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Language

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

ASSISTANCE FOR MOBILE LANGUAGE LEARNERS

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Abstract: The paper reflects on the evolution of mobile language learning and maps the emerging territory of mobile and smart assistance. The concept of 'mobile assistance' is a useful way to frame the ways in which mobile devices and applications can provide ad hoc or ongoing support to language learners inside and outside the classroom. The paper outlines various forms of assistance. As intelligent assistants become increasingly available, the learning landscape continues to evolve. An intelligent assistant might amplify human capabilities, or it might hinder their development. Language learners and their teachers are thus caught up in complex scenarios of newly available technologies that are impacting learning practices.

Keywords: M-Learning, Learner support, Informal learning, Intelligent assistants

1. INTRODUCTION

Language learning has traditionally been separated into, on the one hand, structured and supervised activities such as language lessons and courses, and on the other, self-directed or self-managed learning through access to language resources and informal conversational practice with native speakers [1]. Technology-enabled learning, especially mobile language learning, has broken down this distinction, blurring boundaries between formal and informal learning [2]. In doing so, it has put the spotlight on the changing role of language teachers and tutors, as well as new online communities of language learners, within an increasingly diverse and rich ecology of technological tools and resources that can provide different types of (additional or alternative) assistance in the course of language learning or communication in a target language. In parallel, there is interest in the difficulties that some learners have in assuming a self-directed stance [3][4], which can hinder them from being able to benefit fully from the tools and resources that are now available. Assistance may be required both in the process of language learning and in the development of learning skills and attitudes. It is therefore important to understand more about forms of assistance that may be required. This is currently an under-researched topic, and a key aim of this paper is to give it greater prominence in order to encourage further investigations.

2. EVOLUTION OF LEARNING AND MOBILE LANGUAGE LEARNING

The digital age has been referred to as "an age of abundance in terms of resources, opportunities and networks" [5], which invites educators to re-think their pedagogy. Rapid technological advancements as well as evolving social attitudes and more diverse approaches to teaching and learning have produced a vast array of pedagogical innovations that educators can choose from, at least in principle [6]. Mobile learning as a pedagogical approach emerged in response to the availability of mobile phones and other portable devices, but it has increasingly emphasized the mobility of the learner [7], as the digital age has also become a 'mobile age' for many people [8]. Mobile language learning soon became one of the leading areas of research and development within the field of mobile learning, and it also became an everyday practice engaged in by anyone wishing to learn a new language or improve their language skills with the help of free apps and online resources. Mobile language learning includes both the use of very simple applications such as flashcards on smartphone screens [9], and increasingly sophisticated systems that incorporate knowledge about learners, their goals and behaviours and can make recommendations and suggestions to their users [10] [11]. Most mobile applications, however, are between these extremes: they provide some content and interaction, but they vary in complexity and may be ambiguous as to whether language learners can and should use them independently or with some human guidance and supervision.

Studies have shown that learning with the use of smartphones, tablets and other mobile devices brings numerous benefits to the process of language learning. To start with, there are many applications that support language learners in the four fundamental skills of reading, writing, listening and speaking. Furthermore, studies show that there is often increased learner motivation by being connected through mobile social media to other learners, there are better opportunities for revision and practice, and it is easier to memorize new vocabulary or dialogues through frequent repetition in the course of the day. Learners can review what they learned in class, gain increased exposure to the target language, and add variety and enjoyment to their learning [12][13]. Mobile games can motivate students and sustain their engagement, resulting in better learning [14]. Multimedia vocabulary lists may be jointly created by learners, in the form of shared notes, photos and audio recordings. Researchers emphasize features such as portability of learning, social connectivity and interaction, context-relevance and personalization [15]. Mobile learning also offers more ways of supporting collaboration in language learning for joint task completion and for speaking and writing practice

as well as a means of reducing learner nervousness and embarrassment [16].

3. THE CONCEPT OF MOBILE ASSISTANCE
The concept of 'mobile assistance' seems to be a useful way to frame the ways in which mobile devices and applications can provide ad hoc or ongoing support to language learners inside and outside the classroom. The idea of 'assistance' started to feature in mobile learning in the era of so-called 'personal digital assistants' (PDAs) [17] [18] around the turn of the century, and it has re-emerged thanks to the rapid rise of smart virtual assistants in commercial transactions encountered in everyday life. The idea is also in tune with growing awareness of many learners' special needs and disabilities requiring the use of assistive technologies, and the assistance needs of ageing populations across the globe who may benefit from being helped by human-like robots and other kinds of technological support.

As has been explained in more detail in [19], a learner might require assistance to get over an unexpected hurdle, to enable them to progress in their learning or to reflect on their progress. Mobile phones are a convenient everyday means of summoning help in emergencies and getting in touch with people who can offer support, as well as a means to access specific resources. Assistance may be needed as a matter of urgency, or on a more continuous basis to support the process of learning and reflection on progress.

4. FORMS OF MOBILE ASSISTANCE
Based on a literature review of mobile learning projects and further conceptualisation of mobile assistance, [19] offered an initial classification of types of mobile assistance, encompassing: motivation, support for well-being, progress monitoring, direct help, sustained help, cognitive support, organisation of learning, social support, personal development, individual requirements, mediation, communication and enrichment. Although these forms of assistance may not always be specific to mobile learning, they make use of the affordances of mobile technologies as well as learner mobility. For example, motivational support can be an ongoing activity, thanks to the ability to stay in touch with the learner and offer regular support. Sustained help can relate to actions such as helping learners to develop good language learning habits. Cognitive support can be focused on assisting learners with noticing how language is used in their everyday environments. Enrichment can be offered through use of augmented reality to add layers of helpful or challenging information to a learning task.

