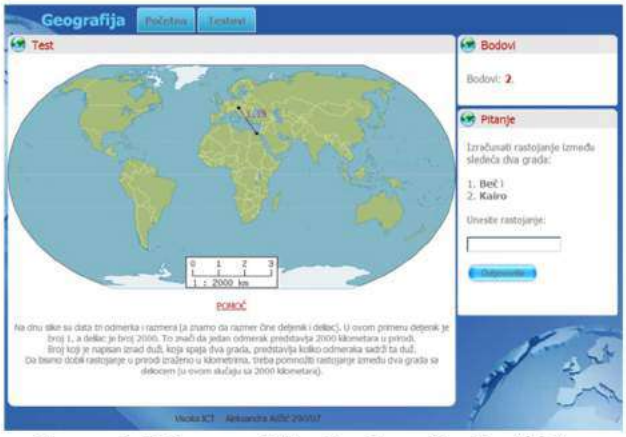

Image 2: Using specialized web application [7] for interactive work with map scales

Such software solutions are good and solve all the practical requirements that are required for learning and testing students in the Geography subject, but they have their own shortcomings that are in fact the benefits of e-learning system:

- do not have centralized student entry, which is assigned to all subjects by entering it into the application
- do not have administrator support in terms of graphical tools, user management, notification, etc.

- are not intended to work with a large number of users in terms of optimizing server resources
- the data, i.e. the results of the work can be difficult to reconcile with the data formats of the same students who listen to other subjects through a standardized e-learning system
- require students to have different tools, environments and codes when working on a group of other subjects and the subject of Geography

Therefore, it is very important that the classic e-learning system enables the development of additional code, in the form of specialized additions or new versions, which is already in use, quantitatively and qualitatively improved, and enable the unimpeded realization of content creation and continuous quality testing students. In particular, this interactive work in the graphical environment would further motivate students to master these learning units and adopt them with the expected levels of achievement.

4. CONCLUSION AND FUTURE TRENDS

E-learning systems must be improved to keep pace with the development of technology and student habits. For this purpose, it is necessary to consider the specificity of individual subjects and to make these specificities in the way that material is presented and testing implemented to support the learning process. In this paper, we have demonstrated, on the example of geography, the need to consider and implement the specificity of the subject in e-learning systems. It is recommended to develop add-ons to available LMSs, that can be developed separately as example of web application for geography [7], to improve the existing e-learning systems. Further research should be related to particular subjects and how to use interactivity to give the best results in the process of material mastering.

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THE DEVELOPMENT OF ELEARNING AND ITS ROLE ON IMPROVING THE EDUCATIONAL PROCESS IN THE REPUBLIC OF SERBIA

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Abstract: *The aim of this paper is to present the impact of eLearning on the overall educational process in the Republic of Serbia. As to improve the process itself there is a necessity for continuous developments in the field of eLearning and its implementation. In this paper we will analyze the state strategies, recommendations of regulatory bodies in regards to eLearning, as well as the threats and expences that might be encountered in the implementation of eLearning. Moreover, a research conducted amongst the students of a university in Belgrade and their eLearning preferences, has an aim of determining whether the eLearning implemented goes in line with the needs and preferences of students or are they neglected and the eLearning developments concentrate mainly on the IT novelties regardeless on the needs and wants of the end users-students.*
Keywords*: eLearning, education strategies, eLearning in Serbia, student preferences*

1. INTRODUCTION

The process of education is considered today as one of the core elements of society and presents the foundation for its progress and development. [1] This paper aims to draw attention to the importance of continual developments of eLearning in reforming the educational process. In this sense a research conducted amongst the students of a university in Belgrade aims to demonstrate whether the students preferences and needs are considered when enhancing the eLearning or is the emphasis solely on the IT developments.

2. ELEARNING AND STRATEGIES OF ELECTRONIC EDUCATION IN THE REPUBLIC OF SERBIA

The internet as a new medium has become a crucial part of our everyday lives and has given space for new information and knowledge. One of the main reasons for developments within the educational system is due to a shift from traditionaly-closed education to an approach where the student has become the center of attention. [2] An essential characteristic of e-learning is that it can't resolve all the problems that exist in traditional education but can give contributions to the traditional teaching techniques. [3] It is important to say that distance learning and the eLearning are not implemented to their full capacities in our region as they are in the rest of the world. Unlike, the western countries which have a long tradition and are prone to developments in the educational processes including the eLearning, introduction of eLearning in our surrounding was on a case to case basis and we can even say that it was a result of enthusiasm of individuals rather than a systematic framework. [4]

The eLearning in its essence is a non standard approach to education with an emphasis on the content rather than the form and for that reason we can say that there is no surprise as to why it was not implemented in our region. As Radovic-Markovic and Bodroski-Spariosu [5] mention in their study, Serbia does not have broad experience deploying online education and virtual faculties. The main characteristic of educational systems in Southern Europe is the continuous persistance on fulfilling a particular form. For that reason any other forms of education were perceived as a threat to the existing system. In the past the implementation of IT techniques within the educational process was limited to individual projects. Of course, this was in the past. Nowadays, most of the educational institutions implement new technologies and the internet network has become widely accessible throughout Republic of Serbia.

Implementation of e-learning in universities should be viewed as a part of the educational reform. For e-learning to be efficient and effective, a great deal of care and attention needs to go into its implementation. [6] It is very important to say that the implementation of eLearning is not a simple process and cannot be observed solely as to the investments in staff training and equipment. The main prerequisite for successful eLearning is that the projects are fully supported by relevant institutions. Besides the institutional support other essential elements are the finance, tehnology as well as organizational support.Based on this claim a conclusion arises that it is necessary to fulfill all the previous criteria in order to achieve greater IT involvement within the educational process. [4]

Most of the developed countries along with R. Serbia have adopted educational strategies that define their framework as to further developments in the field of education. Many of the schools and universities have the autonomy/freedom of choice as to the implementation of eLearning or the IT in general.

The law stipulating the educational system of RS [7] states that achieving the general outcomes in education is accomplished by the overall educational process at all educational levels and by means of various teaching

methods. The educational standards further include the techniques and skills required by the individuals who hold posts as professors or teachers. The same document stresses the following as the most essential in the educational process:

- Getting high quality knowledge and skills that subsequently allow for developments of stands in various spheres of life and education such as the linguistics, maths, science, culture, tehnical, IT or others that are vital for functioning of an individual in a modern society.
- Capacity development as to the implementation and analysis of information along with an adequate knowledge of IT technologies.
- Developing key competencies essential for functioning in a modern society as well as being trained and skilled for particular professions. Furthermore, developing professional competencies required by the scientific, economic and other spheres of life.

The educational strategy of the Republic of Serbia until 2020 stipulates the use of IT technologies and various, education methods in -*online* surrounding (such as: e-conferences, blogs, electronic tests), as a foundation in achieving better quality of the educational process. The strategy also deals with the possibilities of proposing distance learning and the eLearning. [8]

The national youth framework in the Republic of Serbia gave as a non promising insight as to the IT knowledge amongst youth. Based on the findings and statistics in the framework conducted by the Institute of Psychology, 85% of the high school students have computer access at their homes but as to the use of computers at schools they can only use them on their IT courses once a week. Moreover, the students acquire computer skills by themselves and this shows that there is a lack of systematic approach of the state and respective ministry in regards to the IT. As a result of such disturbing findings the aim of the strategy is to raise the degree of IT knowledge amongst youth. Some of the measures proposed by the strategy are [9]:

- Increasing access and training to all categories of students-financing IT training and seminars;
- Providing internet access and cable tv to all categories of youth;
- Allowing internet access in all the schools as well as other cultural institutions.

The strategy implemented by the IT society adopted in 2010 offers some sugestions as to the eLearning [10]:

- Introducing a modern eLearning concept and open distance learning;
- IT has to be an integral part of the educational system;
- Study programmes and teaching processes must be adapted to the needs of the IT society and the teaching staff has to be trained for modern educational processes;
- Development of life long education.

It is very important to say that the institutional framework for the development and advancements of Elearning in Serbia is not adequate. The reason for such claim could be supported by the fact that the educational system of Republic of Serbia gives recognition to such an institute but at the same time lacks the provision of strong and systematic support.

3. DIFFICULTIES AND EXPENCES IN THE IMPLEMENTATION OF ELEARNING

Various international and local researches [11] [12] have shown that there is an insufficient quality of knowledge amongst students coming from the Republic of Serbia due to the reproductive knowledge approach [13] and the lack of individual researching. This means that there is a more indepth need towards systematic changes rather than just the formal changes of the teaching materials themselves. We can conclude that there is a necessity for a didactic modernization [14] as well as the inovations in the methodology of teaching. Each particular teacher or a professor at any level of educational system should possess wider knowledge and skills in order to lead the educational process in a successful manner. Their knowledge should not be limited solely to their particular subjects of expertise. Such skills may be reffered to as the general teaching competencies and they relate to various items such as the knowledge, skills, principles of ethics and motivation in order for them to be successful in their line of work. [15]

This raises a very important issue on the competency of the teaching staff for further developments of eLearning. A successful teaching process embraces the didactic-methodic approach, and is constituted of very complex criteria for assessment of teachers/professors and their competencies. The eLearning requires that the teaching staff has a wide spectrum of skills and knowledge put together with an aim to improve the overall educational process. The teaching staff must know what are the methods and approaches to students that give the best results in particular cases. Moreover, the teaching staff has to gain additional competencies as to adapt the teaching materials to current developments of science for their students. [15] There aren't any particular researches in the RS on this particular topic but we can conclude that the adapting of the existing teaching staff for further developments in the eLearning is a problem that is unlikely to be solved. In that sense it would be good if more research is done on that topic and the results gathered could be very useful when adopting future strategies and approaches in regards to the eLearning.

The eLearning also brings certain risks in regards to the education process, such as the fraudulence on exams as well as awarding appropriate diplomas (there should be a distinction amongst traditional and eLearning students). Such problems shouldn't be neglected since there is a latent possibility of fraud while taking an online exam. According to [16] issues that might be raised are as follows:

- inability of student identification;
- using literature without consent;
- use of innapropriate technical devices.

These items clearly point out to dimensions of this problem and the reasons why the electronic education is often criticized. There are a number of alternative solutions to this problem. One of them is the possibility of organizing routing via video link. This method involves provision of additional technical equipment, which will not present a problem on behalf of the educational institution, but a major expense for a student. However, we should bare in

mind that possible cases of fraud/dishonesty cannot be fully resolved but the possibility of their occurrence can be reduced. Another solution to this problem is the current hybrid model of eLearning implemented at Belgrade Metropolitan University (BMU), where as the student completes his/her course prerequisistes on the e-platforms but takes the final exam at the premises of BMU. This reduces the possibility of fraud/cheating on the exam. Differentiation amongst diplomas traditional and elearning could be another solution as proposed by Medan [16]. It is essential to say that according to the Law on higher education of RS, diploma acquired over the Internet is completely equated with the one acquired on traditional teaching as to acquired skills and knowledge.

If we look at the eLearning in a long term the advantages of such an educational approach are as to the financial savings in the long run. What should be mentioned is that the start up of eLearning might be very expensive. When we refer to the expences we consider the following [17]:

- setting up e-learning systems;
- provision of suitable teaching curricula in an electronic form - as for a successful completition there is a need for a larger number of teaching staff, softwares, hardwares and other it components;
- provision of servers and their maintainance since this is where all the teaching materials are kept.