An interesting case of integrated mobile assistance was developed through the MASELTOV project (www.maseltov.eu, 2012-15). The project developed a prototype suite of integrated smartphone services and tools aimed at mobile populations, especially people arriving in Europe. The services and tools, which were accessed through a single mobile app, were devised with the purpose of fostering social inclusion, in particular by facilitating language learning and practice. They provided users with information for emergencies, help with navigation around a city, access to short language lessons, a translation tool, playful cultural learning, several means of social interaction, and personalised recommendations based on learners' movements and interests. The research in the MASELTOV project also addressed the issue of how people such as teachers, friends, volunteers, mentors and an online community could support learners who were using the services and tools provided via the app, helping them in their daily language practice and cultural learning.

5. ASSISTANCE GETS SMARTER: INTELLIGENT ASSISTANTS
Technological advances continue to change the face of mobile learning. For language learners, the ability to practice communicating in the target language, and to have access to help when attempting to communicate, have always been important. In the age of artificial intelligence, smart assistants might become one way to support these requirements. Intelligent assistants that respond to questions and instructions are now commonly found on smartphones. They are found in some cars and in smart home devices. They may also be encountered on wearables such as watches, glasses and clothes. Furthermore, they are starting to make an appearance as social robots. Researchers have claimed that a 'wearable affective robot' might recognize students' emotions and improve education efficiency and quality [20]. Interactions with intelligent conversational agents and assistants are certainly not unproblematic and could be compared with having a very bad PA (human personal assistant) [21]. These services are constantly improving, however, and there is growing evidence of successful applications, for example with children learning to read [22]. In another example, [23] describe a humanoid robot playing with children in a game that helps them learn new vocabulary. An intelligent assistant or robot teacher, in whatever form, might amplify or improve human capabilities, but it might also hinder their development. Unlike an experienced human teacher, an artificial agent does not have the capability to exercise sound judgment.

6. CONCLUSION
This paper offers a brief and consequently broad-brush overview of an important new direction in the development of mobile language learning. There is scope for much more research on different forms of assistance for mobile language learners and evaluation of its acceptability and effectiveness. The paper also highlights that increasingly smart technologies might assist language learners. There is a fine line between smart technologies acting as 'teachers', and those that may offer specific targeted types of assistance, which raises many questions that will need to be investigated by researchers, in collaboration with learners and with language teachers.

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DISTANCE LEARNING – THOUGHTS ON OPTIMAL TEACHER TRAINING AND THE FUTURE SCHOOL

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Abstract: *Rapid development of new technologies and innovative pedagogies, necessitate the development of teacher education for school and kindergarten teachers to invigorate the education system. Applying concepts such as distance learning, characteristics of the new learner, and Neuro-education in the training of school and kindergarten teachers can enhance teaching to meet the needs of modern-day learners. But education systems are often inflexible due to manpower demands, financial costs, fixed priorities and challenges involved in adopting alternative teaching methods and thinking. Education reform needs appropriately trained educators. Which criteria should guide the selection of candidates suitable for innovative teaching and their evaluation? Neuro-education applies discoveries about brain function in learning. These findings encourage dialog between educators and neurological researchers and enable the development of joint projects. Consequently, teacher educators need to provide practical knowledge, skills and technological tools to student-teachers that can enable the teaching profession to train the future generation.*

Keywords: *Teacher education for school and kindergarten teachers, Neuro-education, distance learning, education reforms*

1. INTRODUCTION

Education systems in Israel and worldwide deal with many questions concerning the role of the school and/or kindergarten in the present era of dynamic change. This naturally leads to questions concerning the development of appropriate teacher training to meet the needs of the new generation of educators. Education researchers discuss the adaptation of the education system to the present reality, seeing it as an opportunity for alteration of the teacher training system and the structure of what is known today as the school or kindergarten. Will these educational institutions continue to exist as we know them? Will they continue to receive pupils every morning at 08:00? How many hours will pupils spend there? How should teacher training alter for the new institutions? etc.

2. OPTIMAL TEACHER TRAINING

Neurological research on the effect of the brain on learning processes, and the development of learning processes and teacher training, and also the physical conditions suitable for teacher training will lead the education system into a new sophisticated and innovative era. The empowerment of the educators' role and its elevation to a respected and desired profession, means that teachers should be equipped with tools and didactic technological means and research on moral, critical thinking and be able to produce graduates of the education system who are capable of integrating into the global marker of the second half of this century. The future classroom should be developed and constructed so that the educator can lead alternative teaching, to help graduates of the future to cope with the challenging environment.

Interesting data on teacher training in the era of technological innovation and integration in teaching can be derived from the Teaching and Learning International Survey [1] that asked teachers and principals from 48 states (32 in the OECD) about their working conditions and learning environments in their schools.
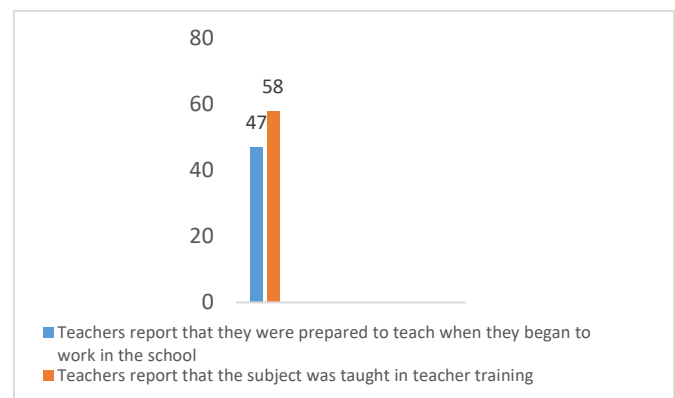
Figure 1. From teacher training on technology-assisted teaching to readiness to teach

It is obvious from the TALIS [1]. report that technology is used widely in schools and parallel appropriate training, but still not in a meaningful way that could influence the teaching system in the classroom. Perhaps the reason for this is the rapid development of technology alongside the attempt to repeatedly close gaps without much success that requires many resources. Encouraging student-teachers to use computer-assisted teaching could help to assimilate the use of technology in future teachers' teaching. Helping the student-teachers to cope with their learning tasks while

training would improve training and expose the future teachers to the integration of telecomputing in distance teaching and/or the integration of digital tools in teaching. Despite the recognition of the importance of technology integration in teaching, there is a gap between the preparation of teachers and what happens in the field [2]. It was found that the use of technology in school is relatively less than the pupils' use of technology outside the school, and that when technology is used in the lesson it is usually introduced in a superficial or partial manner and is performed in a shallow and limited way, usually to expand a subject or for entertainment [3]. It was found that even if they receive the relevant technology in their classroom, teachers still fear to use it. Teachers explain their lack of use of technology as stemming from the fact that they do not have the time to learn about the tools, fear the change, and lack a sense of self-efficacy to cope with change.
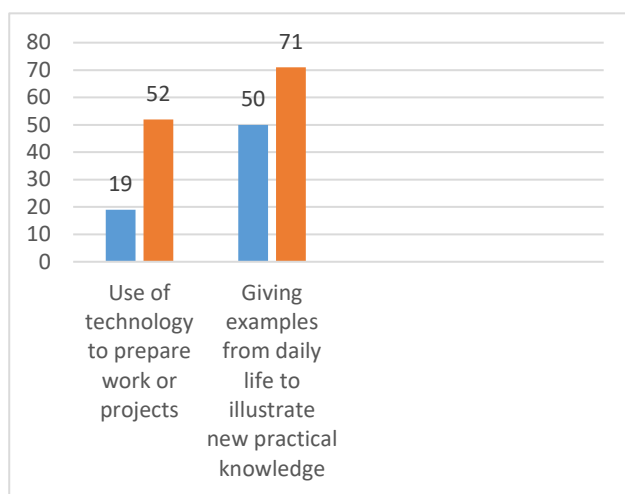
Figure 2. Advanced teaching practices

Figure 2 from the Talis report [4] indicates that there is a strong and impressive increase over five years in the transition to the use of computers (33%) and in parallel there is an increase of 21% in the use of daily life illustrations that necessitates the use of digital tools to perform innovative learning. Undoubtedly these statistics together with the findings of other research that examines how the brain learns, can lead to an improvement in learning processes and change in teaching methods in the near future.

The subject of the integration of computer technology and digital tools in teaching has immense potential which has already been partially realized and should be exploited for the benefit of both pupils and teachers. This will strengthen existing teaching skills, and allow teachers to incorporate a world of content that is close to the children. The pupils can access knowledge from any computer and enjoy alternative learning experiences, developing high level thinking skills and the education system can become more transparent and accessible at any given moment. Digital tools can be used to construct new knowledge in schools with the help of new tools with a wide variety of levels of involvement that pupils and teachers can access in a relatively short time and this can invigorate teachers' pedagogic abilities. It is therefore important to ensure that

both pupils, teachers and student-teachers will have a comprehensive program that integrates computer technology in different disciplines through information banks available to all on the information autostradas of the Internet. The rationale for change relies on testimony regarding the process of the global digital revolution, expressed by the rapid development of technology and also in the alteration of learning programs and processes for novice teachers' evaluation [5]. Attempts to train the teacher public in Israel to use knowledge-rich technology have been attempted in the past in different projects such as: "a computer for each teacher" or "smart whiteboards" introduced by the Ministry of Education and also by teachers' organization, but in most cases these attempts remained short lived initiatives since very little was invested in their assimilation.

The growing use of digital books [6] can definitely help educators to enter the new era and lead alternative pedagogic innovation. The growing use among teachers and pupils of this tool will empower the integration of technology in teaching alongside the use of learning resources, enabling them to search for materials for the development of higher order thinking skills.

Simon [7] investigated the efforts made by the education system in Israel at the beginning of its path in the integration of technologies in education (Simon, 2016). He found that the question of what is the "missing link" that can empower teachers to make proper and intelligent use of technologies remains unresolved.

It appears that the trend over the last forty years has demanded greater professionalism from the teaching profession and transformed the teaching vocation into a profession like any other for example: doctors, lawyers etc. Continuous processes of professional transformation [8] have altered the teaching profession's role from the transmission and delivery of knowledge to a profession in which the future teacher is expected to be a leader, innovator and instructor have accelerated. It is hoped that this development will enable the teaching profession to provide a professional response to the demands of the modern era with values and skills appropriate for the new teacher demands.

3. CONCLUSION

In conclusion, the increasing use of alternative learning trains the future generation of educators to use technology to lead the future generation of leaders that will employ many technologies and digital devices. It is therefore very important to think about and develop the use of these digital tools through the application of what is known about learning processes of the human brain and the influence of technology on these processes and on the ways of thinking of tomorrow's generation. Albert Einstein said, "A person who has never made a mistake has never tried anything new." Therefore, we owe it to our children to make the mistakes that will result in the success of alternative meaningful and relevant learning

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LMS CONTENT DEVELOPMENT IN ESP: LEGAL ISSUES

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Abstract: Content-based instruction is an approach in English language teaching where teaching is organized around the content or information that students will acquire, whereas language is a means of acquiring information, rather than an end in itself. The university language teacher has the responsibility to identify not only relevant grammatical or other linguistic aspects but also the content needed and the materials suitable for students' needs. Thus, using authentic materials is beneficial for ESP teachers who are not experts in the study field of the faculty where they teach, because the authentic materials provide a good source of language and the content the teachers need to deliver. However, when a teacher finds useful authentic resources, the copyright issues arise. In this paper we will discuss several legal aspects of content development in ESP within learning management systems at tertiary level (university institutions, colleges, and high schools) with the special emphasis on intellectual property rights.