4. APPLICATIONS OF E-LEARNING IN THE REPUBLIC OF SERBIA

At the level of the Republic of Serbia there are currently no significant researches that would have allowed us a comparative analysis of the effects of e-learning and the classical model of education. For this reason, we must tackle with the previous analysis of e-learning, mainly conducted at the level of individual higher education institutions.

According to Stojadinovic, Ilic and Mihajlović [18] from the Faculty of Management, former Megatrend University, a pioneer in distance learning in the Republic of Serbia was the University of Belgrade Faculty of Economics, and since 2004 other educational instutions such as Faculty of Organizational Sciences, Civil Engineering from Subotica, Business Academy in Novi Sad, and then Megatrend University, now University John Naisbitt have introduced eLearning.

According to the provisions of the Law on Higher Education of RS from 2005, diplomas and degrees obtained in traditional and internet classes were equalized, and therefore the Metropolitan University, ie. Faculty of Information Technology was the first to receive the accreditation for eLearning.

The distance learning at various higher education institutions in Serbia involved the techniques of e-learning such as: participation in the educational process, meeting the pre-exam and exam preparation via Internet, which means that the students gained the same forms of educational processes that were intended for students who have the education in classical model.

The lectures were followed via multimedia, text and audio contents in the form of lectures and exercises. It was expected that the system was to integrate multimedia presentations and interactive content exercises, but also at the same time to communicate with teachers and colleagues via email, forums and Skype. In regards to the rights and obligations of students' studying at distance learning' they were equated with self-funded students-category. It is important to mention that the difference was that the distance learning students at state owned faculties were unable to attend classes and take the preliminary exams prior to taking the exam at the university premises.

All the students who met the exam requirements could move on to the next school year and get a status of budget financing studies-applicable only at state owned universities. At the state owned universities the remote-distance learning students were enrolled under the same conditions as the other students, respectively, after a single ranking, based on their entrance exam. Depending on their ranking placement, students mode of study was established: budget, self-financed or "remote". At private universities distance learning is solely financed by the candidates themselves with certain tuition reductions/respective faculties hence the price presented a disadvanatage for candidates that would enroll into the eLearning. This type of study has proven to be suitable for students from abroad or inland, as well as for employees who are unable to attend classes regularly at the university.

V. Milicevic, Z. Milicevic and Ilic [19] suggest slightly different information as to which higher education institution was the first to implement eLearning in Serbia. According to them, a pioneer in this field, was the University of Belgrade School of Medicine since it started with its first online courses in the 1999/2000 school year. In that particular year 19 students had the opportunity along with the traditional classes, to follow lectures on histology, in a more different way, by using a web site where they were able to view a large number of courses, lectures and exercises, and e-mail address was used as the main form of communication between students and professors.

In the following years, other forms of distance learning were offered such as blogs, forums and mailing lists. All these advancements in a more modern approach to learning by the School of Medicine culminated with the Moodle introduction which at the time was the best software solution. According to the data presented by the School of Medicine the number of students that used distance learning and passed the exams is above 350. [19]

A great contribution to the development of e-learning in Serbia was given by the Academic Network of Serbia - AMREC, which is a leading research and educational computer network in the Republic. It was established in the early nineties, and started by networking several universities in the country, and today it connects more than 150 educational and research institutions. [20]

5. RESEARCH METHODOLOGY

The method used in the theoretical part of the paper was descriptive-speculative, whilst the research itself concentrated on the transversal study and was

predominantly empirical. The research was conducted at Belgrade Metropolitan University in the period between the 19th to 25th of August 2017. The target group of the research were the students at BMU, on various study programmes as well as different years of study. Moreover, the participants of the research were both the students of undergraduate studies and the postgraduate-master studies at BMU. It is very important to say that BMU offers two modes of study: traditional - in-class and internet studies – distance learning. An important common denominator for both the traditional mode and the internet is the use of the same eLearning platforms in the studying process. For the purpose of this research a descriptive technique was selected and hence a questionaire was designed accordingly. A sample of the questionaire can be viewed at https://docs.google.com/forms/d/e/1FAIpQLSfbA-zXwNcoyh8bgyn1EH3ikDiZJPzYzmiT8mulq9TVWwBaxA/viewform, and the same was sent to the students at BMU. A simple random sample was used, which means that every participant had an equal opportunity to be included in the sample and all the students of BMU took part as a basic set, to an adequate extent as to their characteristics, thus enabling the sample to be representative. The sample contains 296 participants in the research - students at BMU and the statistical error is 4.7%, while the data was collated and processed with the use of SPSS as well as the descriptive and comparative statistics (X^2test, t-test, regression and correlation).

6. THE RESULTS OF THE RESEARCH (DESCRIPTIVE AND COMPARATIVE STATISTICS)

The results of the research have established a link between the mode of study (traditional, internet) and the employment amongst students, but the correlation of other variables was not as strong. Hence we can conclude the following: the internet students are not always employed full time, whilst some students attending traditional mode of studies are employed full time (50% of the internet students are employed full time while only 17% of the students on traditional studies are employed). Generally, 31,1% of the BMU students are employed full time, and the internet studies at BMU enable them to work and study simultaneously. The majority of the participants in the research stated that they prefer communicating with their professors via mail 66.2%, while 32.4% of the students opted for face to face communication with professors and only 1.4% via Skype.

There isn't any significant statistical difference as to the response of BMU students at all study levels (undergraduate studies and the postgraduate-master studies) towards the statement or the question is *the eLearning a more useful tool in the studying process than the old fashioned text books*. According to the results of the research the students at all levels at BMU stated that the eLearning is more useful than the text books - most responses were a 4 on a 1-5 scale, whereas with 1 the participant states disagreement with the statement and the 5 demonstrates full support. It is very important to say that 48% of the undergraduate students and 57% of students at master studies have said that they agree fully or to great extent with the statement. Moreover, there aren't any statistically significant differences amongst the students coming from different faculties within the BMU university, coming from various study programmes, methods of study or year of study. What is essential to be mentioned is that there was a statistically significant difference as to the gender of the students (t-test; Sig=0.02<0.05). According to the results 54% of the male students agree fully or to great extent whit the statement that the eLearning is more useful than learning from text box, whilst 41% of the female students supported the statement.

Table 1: Distribution of respondents (in %) according to responses as to degree of agreement with the statements about eLearning

Questions in the form of statements that were evaluated by respondents	**I totally disagree**	**I mostly disagree**	**Neither agree nor disagree**	**I mostly agree**	**I totally agree**
E-learning is a more useful form of learning than learning from printed books.	10,8%	14,9%	25,7%	35,8%	12,8%
E-learning was a predominant factor when enrolling into studies at BMU	31,1%	22,3%	11,5%	14,2%	20,9%
The eLearning satisfies my needs.	9,5%	16,9%	25,7%	37,8%	10,1%
I use only the study materials in PDF format when I'm studying.	12,2%	16,9%	17,6%	22,3%	31,1%
When I study, I like to use the study materials divided into smaller sections.	15,5%	13,5%	20,9%	29,1%	20,9%
I watch audio-visual content in lessons. (Youtube)	27,7%	20,3%	16,2%	16,9%	18,9%
I access to my student e-mail (Zimbra) via my mobile phone.	17,6%	6,8%	10,8%	20,9%	43,9%
I access elearning via mobile phone and I use the phone for learning purposes.	58,1%	19,6%	8,8%	6,1%	7,4%
I learn via eLearning platform, from electronic lessons.	28,4%	20,9%	18,9%	20,9%	10,1%
I learn exclusively from the lessons I have previously printed.	34,5%	15,5%	15,5%	16,9%	17,6%

There is also a statistically significant difference in the response of undergraduate and postgraduate students as to the claim that *the eLearning was a predominant factor when enrolling into studies at BMU* (t-test;

Sig=0.02<0.05). The students at master studies 85% agree fully or to great extent, while at undergraduate level most of the students claimed that they fully disagree or disagree with great extent (32% fully disagree and 23% disagree to great extent) that the elearning had an impact on choosing the studies at BMU. This can be explained if we take into consideration that the students at masters level are predominantly older, and employed and to them the eLearning presents a useful tool for studying. There is a statistically significant difference in regards to the response of traditional and internet students (t-test; Sig=0.00<0.05). Amongst internet students 62% agree fully or to great extent, while we encountered a reverse situation with traditional students out of which 73% stated their full or partial disagreement with this statement. We have established a correlation as to the observed variables; the age of students and their response to the statement that the elearning was one of the reasons for choosing studies at BMU (Sig=0.00<0.05; Pearson Correlation=0.52). Older students meaning 28 and above stated that the elearning was one of the reasons for studying at BMU, while the younger students didn't support the statement. The correlation of observed variables is medium and positive, which means that when students are older (with increasing the age of students), support towards the claim that the eLearning was one of the main reasons for studying at BMU is stronger.

There are no signs of statistically significant difference in response of the students at various levels of study, different faculties, study programmes, mode of study, year of study and their gender as to their perception whether *the existing eLearning at BMU satisfies the needs and expectations of the students*. A large number of students at undergraduate studies (38%) gave support for the claim that the existing eLearning satisfies their needs.

As for the statement - *when I study, I like to use the study materials divided into smaller sections*, there is a statistically significant difference in response based on the mode of study (t-test, Sig=0.01<0.05); most of the internet students (65%) agree with the claim, while only 37% of traditional students support the claim.

There is also a statistically significant difference in response of the students of different faculties within the university to *studying solely from printed materials* (t-test, Sig=0.00<0.05). The students at the Faculty of Management opted predominantly to studying from printed materials (59%), while the percentage was lower on the Faculty of IT (42%) and Faculty of Digital Arts (39%). It is important to say that the techniques differentiate on the three faculties due to the nature of studies hence the approach to studying is different. There is also a statistically significant difference in regards to the gender of the students involved in the research, where the female students use mostly printed materials 43%, and only 27% of the male students do the same.

There is a correlation between observed variables, that the eLearning satisfies the needs and expectations of students and that the students:

- study predominantly from the PDF files (positive and weak; Sig=0.02<0.05; Pearson Correlation=0.20),
- study from materials divided into sections (positive and weak; Sig=0.01<0.05; Pearson Correlation=0.23),
- use the audio-visual contents as study materials (positive and weak; Sig=0.02<0.05; Pearson Correlation=0.19),
- study by using eLearning materials - lessons in electronic form (positive and weak; Sig=0.00<0.05; Pearson Correlation=0.33).

On the basis of such results we can conclude that those students which have a positive attitude towards the existing elearning at BMU, use its advantages to a full capacity and hence believe that the elearning offered satisfies their needs and expectations.

When looking at *the advantages* of the current eLearning, the students place a particular emphasis on the access to all materials that they need for exam, 24/7 on any destination in the world. Other important advantages are the clarity and easy access to searching materials as well as the satisfaction of users who claim that using eLearning enables them to fulfill course requirements more easily and efficient. According to the experiences of eLearning users, there are also some *weaknesses* to the eLearning such as the lack of study materials in audio-visual form - many students claim that this would allow them to study more efficiently and effectively. Another suggestion given by students would be allowing the online students to follow in class lectures over electronic systems, thus enabling them to have the feeling of being a part of in class lectures. As the weaknesses of the current eLearning students stated the problems with division of lessons to smaller sections, which takes more time in opening and closing previous sections, along with additional questions at each section. The technical aspect was also noted by students in particularly when accessing the eLearning and completing the online tests, along with the problems that might arise due to the loss of internet connection. This is particularly important when doing the online tests, if you lose your internet connection. Some of the other critics to eLearning were due to the fact that in order to access new materials all previous chapters must be completed and students cannot highlight parts of the text. A very important suggestion given by students as to the elearning at BMU would be creating the course materials in mp3 form which would allow students to follow the lectures while performing various activities in their everyday surrounding.

7. CONCLUSION

We live in a time of rapid development of IT that intervene with the traditional education processes, and constantly brings novelties. The perception of the traditional learning process changes and the mentor nowadays is not only responsible to simply pass down the facts and data to a student but at the same time must create a value. A successful component of quality eLearning is professional teaching staff along with an up to date technology. Despite the fact that it seems common that in practice the students are more aquainted with computers than the professors it seems as if the competencies are not the greatest obstacle to the eLearning process.

What seems to be a greater obstacle is a lack of the institutional strategy and framework for the implementation of new technologies into the educational process. A stronger support should be provided by the official institutions in terms of the finanaces as well as the organizational-technical part. This would allow space for a systematic introduction of IT technologies into the educational process in the Republic of Serbia. The institutional support has to create an atmosphere for successful implementation of eLearning through continuous teaching staff trainings as well as organizing systems of technical support. The overall process of eLearning is very important since the sooner the novelties come into place-educational system- the sooner we will adapt to them.

Each system has its advantages and flaws, but should always strive towards continuous development in particularly with the needs and expectations of the end users - in this case the students. It is needless to say that the efficiency and effectiveness of a system goes in line with the satisfaction of the students and in our case the eLearning. Based on the results of the research about a half of the students at BMU believe that eLearning is a more useful way of learning in comparison to the traditional text books. They also believe that the current eLearning satisfies their needs and expectations and that they use its tools to a full capacity. On the other hand, we have the second portion of students at BMU which show a lower degree of satisfaction with the eLearning. One of the major sources of discontent would be the lack of lesson materials in audio-visual form, which existed in the past eLearning platform. Since there were changes as to the eLearning platform we can conclude that the needs and expectations of the end users-students are not always taken into consideration. Arround 35% of the students at BMU, mostly from the Faculty of Management, prefer to study from previously printed materials in a hard copy, hence we can conclude that some of the habits cannot be changed easily despite the developments in the field of technology and eLearning, and its more efficiency methods for work. As for the eLearning via cell phone, we can conclude that 78% of the students don't have a habit of using their cell phones for learning, but 65% use them in communication with their professors.

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A CRITICAL ANALYSIS OF A DECADE OF USING THE MOODLE PLATFORM IN ARCHITECTURAL EDUCATION

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Abstract: *The paper gives a critical analysis of a ten years long period of using the MOODLE platform to support teaching at the Faculty of Architecture, University of Belgrade. Methodologically the study is based on the content analysis. The paper begins with some statistical examinations, illustrating trends in using the Moodle platform for different courses and the various pedagogic modes. After explaining the basic pedagogic concepts of architectural education in core of which stands design studio, the paper continues with an overview of various modes of MOODLE application that occurred in the recent ten years. The study results in a selection of pedagogic modes that have been particularly useful in the observed period, some of which that could be applied in other fields of teaching engineering sciences or arts. The paper concludes with a discussion of features of the MOODLE platform that could be further developed in terms of meeting more specific needs of architectural education and contemporary education in general.*

Keywords: *architectural education, pedagogic modes, MOODLE platform*

1. INTRODUCTION

Architectural education at the Belgrade University has a long tradition and in 2017 it celebrates 170 years [1]. The teaching methodology has been changed and improved according to many influences including technological development.

A big part of the actual generation of teaching staff completed their studies and started their professional carriers with no computer using[1]. Today, however, it would be difficult to even imagine a course with no some kind of digitized contents, be it lectures presentations, drawings, maps, images of building sites, as well as students' assignment submissions.

A need to introduce some e-learning aspects in traditional teaching contents stands in the essence of architectural education, based predominantly on visual materials or other kinds of materials (e.g. physical models) that can easily be transformed into images. In traditional architectural education such materials were present in the design studio[2] space and visible to all participants in the design process. That way the group of students is stimulated to behave as a learning community. This is especially important during the design interim and final critiques. The studio physical spaces are, however, too busy during the semester, so exhibitions of students' designs last sometimes just one day. The teaching staff felt that it is e-learning that could complement the physical, face-to-face teaching modes, by adding some solutions like virtual exhibition spaces and the like.

A possibility to directly manage course contents, without the help of a Web master was the second equally important motivation for teaching team to start to search appropriate e-learning solutions.

The less important and relatively recently introduced was an intention to create tests and examine students' achievements using e-learning systems[3].

Having in mind these basic intentions of architecture teaching teams, it is evident that it is going on the blended teaching mode, rather than on an online learning. The recent decade shows that architectural education still relies on the basic principles of the traditional face-to-face education, and that e-learning could significantly complement this kind of teaching.

2. THE E-LEARNING SUPPORT BEFORE MOODLE

[1] The Author was the first student to implement CAD in her diploma work in 1991, awarded by University of Belgrade as the best diploma work in the field of architecture in the scholar 1991/92.

[2] The term "design studio" is equally used for the physical space in which de design is taught, and for the teaching mode where the teaching team works with small student groups on an assigned design project. For more see [2].

[3] For examination this feature of e-learning is practically not possible, since the computing lab does not exist anymore and the students bring their own notebook computers. It is therefore just testing done from home that rests as a solution.

First steps in e-learning at the Faculty of Architecture were done in early 2000ies.

Blackboard

After lecturing at the UNITEC Institute of Technology in Auckland, New Zealand, where Blackboard course management platform supported e-learning [3], the Author of this study tried to get the similar support at the Belgrade University. In that time the Belgrade University was far from the idea to make any investment in e-learning and the rare examples of this method of teaching relied on enthusiasm of a couple of academics. On the other hand, once developed and acquired the methodology of e-learning, for the Author it was impossible to step back and teach only based on traditional methods.

First versions of online support was realised by using the Blackboard free trial course, lasting maximal 90days. This system was applied in elective courses with up to 30 students. Since it was not enough to cover full semesters, this solution was just partly suitable.

Archnet Workgroups

The second stage of introducing e-learning was supported by Archnet [4], a virtual environment dedicated to architects, architecture students and teachers worldwide, situated and edited at MIT (Massachusetts Institute of Technology). Among other features, Archnet had group workspaces (workgroup), suitable for some blended learning activities. The most important activity required by Belgrade Architecture Faculty was forum, in which every student had a possibility to post small textual message and an illustration. This platform was equally suitable for small groups of students (up to 30 at the elective courses), and for big groups (of nearly 300 students in core courses). After several years of using Archnet workgroup, the Archnet editors decided to make some changes of the system, so the blended teaching could not entirely rely on the Workgroup. It was necessary to search for some new platforms that will meet requirements of an already developed teaching methodology.

An in-house programmed e-learning system

In the year 2006, the Author started to be in charge for editing institutional Web site and to lead a programming team that supported Web publishing. The programming activity behind the Web site allowed a possibility to create a learning environment, powerful enough to support teaching activity not only of elective courses, but of core courses with approximately 300 students enrolled. Although fully functional, this system made a huge pressure on institutional servers and invoked complains of system administrators that were not ready for any publishing by students on the institutional Web server. It was again obvious that it would be necessary to find a more sustainable e-learning system.

3. INTRODUCTION OF MOODLE

Having a long and reach experience in blended learning using various platforms, the Web team from Faculty of Architecture was recognized by the University of Belgrade Computing Centre (RCUB) as a good partner to develop a strategic approach towards a comprehensive solution for the e-learning support to entire community of the state academic institutions (AMRES). Since the budget for this did not exist, an emerging open source solution was a logical choice, and MOODLE[4] was the platform [5] with many positive features:

- Functionally meeting requests of blended learning
- Already used by many academic institutions worldwide
- Free to download and install
- Already successfully used by Medical Faculty of Belgrade University [6]
- Wide community of users well spread in user groups ready to share technical and practical usage experiences

Installation of the MOODLE platform by the Computing Centre of Belgrade University [7] (**Image 1**) had several advantages:

- Availability to all members of Serbian (state) academic community
- Centralized server space and maintenance
- Supported by introductory trainings
- Regular update to new versions of software

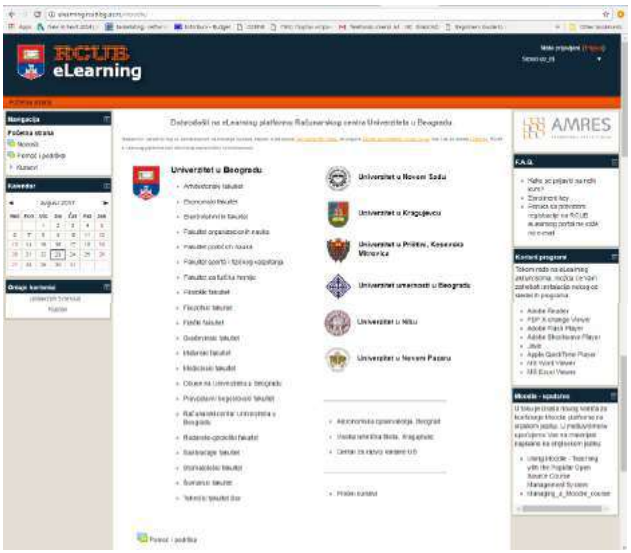

Image 1 The entry page of the RCUB e-learning portal [7]

[4] MOODLE is used as an acronym for modular object-oriented dynamic learning environment.

For the Faculty of Architecture, shift of the e-learning platform to MOODLE meant new challenges but for the first time an institutionalized e-learning solution, sustainable in terms of preserving courses, maintaining and tuning according to specific needs of architectural education.

4. OVERVIEW OF ACTIVE COURSES IN MOODLE IN LAST TEN YEARS

After creating initial courses using the AMRES MOODLE platform, it was evident that two systematizations will be needed to introduce. First systematization of the courses by faculty was introduced with aim to distinguish which course belongs to which faculty. Once having created separate category of courses for the Faculty of Architecture it was necessary to establish a chronological structure of courses by school year. This was important from the very beginning because there was a request from one teaching team to create an archive for the course taught in precedent school year. The main reason for this was the feature of MOODLE based course to be locked from public access and available only to the designated students.

Table 1 Number of courses and participating students per school year

School year	Number of Moodle supported courses	Number of students - participants	Number of courses with student activities
2007/2008	1	300	0
2008/2009	2	60	2
2009/2010	7	3x300 3x30 1x0	4
2010/2011	18	5x300 13x30	9
2011/2012	11	4x300 5x30 1x40 1x15	9
2012/2013	17	4x300 11x30 2x0	10
2013/2014	19	4x300 11x30 1x6 3x0	6
2014/2015	13	2x300 11x30	8
2015/2016	11	2x300 9x30 1x25	10
2016/2017	6	2x300 4x30	5

In the **Table 1** it possible to follow the progres of MOODLE usage from schoolar 2007/08 to 2016/17 (Column 1). In the table we have analysed total number of created courses, despite the fact that some of the courses remained empty or teaching team have removed the contents (Column 2). In the Column 3 it is visible an approximate number of students enrolled. Here we could distinguish the courses offered to whole generation (approx. 300 participants), the elective courses (approx. 30 students) and studio (approx. 5 – 20 students). In the last column it is given the number of courses in which an active participation of students was expected.