Keywords: ESP, LMS, eLearning content development, intellectual property right, copyright, citations, quotations, repurposing.

1. INTRODUCTION

Nowadays many universities offer online or distance courses for their students. Sometimes an online course is complementary to traditional classes, sometimes it is the only way of delivering materials needed for a student to pass the exam. The most complex aspect of content delivery and management is by using learning management systems (LMS) by means of which teachers not only deliver and manage the subject content but they also have a wide range of learning analytics options (the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs). In this paper, we will discuss some legal issues concerning teaching materials within the LMS officially provided by a university. All eLearning materials are copyrighted automatically under the law when created (in Serbia it is The Law on Copyright and Related Rights, hereinafter: The Copyright Act). Furthermore, many authors protect their work by putting a copyright notice. Typical copyright notice consists of a copyright statement: the copyright symbol (© or (c)), the word copyright, name of the copyright holder, year in which the work was copyrighted, and the words "all rights reserved".

However, our concern here is not about whether the teacher is protected from unauthorized copying and plagiarism. The questions we would like to discuss here are unauthorized copying and plagiarism in order to create content for English for Specific Purposes (ESP) courses and what an English teacher can do in order to use authentic materials in a permissible way. We will consider the following aspects:

- the development of content using authentic materials: what is permissible, what is not; and
- the authorship of the developed material: the original author, the ESP teacher as an instructional designer, the University where the teacher works, or a third-party.

2. DEVELOPMENT OF CONTENT USING AUTHENTIC MATERIALS

Authentic materials are of vital importance for teaching foreign languages, especially when teaching ESP. In this paper we will refer to the authentic materials in terms of real-life texts, not written for pedagogic purposes and not initially designed for the purpose of teaching, not altered, adapted or simplified as they, in such form, provide exposure to real language. They relate more closely to learners' needs and they support a more creative approach to teaching. These authentic texts are used for language exposure; when it comes to practising key structures, the authentic texts are to some extent adapted for exercises. For the sake of this paper it is enough to say that there are two broad categories of authentic materials beneficial for ESP students, such as text and audio-visual. Nowadays when we talk about audio-visual material, we usually refer to the combination of auditory and visual materials, such as films/movies, animated materials with recorded sound, video recordings, commercials, trailers, interactive training courses, video catalogues, computer games. There are following options where to choose class materials for IT students from:

- Field/subject specific vocabulary lists;
- Corpora: Using corpus linguistics;
- Official sites (Microsoft, Cisco, MicroTik, etc.);
- Newsletters, magazines, (scientific) journals, blogs, fora (IEEE Spectrum, etc.) [1]; and

- Published specialist books.

3. USE OF COPYRIGHTED WORK

As defined in The Practical Law Guide, intellectual property rights (IP rights) are "personal property rights which are designed to encourage the creation and exploitation of inventions, designs and other materials by entitling the owner to prevent their unauthorised use. They enable the owners to generate regular income by using the protected materials themselves or licensing others to do so. They may also raise capital by selling them outright." [2]

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) lists the rights that fall into the scope of intellectual property rights: copyright and related rights, trademarks, geographical indications, industrial design, patents, layout-designs (topographies) of integrated circuits and undisclosed information (trade secrets). [3]

The focus of this paper will be on copyright and related rights, as other rights could be breached via LMS only under extraordinary conditions.

The Serbian Copyright Act defines the works of authorship "*as an author's original intellectual creation, expressed in a certain form, regardless of its artistic, scientific or some other value, its purpose, size, contents and way of manifestation, as well as the permissibility of public communication of its contents.*" [4]. For example, this act enlists books, sketches, paintings, movies and other types of works as those that can be granted the status of copyrighted works. Almost identical provisions exist in all countries of the region. They all envisage that an author (or a copyright holder) has an exclusive right to allow or to forbid to third parties, among others:
- to reproduce;
- to place in circulation;
- to perform;
- to broadcast;
- to publicly communicate; and
- to adapt the work.

A) Consent

As previously stated, the author may allow the use of their work. This consent can be tacit and explicit. The most usual way of explicit consent is a license agreement.

Internet access is widespread and the exchange of works is faster than ever before. Therefore, private initiatives were created in order to make obtain the consents easier, especially when they are given without pecuniary compensation. Special attention should be paid to Creative Commons (CC) licence. CC licences allow for legal use, sharing, repurposing, and remixing as long as the used material is attributed accordingly. There are six licences [5]:
1. Attribution – CC BY: lets others distribute, remix, tweak, and build upon the work cited, even commercially, as long as they credit the author for the original creation.
2. Attribution-ShareAlike – CC BY-SA: lets others remix, tweak, and build upon the work cited, even for commercial purposes, as long as they credit

the author and license their new creations under the identical terms.
3. Attribution-NoDerivs – CC BY-ND: lets others reuse the work for any purpose, including commercially; however, it cannot be shared with others in adapted form, and credit must be provided to the one who reused the original work.
4. Attribution-NonCommercial – CC BY-NC: lets others remix, tweak, and build upon the work cited but non-commercially, and although their new works must also acknowledge the author and be non-commercial, they don't have to license their derivative works on the same terms.
5. Attribution-NonCommercial-ShareAlike – CC BY-NC-SA: lets others remix, tweak, and build upon the work cited, non-commercially, as long as they credit the author and license their new creations under the identical terms.
6. Attribution-NonCommercial-NoDerivs – CC BY-NC-ND: only allowing others to download someone's works and share them with others as long as they credit the author, but they can't change them in any way or use them commercially.

B) Consent-free

The consent rule is followed by exceptions envisaged in the Copyright Act. These exceptions can be divided into two groups:
- Those where the above-mentioned actions can be done without consent and without paying the royalty fee (Articles 42 – 54v); and
- "Statutory licence" (Articles 55-57). The consent does not have to be obtained, but the royalty has to be paid.

As it can be seen in both cases, the consent can be avoided, but the difference is to be found in terms of royalties.

a) Absolutely Free

The first set of exceptions is related to the use where royalty does not have to be paid. For our case study the relevant is the one set within:

Article 49
Short excerpts of a work of authorship, or individual short copyright protected works, may be reproduced or be communicated to the public (right of quotation), without the author's permission and without paying remuneration, on the following conditions:
1) The work has been disclosed;
2) The mentioned parts or short works, are integrated into another work without alterations, for the sake of illustration, confirmation or reference, with a clear indication that a reference is involved and in compliance with the fair practices; and
3) The name of the quoted author, the title of the quoted work and when and where the quoted work was disclosed or published are noted in a suitable place, if those data are known.

For instance, in case of LMS used for teaching English for specific purposes, short stories, magazine articles or several paragraphs of a novel can be used in order to illustrate how specialist language is used in different types of publications.

b) Statutory Licence

On the other hand, there are exceptions that exclude the obligation to obtain the author's consent for the use of the work, but with the obligation to pay the royalty.

These rules are set in the following provision:

Article 55
(1) Without the permission of the author, and with the obligation of paying the remuneration for copyright, it is allowed, in the form of a collection (database) intended for tuition, examination or scientific research, to copy on the paper or similar carrier, by photocopying or some other form of photographic or similar technology which gives similar results, the parts of the published copyright-protected works, individual short published copyright-protected works in the field of science, literature and music or individual published copyright-protected works in the field of photography, architecture, applied arts, industrial and graphic design and cartography if it concerns published works of several different authors, unless the author explicitly prohibits that.

(2) Provision of Paragraph 1 of this Article shall not apply to sheet music.

As can be seen, these provisions also cover works in different fields, and they also cover both short and parts of longer works.

The main difference between the norms of Article 49 (citations) and Article 55 (Statutory License) is that the second relates to the *"collection"* of works intended for tuition. The background of this separate provision is a matter of practicality. If an author is making a collection or compilation of works, it is rather hard to obtain multiple individual consents and to negotiate individual royalty fees. Therefore, the obligation to obtain consent is lifted in the situation where multiple authors of different individual works are involved.

However, the main focus is still on the word "collection" which includes collections of poems and stories, albums, etc. where they are not followed by any specific additional work of the author of such compilation, except structuring them into a coherent collection.

An LMS designed for English language learning and instruction is not a mere collection of works, but it is a work mainly comprised of language lessons, with examples, followed by substantial commentary and explanations. The copyright-protected works are deeply integrated into the final work. Therefore, in our opinion, in most cases, the English language LMS's use of other copyrighted works or their parts can be subsumed under the quotation rules. This is in line with the viewpoint of Mr Vladimir Maric, director of the Serbian Intellectual Property Office, stating that the quotation always has to be integrated into the new work of art. [6]

Some learning management systems, such as LAMS at Belgrade Metropolitan University, allow sharing learning objects among teachers. A learning object (LO) is "any digital resource that can be reused to support learning with at least three internal and editable components: content, learning activities and elements of context. The learning objects must have an external structure of information to facilitate their identification, storage and retrieval: the metadata. [7] The basic idea behind LO is reusability, which, broadly speaking, means – sharing with others, as well. Some possible problems include the situation when individual teachers share resources with colleagues they are almost never cited or attributed accordingly.

The corrective rule that also has to be considered is the one set within the provision of Article 41 (Par. 2) of the Serbian Copyright Act:

In each specific case, the scope of limitation of exclusive rights may not conflict with fair exploitation of the work nor may unreasonably prejudice the legitimate interests of the author.

This provision gives additional instructions that the standard of fair use has to be followed in the assessment of proper application of the citation clause. Therefore, for example, if the copyright-protected work is used excessively and it represents more than 60% of the final work than such use would not be considered as suitable to be subsumed under this clause, due to the standard of fairness. The percentage given above is provided as an example, and there are no strict legal rules that would give the exact limit.

4. EDUCATIONAL PURPOSES

Special exceptions are envisaged for educational purposes. However, the Copyright Act has quite limited wording, in comparison to the corresponding exception at the EU level.

a) Serbia

The Serbian Copyright Act provides an additional exception for the free use of copyright-protected work. Article 44 prescribes that the consent and royalty are not necessary when the published work of art is used for non-commercial purposes. The full wording is rather vague but implies that:
- Only "direct" use at the physical class is possible,
- Use at physical schools' events; or
- Via digital means, but only within the premises of the educational establishment.

Furthermore, we are of the opinion that the courts in Serbia would interpret "non-commercial purposes" in such a way that only publicly owned educational establishments, i.e. state schools can refer to this exception.

Therefore, the right to quote is a more suitable option for the practical issues' creators of LMS within Serbia.

b) EU

The old EU legislation was unclear on the scope of exceptions or limitations as they apply to digital uses. In addition, there was a lack of clarity as to whether those exceptions or limitations would apply where teaching is provided online and at a distance. The European Union and

professional audience realised that developments in information and communication technologies had created various new educational tools. These include Virtual Learning Environments. They also noted that the existing exceptions for educational establishments had been crafted at a time when such tools were not available and when the Internet was in its infancy [7].