5. TYPES OF COURSE CONTENTS

According to the contents, there are several types of MOODLE based courses:

- Courses distributing teaching materials
    - Distributing lecture presentations week by week
    - Distributing initial course materials (for example for studio projects)
    - Distributing information on the course progress (for workshops and studio projects)
- Courses including student activities
    - Student activities based on discussion forums
    - Student activities based on assignment submissions
    - Student activities based on tests

*Distributing presentations for lecture based courses***.**

For the lecture based courses, an opportunity to manage course contents in a password controlled environment without a help of a Web master, was a motivation to start to use the MOODLE system. This is regarded as a very basic usage. An interesting request came from the teacher that wanted to create such course for the previous year, so despite the system started in 2008/09, there is a category of courses for 2007/08 containing only one course, but available to a whole generation of approximately 300 students. Despite the fact that all lecture presentations are given to the students, the virtual content cannot replace a face to face teaching, so this group of courses still belongs to the blended learning courses. With adding some textual contents or video material complementing the presentations, and creation appropriate activities, such courses have potential to become real online courses.

Distributing materials for studio project

Another group of MOODLE based courses was created for the so called studio project, a teaching mode that stands in the very core of architectural education. Unlike the lecture based courses that could be replaced with online contents, the design studio requires phisical presence of all participants, both teachers and students. Contemporary design studio, however, relies on reach multimedia

contents, including digital imagery, maps, CAD drawings, video sequences, etc. Using the MOODLE based environment for distributing such contents could be called “blended 1“ or “basic blended“ level since it does not include any interaction with students. The contents of such course has been built at the beginning or even before the studio project starts and does not change during the semester, so it is often visited in first couple of weeks, and is not visited as the end of semester approaches.

Following progress of courses

Similar to the previous group of courses stands the one supporting the studio project teaching, also distributing the studio materials, but following the student work during all semester (**Image 2**). Since the students in the design studio produce mostly visual materials – sketches, drawings, maps, physical models, etc., and present them in the form of studio presentation available to all participants, teaching team produces photographs and video recordings of the most interesting moments of these presentations. Recording, publishing and commenting of interesting moments is a time consuming activity for teachers, but works as a motivation for participating students and serves as a record of applied methodology. This type of courses still does not presume any activity for the students except following the distributed material.

Image 2 Fragments of the virtual environment for the Workshop ”Integrative Urban Design” led by dr Tatjana Mrđenović

Courses based on discussion forums

First in the group of courses in which an active participation from the part of architecture students is expected are courses with activated discussion forums. To this group of courses belong equally the core lecture based courses offered to whole generation (approx. 300 students), elective courses (20-30 students) and studio project courses (5-20 students). The methodology of using a discussion forum in the blended learning mode comes from experiences with the Blackboard platform, as well as with the workgroups available in Archnet environment. The type of forum applied in majority of courses is the so called “single simple discussion”, in which a teacher posts the task and the students post replies. The most important feature for application in architectural education is a possibility to illustrate the discussion forum post. Using such forums in which an initial post, as well as all levels of reply could be illustrated, offered a possibility to work with large groups of students, i.e. with entire generations. This required a special kind of tasks, response to which needed to be unique and visual. Using this teaching technique the following courses have been realized [8], [9]:

- Mathematics in Architecture 1
- Mathematics in Architecture 2
- CAAD Principles
- …

In these courses the discussion forums have been set week by week, following face to face lectures. In the mathematics courses the students were required to apply a mathematical concept introduced in the lecture for particular week and to post a 2D image or 3D presentation of their own creation according to a given concept. Such visual material has several advantages:

- It is easy to comment and mark
- It is transparent and visible to all participants in the learning process
- It represents a virtual exhibition of student creations that could be preserved long time after the course realization
- It is part of a digitized archive of the course that could be used in other courses or as other kind of teaching object
- Stimulates students to work better due the fact that their creation will be widely visible

There are also some disadvantages of using forums in MOODLE:

- It is not possible to preset the size of illustrations[5] as it was in the Archnet workgroup and the in-house course management system.
- The grades are not visible to all students, so they are unable to see the numerical feedback to all posts[6].
- When applied to the courses with a lot of students it would not be possible to give a textual comment to majority of students' posts.

In this teaching mode especially important were first 10% of student posts, usually posted by the best students that indicated a quality of the assigned topics. These first replies and possible comments significantly influenced the rest of submissions.

Particularly interesting is using a MOODLE course in which communication with students is based on discussion forum, in the studio project [10]. The posts in the week by week forums follow the development of the student projects from the very beginning to its finalization. The availability of all design stages of students' projects in a digital form makes easier to the teaching team to choose the best designs for a possible virtual exhibiting. On the other hand, appearance of student works in the virtual exhibition, similarly to real world exhibition stimulates students to work with more energy [11].

Image 3 MOODLE based environment supporting studio projec**t** led by prof. P. Arsić [11]

Courses based on assignments

The second kind of student activity based courses is the one with student submissions on assignments. In a careful exploration of all courses in last ten years, just a couple electives have been based on this communication method. The reason for this could be threefold:

- Architectural education, in it very sense, requires an open communication, visible to all participants
- The system of assignments and submissions is a bit more complex than the system of forums
- A usage of discussion forum simulates the system of assignments since it permits posting attachments of various formats.

6. ADDITIONALY PROGRAMED FEATURES

During the ten years of using MOODLE system in architectural education, some additional features have been programed, while some still remain to be added or changed.

At the very beginning of use, a system of alternative forums have been created, similar to the system that was created on the Web server of the Faculty of Architecture, which preceded the use of MOODLE. The system had a controlled size of the image in a student post, which made incomparable easier grading students' works. A disadvantage of this system was that it has not been connected with the system of course grades, so the marking process was longer than it was necessary. After two semesters of using this addition to the system, a shift to usual forum has been done.

Another addition was made by programming a real time chat window (block[7]), allowing exchange of short textual messages among online users. Unlike the similar system already available in MOODLE, this addition made possible an open communication visible to all enrolled participants. It aimed at improving a virtual presence of both teaching team and students in the virtual environment. This real-time chat, students used to ask some technical questions related to courses, but it never become a dynamic communication channel[8].

Finally an additional block supporting the striped representation of virtual exhibition has been created. The stripe consists of the virtual exhibition thumbnails, while

[5] The implication of this is that some students post screen size images that make the forum difficult to review.

[6] This requires an explicit feedback to the students' posts of a lower quality.

[7] The parts of MOODLE system are known as blocks. Such blocks are available to the course administrators and could be added to the course or not, depending on the course needs.

[8] In the meantime an efficient and intensive communication among the students started to undergo through social networks, particularly through Facebook groups that available on smart phones serve for an almost instant communication for a large number of students.

clicking on each thumbnail opens a larger image of the exhibited work (often a poster with the student's design).

There are certainly more features that could be programed in terms to support architectural education. A particular challenge for architectural education in general brings m-learning, i.e. learning supported by mobile devices.

7. CONCLUSION

The use of MOODLE content management system by the Faculty of Architecture at the Belgrade University begins a decade ago via the platform established on the servers of Comuting Centre of the University of Belgrade (RCUB), a platform available to the network of state academic institution of Serbia (AMRES). Prior to this, the Faculty members gained experiences in blended teaching using the Blackboard platform, Archnet workgroups and an in-house created platform. The advantages of using a centralised system hosted by RCUB are numerous, but the majority of them are technical – availability of significant server power and space, daily and weekly maintenance, regular system update, etc.

During the ten years the total number of courses per year, supported by the MOODLE system, varied from 2 to 19 and it was used equally for core and elective courses. It was also often used just for distribution of course materials (lecture presentations), as well as for interaction with students. The most efficient interaction module is simple discussion forum, in which students respond with textual responses and illustrations.

Initiatives for using e-learning system are coming from teaching teams, e.g. bottom-up. The use of e-learning is still not required by the school management, nor recognized as an additional workload.

In last two years the number of courses supported by MOODLE system started to decrease. Although possible reasons could be various, it is obvious that maintaining a virtual environment and introduction of a blended learning mode, in some stages of course, could require more time and effort from the teaching team. The other reasons may be in the fact that interaction among students started to be supported by social networks and is shifted from computers to mobile devices, available anytime and anywhere.

Integration of virtual learning environments and social media could challenge architectural education in the next decade. Using mobile devices instead of computers might require rethinking teaching methodology, leaving behind some routines and introducing new ones that need to be developed and tested.

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ANALYSIS AND IMPROVEMENTS OF COMPUTER-PROGRAMMING E-LEARNING SYSTEMS BASED ON „LEARN-BY-CODING“ APPROACH

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Abstract: *This paper presents and analyses existing e-learning systems for learning of computer programming fundamentals based on automatic check of problem solutions produced by learners, ie. based on „learn-by-coding“ approach. This approach has important advantages, eg. a separate compiler, additional libraries and integrated IDE are not needed at all, and the complete process of learning is performed via a web-browser. However, existing „learn-by-code“ e-learning systems have some disadvantages, and this paper analyses these disadvantages, and also describes a system for e-learning of Java, which is currently in process of developing at the Belgrade Metropolitan University, and which offers some advantages compared to existing systems.*

Keywords: *E-Learning, learn-by-doing, Codecademy, Codingbat, Java, Python*

1. INTRODUCTION

Beginner programers (students of the first year of basic academic studies), due to a lack of prior knowledge, are often met with difficulties while mastering the basic elements of programming languages such as: variables, types, logical and conditional problems, loops, arrays, methods and objects. The process of verifying the accuracy of the solution of a defined problem often surpasses the level of prior knowledge that a student has [1].

Therefore, this paper presents and analyzes the existing e-learning systems for teaching the basic elements of programming languages, based upon the automatic checking of tasks and results, i.e. „learn-by-coding“ approach. 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. An approach like this is notably easier for the teacher as well, with him having insight into the program code of solved problems.

These systems can be divided into two groups:

- Systems that enable learning from the beginning, including the theoretical part, that include the input of the entire code from the start, the adding of additional code, and the correction of mistakes in the existing code. The example of a system of this type that we will analyze is Codecademy for the Python programming language

- Systems that include defined problems and tests (without the theoretical part, or with the bare minimum of it, implying that the student possesses the basic prior knowledge) based on which the student needs to realize a method in accordance with requirements and tests. The example of a system of this type that we will analyze is Codingbat (former Javabat) for Java and Python programming languages..

This paper analysas existing systems for e-learning of computer programming languages, which are based on „learn-by-coding“ approach, and on the other hand, describes a system recently developed at the Belgrade Metropolitan University which offers some advantages compared to existing systems: a more friendly, more flexible and more comprehensive system is developed for learning of Java, and Java related courses.

2. CODECADEMY

Codecademy e-learning system [2], developed by the company of the same name, enables learning of the basic elements of programming languages, from scratch. The supported programming languages include: Javascript, Python, Ruby, and Java. Apart from that Codecademy enables learning of numerous web technologies (HTML, CSS, Sass, Responsive design), tools (Git, Command Line), frameworks (AngularJS 1.X, React, Ruby on Rails), databases (SQL) and Twitter API.