The Directive on Copyright in the Digital Single Market [8] addressed this issue and now allows free use of work of arts for educational purposes. The exception or limitation provided in the Directive on Copyright in the Digital Single Market should apply only to the extent that the uses are justified by the non-commercial purpose of the particular teaching activity. The organisational structure and the means of funding of an educational establishment should not be the decisive factors in determining whether the activity is non-commercial in nature. It is important that the use takes place under the responsibility of an educational establishment, on its premises or at other venues, or through a secure electronic environment accessible only by the educational establishment's pupils or students and teaching staff. Of course, the indication of the source, including the author's name, unless this turns out to be impossible.

These provisions have to be implemented into the national laws within the following two years. The positive impact of these changes to the Serbian legal system is indirect. Serbia will have to harmonise its legislation as well. Meanwhile, even before the harmonisation, under the Stabilisation and Association Agreement (Article 75), Serbian courts can use the wording of the Directive on Copyright in the Digital Single Market to interpret the provisions of Article 44 of the Copyright Act in a broader manner than they would typically do. This especially applies to the interpretation of the scope of non-commercial purposes.

5. RELATED RIGHTS

The Copyright Act regulates the rights that are related to the copyright itself. Those rights are the right of performers (e.g. singers), phonogram producers (CD), movie producers, broadcast producers and database producers. All of these rights are envisaged in Articles 111-149. Everything that was said for the copyright itself is applicable for the related rights under the explicit provision of Article 144. This means that if a short voice recording of a person reading a copyrighted text, would be also considered as citation, if the name of the person reading the text is properly noted.

6. RIGHTS AFTER THE COMPLETION OF THE WORK

As stated in the introduction, after the new work (LMS) is created, with all the incorporated parts of the works of other authors, the creators of LMS are granted rights immediately after the creation of the work. That is envisaged by Article 8 of the Copyright Act.

If the work is created during the employment, the employer has all commercial rights lasting five years after the

moment of the creation of the right. This period can be even longer if it is especially envisaged by a contract or employer's internal bylaws. Author's moral rights remain intact even in this case. These rules are set within the Article 98 of the same piece of legislation.

CONCLUSION

To develop students' four language skills sometimes textual sometimes audio-visual materials can be used for teaching. There are different sources available in English, where the most common are: published specialist books, corpora, official sites, newsletters, magazines, (scientific) journals, blogs, fora. Nevertheless, for the authentic materials to be used effectively, they must be chosen with respect not only to didactic and methodological aspects but also to intellectual property rights. The authors, i.e. the teachers preparing the teaching material for their students have to both observe the IP rights of others and protect their own IP rights (when the textbook or study material has been completed). As a general rule and legally, intellectual property produced in the course of employment belongs to the employer. On the other hand, traditionally, for example, individual members of academic staff in higher education have controlled the IP in their publications. It is therefore vital that developers, practitioners, instructional designers of eLearning content have a clear idea and understanding of what is permissible with the product of their labours and what is impermissible. [8]: generally speaking, it is permissible to copy and redistribute the material in any medium or format, repurpose it, and build upon the material for educational and non-commercial purposes only, always giving appropriate credit to the original author of the content.

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EFFICIENCY OF DEVELOPMENT OF E-LEARNING MATERIALS BASED ON LEARNING OBJECTS

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Abstract: The paper describes development of e/learning materials at Belgrade Metropolitan Universities based on fine/grained learning objects. Authors use mDite authoring tool developed by BMU to create a multimedia online lesson, dat is managed and delivered to student by LAMS *Learning Activity Management System. Author implemented this approach to develop courses for a short-cycle program "Programming in Java" with 13 short courses, by using existing learning objects developed for a bachelor program "Software Engineering". It is demonstrated that fine-grained learning objects retrieved from BMU Leering Objects Repository significantly increased efficiency of development of learning materials and allowed easy customization of online lessons.

Keywords: *E-Learning, Distance learning, online, learning objects, development of e/learning materials*

1. INTRODUCTION

Fine-grained learning objects have been used for development of learning materials for all courses at Belgrade Metropolitan University. All authors use mDita authoring tool developed at BMU [4] for developing their learning materials that are managed and presented to students by LAMS (Learning Activities Management System) [5]. Each online lesson usually contains 10-15 learning objects. Authors develop new learning objects and store them in BMU repository of learning objects (LOs) for future use also by other authors, if they need. Currently, LO Repository of BMU contains more than 50.000 learning objects. Sharing of LOs increase reusability of LOs and efficiency of development of new learning materials.

Use of fine-grained LOs also allows personalization of learning materials as authors may build online lessons with different learning paths for different categories of students [1]. Each learning path contain common but also specific LOs, so the students may have different sets of LOs, designed according to their need, motivations and capabilities.

This paper[1] presents another efficient use of fine-grained LOs stored and shared in BMU LO Repository in case of development of learning materials for new courses which

predominantly use already developed LOs stored in BMU LO Repository. This was the case when BMU had to develop in short time, courses for a new short-cycle program "Programming in Java", with EQF level 5 [8]. In [2] we presented this program with 11 new core online courses. This paper will focus on development of learning materials based on reusable learning objects.

2. DEVELOPMENT OF LEARNING MATERIALS FOR SHORT-CYCLE PROGRAMS

Short-cycle programs aim to educate and train students in short time (up to 18 months) for a specific job. Short/cycle programs have been introduced in higher education of Serbia in 2017 when new Low for Higher Education of Serbia [7] was adopted. Our PT&SCHE Ersamus+ project [6] provided the groundwork for this adoption of short-cycle programs. One of BMU's tasks was to implement a pilot online short-cycle program. BMU chose to develop and implement "Programming in Java" short-cycle program aiming to educate and train future junior Java programmers. The duration of the program is 12 months and it provides 60 ECTS.

The European ICT Professional Profiles [9], which defined 23 work profiles, i.e. jobs at the first two hierarchical levels, leaving the third level to be define by ICT companies and ICT educators. According to this, BMU specified the job profile: "Java programmer" at the third level and launched the SCHE program "Programming in Java". Our work profile "Java Programmer" is the specialization of the work profile

"Developer", specified at the second level of ICT work profiles.

European ICT Professional Profiles specifies, for each workplace, the following: job description, performance, main tasks and competencies, in the form of e-competences defined in the document *E-Competence Framework (e-CF)* [10]. For the *Developer* position, it has been defined that it must have five e-competencies listed in the *E-Competence Framework document (e-CF)* [7]: B.1. Design and Development, B.2. Systems Integration, B.3. Testing, B.5. Document Production, and C.4. Problem Management.

Having in mind these competences, and the Body of Knowledge (BOM) of BMU BSc program "Software Engineering", a subset of it was created representing the BOM for short-cycle (SC) program "Programming in Java" (Fig. 1). We identified 19 courses of BSc Program "Software Engineering" that use some parts BOM specified for SC program "Programming in Java", lasting 12 months and providing 60 ECTS. We decided to create two versions of SC program: one with 13 core online courses (Fig. 1) and another one with 11 core and one elective online courses. So, the problem was how to map 13 SC courses from 19 BSc courses (Fig. 1).
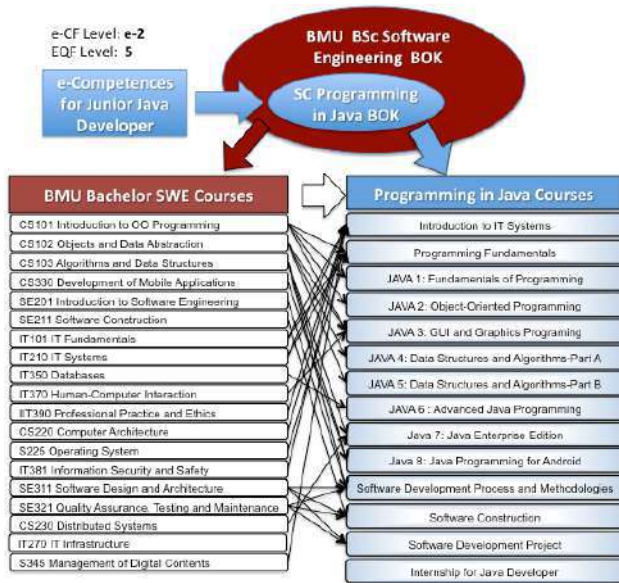
Figure 1: Creation of SC courses by selecting relevant LOs from BSc courses

As all our learning materials consists of small/grained learning objects (LO) the mapping problem became easy one, as we had just to select some LOs for BSc Courses and put them into one of CS courses (Fig. 2).
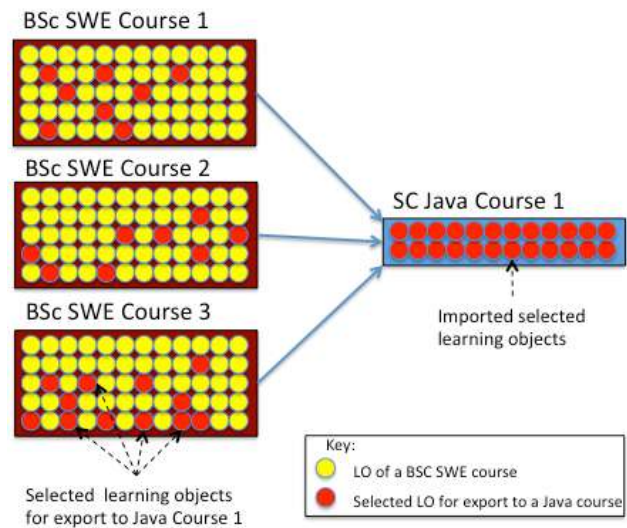
Figure 2: Selection of relevant LOs from BSc courses to create SC course with needed LOs.

The creation of SC course is not finished after putting selected LOs in its basket. We have to decide about the order of LOs. Now we face a specific feature of SC courses and comparison, with BSc courses. As SC courses are created for student that need to get practical knowledge and skills, and have, in general, lower learning capacity then students of BSc courses, we decided to implement a different learning methodology. Instead of putting all lecture objects together, as in case of SC courses, we decided to create at least several smaller groups of learning objects together, followed by relevant exercise objects and assessment objects. So, we got now an online lesson of a SC course with N learning steps, consisting of three sub-steps: learning-exercise-assessment (Fig.3).
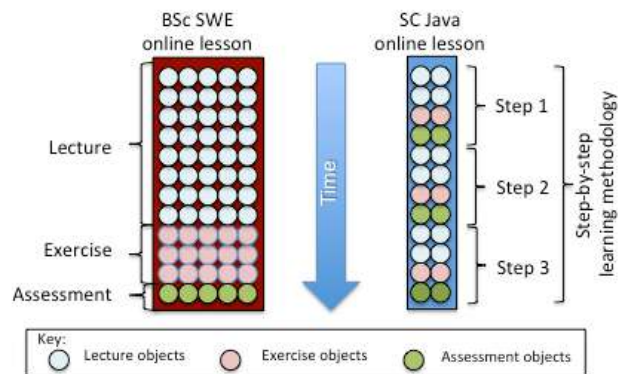
Figure 3: Implementation of "step-by-step" learning methodology in construction of SC courses

Using this development methodology of courses for short-cycle program "Programming in Java" we created its 13 SC courses presented in Fig. 4.