The learning path of Python programming language covers the following subjects: Python syntax (variables, types...), strings, console output, date and time, conditionals, control flow, functions, lists, dictionaries, loops, classes, objects, file input and file output.

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

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

The following image shows the described GUI:

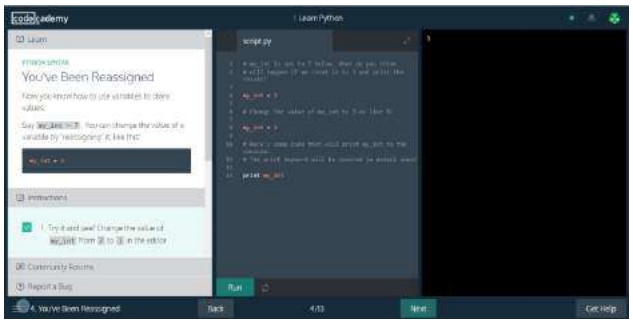

Image 1: Codecademy GUI

The advantages of this system lie in learning from scratch concept, the existence of a concise theoretical part for each subject, a rich GUI that enables the input of the entire code into the integrated editor, supplementing and correcting the mistakes of the existing code, as well as the display of the interpreted code.

The limitations and flaws that we have observed include the following: the existence of identical problems for all students, the inability of adding new problems, the inability of translating them to a different language.

Having in mind the popularity of this kind of approach in the last few years, a number of solutions emerged, listed as follows: freeCodeCamp [3], Code School [4], etc.

3. CODINGBAT

Codingbat e-learning system [5] [6], developed by the Stanford University professor Nick Parlante, enables learning of the basic elements of 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 theoretical part of each sections is reduced to a minimum, which implies that the student possesses certain prior knowledge (such as Java programming language syntax, types, methods).

CodingBat sections are listed as follows:

Table 1: Codingbat sections

Section	Description	Number of problems
Warmup-1	Simple warmup problems to get started (solutions available)	31
Warmup-2	Medium warmup string/array loops (solutions available)	17
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
String-1	Basic string problems - no loops	33
String-2	Medium String problems - 1 loop	21
String-3	Harder String problems - 2 loops	11
Logic-1	Basic boolean logic puzzles – if, else, operators: &&, ||, !	30
Logic-2	Medium boolean logic puzzles - if, else, operators: &&, ||, !	9
Recursion-1	Basic recursion problems	30
Recursion-2	Harder recursion problems	8
AP-1	AP CS medium problems	21

The total number of problems equals 281, which in our opinion enables the student to perfectly master the covered subjects. New sections include:

Table 2: New Codingbat sections

Section	Description	Number of problems
Map-1	Basic Map with get()/put() methods, no loops	9
Map-2	Maps with bulk data and loops	9
Functional-1	Functional mapping operations on lists with lambdas	9
Functional-2	Functional filtering and mapping operations on lists with lambdas	9

The total number of problems in new sections equals 36, which enables the student to master the more advanced elements of programming languages such as maps and basics of functional programming.

With CodingBat being based on solution of specific problems, the GUI is significantly more simple than in the case of Codecademy and is made out of the following elements:

- Name and definition of problems with a few given test

- Editor - an integrated editor in which the user enters the program code. By clicking the Go button, the entered code is compiled

- Output - the result of the compiled code that the user has entered, or an error message. The result is displayed in a two column table: Expected result and Run result.

With simpler problems (sections Warmup-1 and Warmup-2) there is also a Show solution button, that displays the commented results to the user.

The following image shows the described GUI:

Image 2: CodingBat GUI

Apart from the examples shown above, CodingBat contains an administrator's section that enables the teacher to review the problems being worked on by the students in detail (including the number of attempts prior to reaching the correct solution, the time of solving, the review of the program code) and the number of problems by sections.

The following image shows the administrator' section:

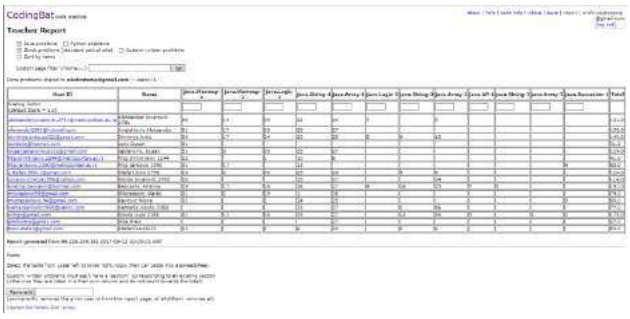

Image 3: CodingBat administrator's section

Another great advantage that CodingBat has over Codecademy is the option of adding one's own problems and adequate test that can be defined in languages other than English (in our case - Serbian).

4. DESCRIPTION OF THE E-LEARNING SYSTEM JAVA ONLINE EDITOR FOR TEACHING JAVA PROGRAMMING LANGUAGE

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 computer programming courses, especially for Java, titled: Java Online Editor JOE.

The system enables learning of the basic elements of 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 developed sistem (JOE), 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 system enables entering Java code in an integrated editor, including syntax highlighting
- Creating/adding any number of new excersises and also theorethical tests for a given section (area of learning),which is not available in the Codecademy system
- Creating/adding excersises which enable modifying of existing excersise solutions and correcting errors (not available in Codingbat)
- Adding new sections with excersises and theoretical tests (new learning areas), eg. a section about multidimensional arrays (not available neither in Codecademy nor in Codingbat)
- Using videos (not available in other systems)
- 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 system combines good characteristics of the existing systems, and offers more flexibility and more learning comprehension compared with the CdingBat and the CodeAcademy solutions.

Images 4and 5 illustrate the GUI of the proposed system.

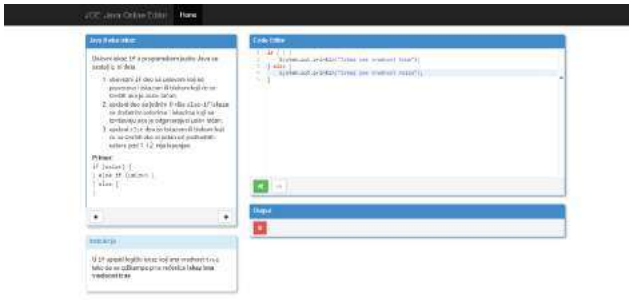

Image 4: JOE GUI – example 1

Image 5: JOE GUI – example 2

5. CONCLUSION

This paper analyzed the existing e-learning systems for learning the basic elements of programming languages, which are based on the "learn-by-coding" approach. A comprehensive and flexible system has been recently developed at the Metropolitan University for learning of Java programming language, titled Java Online Editor . This paper describes this JOE system and compares it with the existing systems. The developed JOE system offers a list of combined and new options compared to other systems, more flexibility and more comprehensive learning of Java compared to other existing systems.

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E-LEARNING CERTIFICATE IN FOOTBALL MANAGEMENT ENVIRONMENT IN SPORT BUSINESS MANAGEMENT EDUCATION

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Abstract: *There is a limited understanding of eLearning applications in the discipline of sport business management. ICTs enable the range of possibilities for interactions between learners and materials, and learners and teachers in the learning process by eliminating the limitations of time and space. The paper explores and identifies some of the latest applications and directions in sport management education and various ICT-based eLearning scenarios on the example of UEFA Certificate in Football Management (UEFA CFM) blended learning programme. The CFM objective is to support the national football associations to increase their knowledge in the fields of sport management. It is expected that UEFA eLearning programme will change in time. However, by looking into the first and second academic year of application as well as an experience of one CFM participant, the authors gained insights for MetaSud projects (knowledge sharing platform, blended learning, eLearning courses, educational documentaries, and webinars).*

Keywords: *blended learning, sport business management, learning management system for sport, ICTs and education strategies in sports industry*

1. INTRODUCTION

There has been an explosive growth in the sport industry in the last decade. Contemporary sport as sophisticated and complex international business has become a significant global industry with enormous commercial potential. It can be said that the global sport industry is growing much faster than GDP rates around the world. Football remains the king – global revenues for this sport equal €20 billion yearly – in Europe alone, football is a €16 billion business, with five biggest leagues (the U.K.'s *Premier League*, Germany's *Bundesliga*, Italy's *Serie A*, Spain's *La Liga* and France's *Ligue 1*) accounting for half of the market and the top 20 teams comprising roughly one-quarter of the market. Sport is one of the few sectors experiencing economic growth both in Europe and globally.

In recent years the world of professional football has been referred to more and more as an industry in its own sake. Its characteristics have been getting closer to those of services or the entertainment business. Ranking of football as a business activity has risen in the economies of those countries where football is promoted as national sport. In many such countries, it represents today a large percentage of a nation's GDP, due to the fact that football events also drive a considerable number of other sectors, such as media and various services. Moreover, football today is an international business – professional players are transferred frequently around the globe, international professional leagues have been created, and the UEFA European Championships or the FIFA World Cup finals are the top media events. In fact, professional football has successfully outmanoeuvred many other team sports to be accepted as the number one sport with regard to media attention and audience reception worldwide [1 - 6].

Successful outcome for all the industry stakeholders is guaranteed only with an understanding and engagement of business management functions and processes comprising governance, strategy, financial management, marketing and sponsorship, event and facility management, human resource management, public relations and so on. The sport environment or context in which these functional areas are managed which includes economic, political, technological, legal and social factors set in the context of the global marketplace (see more on globalisation in [2]), must also be considered when analysing football as business.

It is important to emphasise at the outset that association football is the game controlled by the Fédération Internationale de Football Association (FIFA), and organised in accordance with the Laws of the Game as determined by the International Football Association Board (IFAB). For example, in 2011 FIFA had 218 member associations in total, 53 of which also belonged to UEFA and all of which are in charge of organising, promoting and developing the game of football in their respective countries. According to the UEFA Statutes, to be a member of a national association must be based in a country recognised by the United Nations as an independent state and be responsible for the organisation and implementation of football-related matters in the territory of its country. In order to be able to compete in events organised by both the regional confederations (e.g. UEFA) and the world governing body of association

football (FIFA), each national association has to apply to become a member and must observe the rules, regulations, directives and decisions passed by these respective international associations. The National (football) associations (NAs) are not-for-profit organisations and are committed to making football a positive and inclusive experience for everyone involved in the game, allowing all participants to enjoy the game and maximise their ability [7].

Football today is a thriving business and capable of generating substantial amounts of money. That is to say, this makes managing a national association rather unique and complex, because unlike mainstream management, the football context requires a sophisticated approach that is tailored in a way that optimises its revenues yet redirects most profits into solidarity payments to support initiatives such as development of grassroots sport, investment in personnel and construction of infrastructure. Football is a highly results-driven, and hence a NA's performance may be judged in some cases according to its international ranking or number of wins in qualifying for major championships, factors that are susceptible to change from one month to the next. Therefore, identifying stakeholders' expectations and balancing them with those of a NA is key and the greatest effort to be made by NAs to develop unique competencies in education in their staff to consequently achieve their own objectives.

2. BLENDED LEARNING PROGRAMME

The UEFA Certificate in Football Management (UEFA CFM) is a blended learning programme. The objective of the programme is to support the national football associations (NAs) and the UEFA staff to increase their knowledge in the fields of sport business management [7]. On the one hand, blended learning is an educational programme where more than one delivery mode is used with the objective optimising the learning outcome and cost of program delivery. On the other hand, eLearning is often equated with *electronic learning*, although the initial emphasis is more on information and communication technology (ICT) considerations of networking rather than on eLearning applications which focus on the purpose of learning. An advantage of eLearning is the range of possibilities ICT enables for interactions between learners and materials, and learners and teachers in the learning process by eliminating the limitations of time and space [8].

Also, there are various ICT-based eLearning scenarios which are standardized, so that the paper explores and identifies some of their new applications and directions in sport business management education.

3. WHAT IS BLENDED LEARNING?

E-learning (or *eLearning*) is the use of information and communication technology and electronic media in education. It includes numerous types of media that deliver text, audio, images, animation, and streaming video, technology applications and computer-based learning, as well as local Intranet/Extranet and Web-based learning [3, 4, 5, 6, 9, 10, 11]. General eLearning cycle block-diagram is shown in Fig. 1.

It should be noted that eLearning technology standard specifies the format of content, competency map, or learner profile, but does not standardise the content, competency map, or learner profile themselves. Any restriction forced on the educational context by the technology standard should better be avoided.

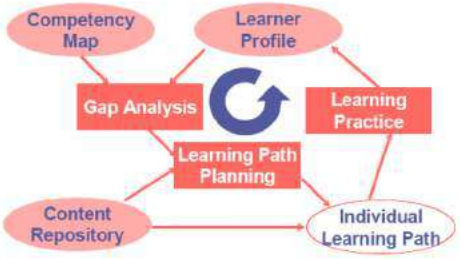

Figure 1. eLearning cycle [9].

Blended learning is a modern strategy that merges the advantages of face-to-face method and eLearning. It focuses on a shift from traditional classroom, from teacher-centred approach to student-centred approach to education. This leads to the development of quality of process of learning and improvement of its outputs, opening possibilities and skills for self-learning and leading to successful accomplishments of learners in related field. A number of prominent authors have been defined the notion of blended learning with the common view that it recognises combination of virtual and physical environments. The definitions mostly underline convergence of face-to-face settings characterised by synchronous and human interaction and ICT-based asynchronous settings and text-based, where humans operate independently, see e.g. in [12]. Blended learning is considered "thoughtful fusion of face-to-face and online learning experiences" emphasising the need for reflection on traditional approaches and for redesigning teaching and learning, opening up new educational terrain.

Blended learning environment as a type of distance education integrates the advantages of online education with the effective aspects of traditional education (face-to-face interaction). In comparison with traditional learning environment which poses restrictions on time and place, eLearning provides an environment for the learners to study regardless of time and place. The factors having significant impacts on typology of learning environment are, e.g. learners individual differences, personal characteristics, learning styles, etc. Both advantages and disadvantages of traditional learning environment and online environment are integrated in blended learning.

4. A NEW LEARNING ENVIRONMENT

The UEFA CFM is a personal development programme, deployed in close cooperation between leading universities and academic experts. The course provides participants with advanced and up-to-date techniques in sport business management. The CFM combines six eLearning modules with three face-to-face seminars addressing key areas of national football association management [7]. Being created by academic and professional experts, each module focuses on an

important aspect of the management of football associations, namely:

M1 - The Organization of World Football (Sean Hamil, Birkbeck University of London, UK);

M2 - Strategic Management of a National Football Association (Mikkel Draebye, SDA Bocconi, Milan, Italy);

M3 - Operational Management of a National Football Association (Antonio Davila, IESE Business School, Barcelona, Spain);

M4 - Football Event Management (Michel Desbordes, University of Paris Sacley (Paris Sud XI), Orsay, France and INSEEC Business School, Paris, France);

M5 - Football Marketing and Sponsorship (Simon Chadwick, Coventry University, UK), and

M6 - Managing Communication in a National Football Association (Alain Ferrand, University of Poitiers, France), see Fig. 2.

eLearning platform allows flexibility enabling participants to continue with their day-to-day work (designed by *MetaSud Communication and Knowledge Transfer*).

In order to access the CFM learning platform a user need to login, enter his/her username and password. All the available courses are displayed on the courses landing page. To view the course, its title should be simply clicked. The amount of work necessary is assessed to be four days per online module (including the written assignments). At the end of the course, participants are graded on the basis of a written assignment. The CFM platform solution is based on video and situational practice exercises. The CFM modules M1-M6 transform the course into multimedia and interactive product available online via a dedicated IT platform LMS (Learning Management System).

Figure 2. CFM eLearning cycle:
Module leaders; login in CFM learning platform and courses page (designed by *MetaSud Communication and Knowledge Transfer*)

5. CONCLUSION

However, by looking into the first and second academic year of application as well as an experience of one CFM participant, the authors gained insights for MetaSud projects (knowledge sharing platform, blended learning, eLearning courses, educational documentaries, and webinars). As a part of this research, the paper, therefore, recognises the importance of an application of ICT in sport business management education.

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ON THE USE OF MACHINE LEARNING TECHNIQUES IN E-LEARNING SYSTEMS

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Abstract: *The paper presents an analysis of the machine learning techniques application in addressing different issues in e-learning. The main problem in contemporary learning systems is how to create system that is a highly adaptive and provides a personalised learning approach. With reference to this, machine learning allows systems to learn or to build up the analytical model and to explore or optimise the internal relationships between systems' inputs and outputs, without being explicitly programmed. An overview of the application of the major machine learning techniques that are used to support adaptability and personalisation of learning systems is presented, referring to the following techniques: (i) metaheuristic optimisation algorithms, i.e. evolutionary algorithms, such as genetic algorithm (GA), ant colony optimisation (ACO), particle swarm optimisation (PSO); (ii) fuzzy logic, and (iii) artificial neural networks (ANN), and hybrid approaches.*

Keywords: *Machine learning, E-Learning, Learning systems, Evolutionary algorithms, Fuzzy logic*

1. INTRODUCTION

Forasmuch as education is important for survival and progress of human society, one of the priorities of the modern civilisation is inventing of mechanisms for efficient knowledge transfer and improvement. In a last few decades, new research in psychology and appearance of new technical possibilities laid down the basis for a paradigm shift in the approach to a learning process. Primarily, there was a need for distance learning and for adjustment of knowledge absorbing process, to address more efficient creation and presentation of teaching materials and adaptation of the learning systems to an individual.

Computer aided learning, distance learning, web-classrooms and virtual classrooms present a part of terminology available for e-learning systems today. This category includes systems who allow users to create, distribute, control, and use learning content and achieve mutual cooperation through computers and computer networks. [1] One of modern threads in educational area is an individualistic approach to the learning process. That means that e-Learning system should have a knowledge of the specifics of every single student and a possibility to adapt teaching content to his specific needs. However, the most widespread systems for e-learning - so called Learning Management Systems (LMS) don't have at all, or possess very limited possibility of learning process personalisation. In contrast to these systems, there are adaptive, but domain-specific i.e. narrowly specialised systems that have the capacity for personalised learning. The term "intelligence" in these systems is defined in different ways, but the essence is the same: the intelligence of the system presents its ability to adapt to the needs of an individual. Unlike traditional learning approaches in which students adapt to the context of learning and where system behaviour is the same in relation to each student, regardless of individual differences and preferences, an intelligent learning systems exhibit much more flexible properties. In terms of methods of acquiring knowledge, intelligence can be measured by the degree of adaptability in relation to the individual user.

Adaptive learning is the ability of the automatic learning system to dynamically change the content of the teaching material depending on the interests of the user. In other words, it provides learning content that is tailored to the goal and learning possibilities of each individual student. For students with a higher knowledge level and desire for learning, system should provide more new knowledge and data on some matter; for students with lower knowledge level, beside new knowledge system should offer the knowledge that student misses which is necessary for successful acceptance of new knowledge. However, it is often difficult to make an adaptive presentation of knowledge since some elements that are labelled as more important or less important must be either displayed or skipped without affecting the meaning of the rest of the content. Sometimes it is very difficult to determine all possible branches so that the presentation of the content of learning still makes sense. [2]

In order to adapt the lectures to each individual, a new form of adaptive and personalised advanced e-learning must use some machine learning techniques to create intelligent part for systems in combination with e-learning. There is requisite in e-learning to implement new technologies and approaches to meet these requirements.

Machine learning is multidisciplinary field in artificial intelligence, statistics, information theory, probability, psychology, and neurobiology which involves the design and construction of computer applications or systems that are able to learn based on their data inputs and/or outputs. The study of machine learning has grown from the efforts of exploring whether computers could learn to mimic the human brain, and a field of statistics to a broad discipline that has produced fundamental statistical computational theories of learning processes. Basically, a machine learning system learns by experience; using specific training process, the system will be able to make generalisations based on its exposition to a number of cases and then be able to perform actions after new or unforeseen events.

The aim of this paper is to present the analysis of machine learning technique applications in e-learning systems, and create their classification and comparison. The main classification implies classification by the type of e-learning problems that were solved using machine learning techniques. Then, within the e-learning problem types, the second classification refers to the type of machine learning technique (evolutionary algorithms, fuzzy logic, hybrid approaches, etc.) used to solve the problems in e-learning systems.

2. MACHINE LEARNING TECHNIQUES

According to the nature of the learning signal or feedback available to a learning system, general classification of machine learning techniques implies classification into four broad categories [3]:

1. Supervised learning
2. Unsupervised Learning
3. Semi-supervised Learning
4. Reinforcement Learning.

Supervised learning is created with accepting labelled examples, such as an input where the wanted output is given. That provides dataset consisting of both features and labels. This technique is commonly used in applications where historical data predicts likely future events. There are two categories of supervised learning: classification and regression. In classification, the label is discrete, while in regression, the label is continuous.

Unsupervised learning uses data that has no previous examples and goal is to find similarities between the objects through data exploration. In fact, it is a technique of discovering labels from data itself. During the training process, unsupervised learning algorithm generates the predictive model which tries to fits its parameters so as to best summarise regularities find in the data.

Semi-supervised learning uses both labelled and unlabelled data for training, and it is desirable that the task already has a "prediction problem". Model then learns to organise data and to makes predictions too. This type of learning is used with methods such as classification, regression and prediction (e.g. face-recognition on videos or photos).

Reinforcement learning algorithm discovers through trial and error which action results in a great reward. The goal is to learn which policy is the best. There are three important components in this type of learning: the learner, the environment, and the actions.

In the observed scientific literature that deals with the machine learning application in learning systems, the most commonly used machine learning algorithms are: fuzzy logic, evolutionary algorithms and neural networks, followed by a variety of hybrid approaches. Since these machine learning algorithms found the most common application in e-learning systems, their basics will be presented in the next sections.

Fuzzy Logic (FL)

Fuzzy Logic (FL) is an algorithm that resembles human reasoning. FL imitates the way of decision making in humans that involves all intermediate possibilities between digital values YES and NO.

FL is, generally, the freedom for truth variables to hold any value between 0 and 1 (inclusive), and fuzzy logic proponents claim this generality allows greater flexibility, freedom, accuracy and compactness when representing real world situations. All the usual properties of Boolean algebra can be extended to fuzzy logic, and probability's degree of belief in a Boolean variable becomes a fuzzy variable's degree of truth.

The conventional logic block that a computer can understand takes a precise input and produces a definite output as TRUE or FALSE, which is equivalent to human's YES or NO. Lotfi Zadeh [4], the inventor of fuzzy logic, observed that unlike computers, the human decision making includes a range of possibilities between YES and NO, such as:

- CERTAINLY YES
- POSSIBLY YES
- CANNOT SAY
- POSSIBLY NO
- CERTAINLY NO

Fuzzy logic has had a great deal of success where it has been applied in the real world, and is often touted as a means of making machines smarter.

Evolutionary Algorithms (EAs)

High-dimensional, non-linear problems with large number of constraints usually do not satisfy prerequisites of traditional optimisation methods like linear programming, dynamic programming and gradient descent. This inability of conventional approach to deal with such challenges of modern real-world problems is the main reason for development of metaheuristic algorithms, i.e. evolutionary or bio-inspired optimisation algorithms. In general, they are motivated by the concept of the evolution, based on reproduction, gene inheriting and Darwin's principle of natural selection [5]. The short description of the most frequently used EAs in e-learning systems is given below.

Genetic algorithm (GA) [5] is the oldest and the most popular example of metaheuristic algorithm with various improvements of the basic version. Although the approach has some issues with speed of convergence and local optima, it was quickly adopted in the research community

and adapted to solving many practical problems. Basic GA starts with a randomly generated population of potential solutions – individuals. Each individual is represented by a chromosome consisting of genes, which are actually optimisation variables. Expanding the search area was done through the process of generating new individuals from the existing ones, i.e. reproduction which is the way to obtain the improved solution. During this process, two operations can be performed – crossover and mutation. Crossover is recombination of genes, such that offspring inherit characteristics from both parents. Mutations are rare perturbation of randomly selected genes performed to avoid stacking at a local optimum. A further improvement of GA is presented by Memetic algorithm (MA) [6] which introduces a concept of experience. The main steps are the same as in GA, except that after offspring is created, it gains experience by performing a local search. The procedure is performed with the intention to allow an individual to improve from the current position by itself, without interfering with other individuals.

Particle swarm optimisation (PSO) [7] was developed as an attempt to mimic behaviour of a flock of birds in discovering a good path to food or reaching a particular destination during the migration process. PSO shares some similarities with GA – a potential solution of the problem is represented with an individual (particle) and algorithm starts with a group of such individuals. The difference is that exploring the search space is not performed by applying evolutionary operators; there is no reproduction process which creates new individuals. Instead, individual is represented by its current position and search for the optimal solution is a result of changing individual's position in a space. There is a local search when each individual explores quality of its current position, then the global search implies the communication among members of the swarm to detect which one is in the best position, and finally, the last step is moving toward the best position with an appropriate velocity.

Ant colony optimisation (ACO) [8] is inspired by behaviour of real ants in the process of searching for food. As an ant move through the space, it leaves pheromone trail, which can be recognised by other ants. Facing an obstacle, the ant has to make a decision how to avoid it, i.e., to choose a direction. At the beginning, these decisions are randomly selected. But later, new ants favour paths with more intense pheromone trail. ACO procedure starts the same way as the previously described algorithms – by randomly generating population of individuals (ants), which represent possible solutions. During exploration of searching space, each ant leaves pheromone trail which is proportional to the quality of the current solution it represents. Just as in nature, ACO supports pheromone evaporation over time, which reinforces shortest paths and prevents stacking at local optima.

Artificial Neural Networks (ANN)

A neural network is a computational structure created as an abstract model of a brain and its functions. It consists of artificial neurons which are small processing units capable of calculating a simple function of input. One neuron's output is transmitted through synapses to the other neurons in the network. [9]

Solving problem by ANN requires training of ANN. In other words, ANN doesn't have an algorithm for direct solution of a problem. Instead, it has an algorithm for "learning" by given examples. After enough number of examples, it is able to generalise and correctly process previously unseen data. The learning process is usually reduced to determining synapse weights, but can involve more complex tasks like learning the structure of the network. The degree of similarity between an ANN and a real brain structure is questionable. Nevertheless, nowadays ANN is recognised as one of the most powerful tool in modelling nonlinear dynamic complex systems.

3. ANALYSIS OF MACHINE LEARNING APPLICATIONS IN LEARNING SYSTEMS

The analysis and classification were performed considering the following three groups i.e. types of typical problems in learning systems:

1. Type 1: Determination of the importance of questions for student evaluations, design of adaptive learning materials and learning system support for that materials.
2. Type 2: Definition of the learning system architecture and creation of an intelligent adaptive learning system.
3. Type 3: Usage, modifications and adaptation of existing learning management systems (LMSs).

Hence, the classification is based on the nature of the problems in learning system that were solved using machine learning techniques. For the above three types of problems, further analysis is performed based on the machine learning techniques, as follow: (i) fuzzy logic; (ii) evolutionary algorithms; (iii) hybrid approaches. The application of ANNs is not given separately because ANNs are mainly used in combination with other techniques, which refers to hybrid approaches.

The explanation of the most common problems which have been solved using machine learning techniques are given in the next sections.

Machine learning application in learning system problems Type 1: Determination of the importance of questions for student evaluations, design of adaptive learning materials and learning system support for the materials

Fuzzy logic

Several publications presented application of fuzzy logic in terms of learning systems improvement, as follows.

Saleh and Kim [10] presented a fuzzy system for the evaluation of students' learning achievement. Precisely, they developed a method for the evaluation of students' answer scripts using a fuzzy logic. The proposed system applies fuzzification, fuzzy inference, and de-fuzzification in considering the difficulty, the importance and the complexity of questions.

Chen and Lee [11] addressed the importance of question attributes in evaluation of students' learning achievements. They presented a new method for students' achievement evaluation by automatically generating the importance degrees of the attributes of questions, using fuzzy reasoning method based on simple arithmetic calculations rather than the complicated fuzzy reasoning method.

Chen and Bai [12] proposed a new method to diagnose learning barriers of learners in an adaptive learning system, based on fuzzy rules. This method evaluates the learning degree and deduces the probability of learning barriers of the learners based on fuzzy rules.

Evolutionary Algorithms

Chang and Ke [13] developed an approach for personalised e-course composition based on a genetic algorithm with forcing legality (called GAn) in some adaptive learning systems. This approach efficiently and accurately finds some appropriate e-learning materials in the database for individual learners.

In order to provide a truly personalised learning environment, Li et al. [14] proposed a self-adjusting e-course generation process composed of the following phases: determination of a learning concept structure, adjustment of the e-learning material difficulty, analysis of a learner's characteristics (such as learner's ability and learning goals), and development of personalised e-courses. The feedback information from learners was used for the adjustment of the difficulty of the e-learning material, and for the update of learners' characteristics (ability and goals). Evolutionary algorithms (EAs) were used for the composition of a personalised e-course according to the individual learner's needs. The most widely applied EAs in learning systems - genetic algorithm (GA) and particle swarm optimisation (PSO) algorithm were compared using an empirical data i.e. actual learners and an actual learning material / curriculum. As a result from this study, PSO showed better effectiveness than GA for a smaller number of learning materials.

For constructing a personalised e-learning system, Huang et al. [15] designed an approach based on the evolvement technique through computerised adaptive testing. They use GA and case-based reasoning to construct an optimal learning path for each learner. The concept implies two major elements: a GA-based curriculum approach that generates a personalised curriculum sequencing; and, usage of the case-based reasoning to develop a summative examination or assessment analysis. The empirical data were used to verify that the proposed approach can generate the appropriate course materials for learners, based on specific requirements of individual learners.

Hybrid machine learning approaches

Other machine learning algorithms or/and hybrids approaches have been also used to solve the observed problems in learning systems, as follows.

Wang [16] designed a hybrid approach, using ant colony optimisation (ACO) algorithm and fuzzy logic, in order to extract a recommendation for the knowledge for personalised web-based learning. The goal of this research is to resolve the above issues by using an advanced, more efficient algorithm that is based on ACO but requires a smaller sample of learners and training cycles. A fuzzy logic was used to obtain a personalised recommendation knowledge, which, in combination with ACO model, resulted in an efficient approach that overcomes limitations regarding larger sample required in a real-life application.

Bernard et al. [17] compared performances of four machine learning algorithms ANN, GA, PSO and ACO, in terms of the improvement of precision of the learning style identification. The testing was performed using empirical data, and results presented that ANN shows the best precision in modelling learning style, followed by PSO. Anyhow, the tested machine learning algorithms showed better precision of automatic learning style identification than the existing approaches.

Machine learning application in learning system problems Type 2: Definition of the learning system architecture and creation of an intelligent adaptive learning system

Evolutionary Algorithms

For automatic and interactive generation of e-learning auxiliary material Huang et al. [18] used PSO. In contrast to the traditional approach, in this research the auxiliary material consists of blogs posted by learners to provide more interactive and cooperative learning environment. In order to address this feature, PSO algorithm for a serial blog article composition was used to generate the best combination of blogs, considering various characteristics of each blog.

In order to consider the relationship between learners' attributes and learning objects' attributes, Yang and Wu [19] used ACO algorithm. In particular, an attributes-based ACO model was proposed to find the appropriate learning objects in a more efficient manner. The main contribution refers to an attribute-based search mechanism that was designed to find adaptive learning objects, and an adaptive learning rule that was developed to identify how learners with different attributes may locate suitable learning objects.

Hybrid machine learning approaches

In order to evaluate and adapt the e-learning systems including deep consideration of e-learners' profile, Hogo [20] proposed a hybrid approach based on fuzzy clustering models and statistical methods. The classification of e-learners profiles is performed using five classes. The statistical methods are used to perform a mapping of learners with respect to the e-learning system. The overall idea is to address the issue of how to return a "bad" student to a "regular" one. This is directly related to the response on the issue of how to adopt the learning content and learning system structure to the learners profile classes. Two different fuzzy clustering techniques are used to find the learners profile, resulting in a very good fit to the behaviour of learners in a real world.

Machine learning application in learning system problems Type 3: Usage, modifications and adaptation of existing learning management systems (LMSs)

The usage of machine learning algorithms for the improvement of existing LMS, such as Moodle, mainly refers to the hybrid approaches, as follows.

Hybrid machine learning approaches

Verdu et al. [21] developed a hybrid approach based on fuzzy logic, genetic algorithm (GA) and expert system which is another machine learning technique that have not been mentioned before in this work. A genetic - fuzzy expert system, to address the classification of automatic questions in an e-learning environment. The main idea of this research is to develop a sequence of adaptive questions, according to the difficulty level, in an automatic way that is in accordance to the learners' needs. In a fuzzy expert system, GA was used to characterise the difficulty level of questions. The output of GA is used to generate the fuzzy rules that classify the questions accordingly. The system was implemented as a part of Moodle platform and successfully verified using an actual learning course.

Aiming to address the subgroup issue in LMS, Romero et al. [22] used evolutionary algorithms (EAs) and fuzzy logic. The overall idea is to obtain rules depicting relationships between the student's usage of the different activities and modules provided by this e-learning system, from one side, and the final marks obtained in the courses, from the other side. ESs were used to develop fuzzy rules. Several EAs based on genetic algorithm have been tested. The approach used Moodle LMS and real data from the University courses. The approach was successfully verified showing its suitability for subgroup discovery in Moodle LMS.

4. CONCLUSION

The paper presents results of an initial analysis of machine learning application in addressing various issues in e-learning and learning systems in general.

The results showed that the observed works have been mainly concentrated on the usage of fuzzy logic, evolutionary algorithms and hybrid approaches combining several machine learning techniques in resolving problems of design of adaptive learning materials and a system support, and determination of importance of questions for student evaluations.

A few papers address the problems of the architecture of learning systems, learning objects creations and classification. However, they did not consider the issue of learning materials or learning objects (LOs) search across the learning system.

Therefore, the directions for a future research on this topic are twofold:

1. It has to be highlighted that this paper is a first attempt in analysis of machine learning application in e-learning systems. The number of studied papers was limited, hence the sample is not large enough to draw the overall conclusions. From the analysis point of view, future research will definitely include a detailed analysis of a larger number of research papers on this topic from all available academic sources.
2. In e-learning systems domain, the search for learning objects (LOs) in LOs repository is one of the most important arising topics, particularly for an adaptive, personalised learning concept. However, this issue has not been properly addressed in the existing research literature. Therefore, from the research and implementation aspect, the main direction of our future research will be focused on the development of an intelligent search algorithm, based on machine learning techniques, for browsing LOs in repositories within a learning system according the given multiple criteria.

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RELATIONS BETWEEN CURIOSITY AND QUALITY OF READING OF READING OF ELEMENTARY SCHOOL STUDENTS

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Abstract: *In this study quality of reading were operationalized as functional speed of silent reading. For that reason, the main goal of the research is to determine the distribution of functional speed reading, and then to examine and analyze the relationships between functional speed reading and curiosity in learning. The research was conducted on a population of elementary school students. The battery of measuring instruments consisted: text for examination speed reading, test for examination the level of understanding meaning of reading text and scale of curiosity. The results show that the majority of pupils achieved below-average results in functional speed reading (48.5%), and average (33.8%), but at least students achieved above-average functional speed reading (17.6%). In addition, the results showed that existing a difference in the functional speed reading in addition to the level of curiosity which pupils perform and students who achieved impressive results in a functional speed reading also show more curiosity. The results represent only one of possible starting point in the research process and improving the quality of reading.*

Keywords: *reading, functional speed reading, curiosity*

1. INTRODUCTION

In the ages we live, reading is a significant need of a person, his duty and task, but also his necessary social ability.A large number of information is available to today' reader,so mastering the skill of reading is one of the necessary precondition for its normal functioning at the current moment.

The results of the study shows that the majority of students from our sample achieved below-average results in the functional speed reading, then the average, and the small number of students achieved the above-average functional reading speed. The obtained results showed that there is a difference in the functional speed reading in regard to the level of curiosity that students exhibit and that students who achieve above-average results in the functional speed of reading show more curiosity and vice versa, students who achieve below-average results in the functional speed of reading also show less curiosity. Gender did not prove to be a significant source of diffrence in the functional speed of reading, while the grade from the serbian language was significant source of functional speed of reading. The results represent only one of possible starting points in the research process and improving the quality of reading within the education system. Physiological factors, cognitive and intellectual abilities, motivational and emotional factors, and additional measures of the student's environment and socio-economic status, as well as specific indicators related to the teaching process, should be taken into account in order to obtain a complete picture of the predictors of reading quality. Only in this way can planning guidelines for individual, necessary and desirable interventions for improving the quality of reading.

2. METHODOLOGY

The starting point of the study is to examine the distribution of the quality of reading pupils of elementary schools, as well as quantitative and qualitatively determining the connection between the quality of reading on the one hand and the awareness of pupils and their socio-demographic characteristics on the other hand.

The reading quality in this study was operationalized as a functional speed of silent reading .

The main aim of the study is to determine the distribution of the functional speed of reading , and then to examine and analyze the relationships between the functional speed reading and the curiosity motive in learning.

The formulated aim of the study implies the following tasks that need to be realized :

1. Determine the distribution of the results of the functional speed reading
2. To determine and analyze the direction and intensity of the interconnectedness of curiosity in learning and the functional speed reading.

3. Determine and analyze the direction and intensity of the interconnectedness of social-status characteristics and the functional speed reading .

The study was carried out on the population of nine grade primary school students. The sample consists of 136 respondents, of whom 68 are female and 68 male subjects.

In this study we used two basic methods of data collection: the method of theoretical analysis, we used it through the development of the theoretical basis of research and in the knowledge and analysis of the contents of previous research that are subject matter and methodologically related to this problem and the empirical and non-experimental (survey) method.

The battery of measuring instruments consisted:
1.text for examination speed reading for pupils nine grade primary school [2,3]
2. test for examination the level of understanding meaning of reading text made as a set of tasks with the offered alternative answers [2,3]
3. scale of curiosity for learning – Scale is Likert type and has 6 item, and the reliability of the scale expressed by the Kronbach alpha coefficient is 0.789.
4. Questionnaire for pupils of the nine grade of elementary schools who provides data on their socio-demographic characteristics that are relevant for this research.
Data processing was performed using the software package SPSS Windows version 20. When processing the collected data, statistical procedures were applied, appropriate to the instruments and phases of the research

4. RESULTS OF RESEARCH WITH DISCUSSION

We determined the functional (effective) reading speed or the speed of understanding the meaning of the read text by calculating the product of the result obtained by the gross read speed and the proportion (or percent) of the correct responses to the test of understanding the meaning of the read text. Respectively,the functional reading speed is obtained when the average number of words read in one minute is multiplied by the percentage of correct answers in the reading comprehension test and divided by 100, or when the average number of words read in one minute is multiplied by the ratio of the correct answers in the test.

After this calculated value, each individual achievement of students is classified into one of these categories: below average, average and above average (Table 1).
We believe that the established speed of understanding meaning of reading text represents a reliable basis for the conclusion of the quality of reading primary school students

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Table 1: Distribution of functional reading speed

Level of functional reading speed	Number of pupils	
	Frequency	**Percentage**
Below-average	66	48,5
average	46	33,8
central	24	17,6
Total	136	100

The analysis of the results presented in Table 1 shows that the majority of the students studied achieved below-average results in the functional speed reading (48.5), then the average (33.8%), and the small number of students achieved an above-average functional speed reading (17.6%). The results thus distributed show a discrepancy between the low and high results, and lead to grouping the results in the filed of slow understanding meaning of reading text, which means that the students showed unsatisfactory results in the functional reading speed.

Psychologists agree that internal motivation is one of the basic conditions for good results in schooling, so it starts from the idea that students do not acquire knowledge by simple repetition or by simply exposing themselves to a situation, but it is necessary that they want and want to master and adopted [4].

Many studies have examined the relationships between certain internal motives and learning success. A number of studies show that students with a higher degree of curiosity achieve better achievements in school performance tests than those students who show a lower degree of curiosity.

An analysis of the previous studies of the impact of curiosity on the results in school learning suggests that there are positive relationships between curiosity and success in schooling, although they are not always statistically significant.

All these findings are also of great importance for the prediction of the quality of reading, as one of the products of school learning, since its formal training starts at the school.

And in this study we proceeded from the assumption that curiosity can be a source of differences in the functional speed of reading students, and that absence or insufficient curiosity negatively reflects on the speed of understanding the meaning of reading text, and vice versa, high curiosity reflects positively on the speed of understanding the meaning of reading text. The obtained results are presented in Table 2.

Table 2: Difference in the functional reading speed in relation to curiosity

	FBČ	N	Average rang	χ^2	df	p
Motive of curiosity	Below-average	66	61,92	9,845	2	0,007
	Average	46	66,24			
	Above – average	24	90,94			

Using the Kruskal-Willis test, it was found that there was a statistically significant difference in FSR in view of the level of curiosity.

The results shown in Table 2 show that students with higher levels of curiosity achieve superior results in the functional speed reading , and that students who achieve below-average results in the functional speed reading have the lowest average rank in the level of curiosity.

A large number of studies related to gender differences in student achievement have shown that girls surpass boys in school performance in most school subjects [5,6,7], so we guided them by examining whether there is a difference in the functional reading speed of girls and boys.

The data in Table 3 show the distribution of the obtained results of the speed of reading students in relation to gender.

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Table 3: Half of students and functional reading speed

Pol	Level of functional reading speed			Total
	Below-average	average	above - average	
male	33	22	13	68
	48,5%	32,3	19,1%	100%
female	33	24	11	68
	48,5%	35,3%	16,2%	100%
Total	66	46	24	136
	48,5%	33,8%	17,6%	100%

$\chi^2 = 0,254$ $df = 2$ $p = 0,881$

The insight into the presented results shows great similarities and slight differences in the distribution of the obtained results of the functional speed reading in boys and girls.
By testing the statistical significance of these differences, it was found that the differences between boys and girls in the functional reading speed were not statistically significant, since the obtained $\chi 2 = 2.020$, with $df = 2$, was not statistically significant, since the obtained value was $p = 0.881$.

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Some of the previous research has shown that success in the Serbian language depends on understanding meaning of reading text [1,8].

The results of the research conducted in Serbia have shown that the greater progress in understanding the reading text, under the influence of the experimental program, came from students with a better mark from the Serbian language.

The most advanced students in the experimental group who have a mark 5 [1]
Following the results of previous research and in this paper, we proceeded from the assumption that the mark from the Serbian language can be a source of difference and a determinant in understanding the meaning of reading text.

The distribution of the obtained results is shown in Table 4.

Table4: Success from the Serbian language and functional speed reading

Succes s from the Serbian langua ge	Level of functional reading speed			Total
	Below - average	average	above - average	
Total	20	3	2	25
	80%	12%	8%	100%
Good	29	16	7	52
	55,8%	30,8%	13,5%	100%
very good	12	15	6	33
	36,4%	45,4%	18,2%	100%
Excellent	5	12	9	26
	19,2%	46,1%	34,6%	100%
Total	66	46	24	136
	48,5%	33,8%	17,6%	100%

$\chi^2 = 25,503$ $df = 6$ $p = 0,001$

From the results shown, it is evident that there are many more students among the students who understand the read text more slowly (80%) than among the students who have good success (55.8%), very good (36.4%) and excellent success from the serbian language (19,2%).
Viewed from the opposite side, students who have better school success also show better results in the functional speed of reading

The best results in the functional speed of reading were achieved by students with excellent success in the serbian language (34.6%), then those with very good (18.2%),

with good (13.5%) and the least ones with sufficient success from the serbian language (8%).

The results presented above show the linear connection, i.e. show that students who have better success in the serbian language also have better results in the functional speed of reading .

5. CONCLUSION

In the ages we live, reading is a significant need of a person, his duty and task, but also his necessary social ability.
A large number of information is available to today' reader,so mastering the skill of reading is one of the necessary precondition for normal functioning at the current moment

An insight into the results obtained by this study shows that the majority of the students from our sample achieved below-average results in the functional speed reading , then the average, and the small number of students achieved the above average functional speed reading
The obtained results showed that there is a difference in the functional speed of reading in regard to the level of curiosity students exhibit and that students who achieve above-average results in the functional speed of reading show more curiosity and vice versa, students who achieve below-average results in the functional speed reading also show less curiosity

Gender did not prove to be a significant source of difference in the functional speed reading , while the grade from the serbian language was. The results we have come to represent only one of the possible starting points in the process of researching and improving the quality of reading within the education system. Physiological factors, cognitive and intellectual abilities, motivational and emotional factors, and additional measures of the student's environment and socio-economic status, as well as specific indicators related to the teaching process, should be taken into account in order to obtain a complete picture of the predictors of reading quality. Only in this way can planning guidelines for individual, necessary and desirable, interventions for improving the quality of reading.

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