#	Course	Duration (Days)	Online Days (3 hrs/day)	Workshop Days 3hrs/day	Learning Hours 3hrs/day	ECTS
1	Introduction to IT systems	15	14	0	42	4.0
2	Programming Fundamentals	11	8	2	30	3.0
3	Java 1: Fundamentals of Programming	17	14	2	48	5.0
4	Java 2: Object-oriented programming	13	10	2	36	3.0
5	Java 3: GUI Programming	17	14	2	48	4.0
6	Java 4: Data Structures and Algorithms – Part A	16	13	2	45	4.0
7	Java 5: Data Structures and Algorithms – Part B	16	13	2	45	4.0
8	Java 6: Advanced Java Programming	15	12	2	42	4.0
9	Java 7: Java Enterprise Edition	24	21	2	69	7.0
10	Java 8: Java Programming for Android	14	11	2	39	4.0
11	Software Development Process and Methodology	18	15	2	51	5.0
12	Software Construction	21	18	2	60	6.0
13	Software Development Project	6	5	10	45	4
14	Internship for Java Developer (8 weeks)	40	0	0	0	3
	Agregate:	243.0	168.0	32.0	600.0	60.0

Figure 4: Online teaching hours and ECTS of the courses of the SCHE program "Programming in Java"

As can be noticed, the use of reusable LOs in development of new courses provides the following benefits:

1. **Efficiency:** We spent 1-3 days for developing a new SC course if only available LOs were used.
2. **Design flexibility:** Rearranging of LOs is easy and allows easy configuration of online lessons, supporting different learning models.

3. USE OF REPOSITORY OF LEARNING OBJECTS

One of main benefits of using LOs in development of e-learning materials is the *reusability of LOs.* In order to support of reusability and sharing of LOs BMU developed a repository of LOs, currently storing more then 50.000 LOs. It is important to provide an efficient system for retrieving of LOs. BMU uses the following techniques for searching and accessing required LOs:

1. Use of keywords stored as values of attributes of LOs (metadata), such as: LO title, LO keywords, difficulty level of LOs, and reading duration of LO.

2. Navigational access by using the known taxonomy of BoK.

BMU uses SWEBOK V3.0 [12] (for all SWE knowledge areas) and Computer Science Curricula 2013 [11] (for programming fundamentals) for BSc Program "Software Engineering". It can also be used for development courses of short-cycle programs, as shown in previous section. An alternative approach is to uses LOs stored in a repository

of LOs. Authors of LOs are asked to specify a string specifying access path to a set of LOs using the same topic of BOK, as explained in [3]. Fig. 5 shows the structure of SWEBOK V3.0 that is used for navigational access to LOs. BMU defined a taxonomy of strings for specified knowledge areas, knowledge units, and topics.
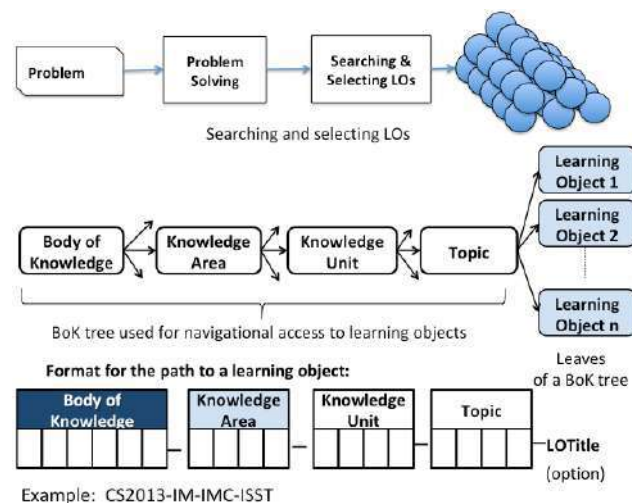
Figure 5: The structure of a BoK and the format of the path to LO

If an author of e-learning materials needs a specific LO, he has to have a look to the specification of all components of a BOK and use it to retrieve all LOs sharing the same topic of BOK, as shown in Fig. 5. Course designer then can choose the appropriate LO and import it into his/her online lesson that he/she is developing. Fig. 6 shows this development process of learning materials based on reusable LOs.
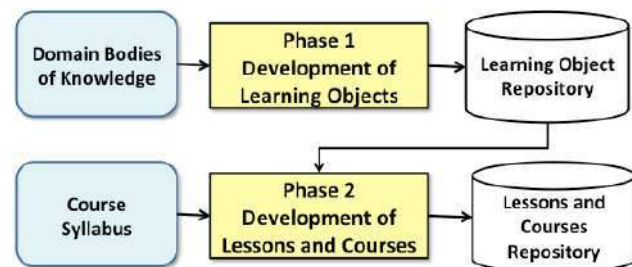
Figure 6: Development of learning materials based on shared learning objects stored in LO repository

The structure of the repository of learning objects allows to search by defined metadata. Apache Solr [13] is used as a search engine to search the repository of learning objects, who communicates with the search interface located within the mDita editor and is accessed by the author of the teaching material. The Alfresco Document Management System [14] is used to store physical files of learning objects. Within the learning object repository, the XML files of the learning objects containing the metadata are searched. The repository also contains HTML learning objects and content which is located in learning objects (images, audio and video materials, additional resources). Figure 7 shows the structure of the repository of learning objects and how the search is performed and the search results obtained are presented. The process of searching the repository of learning objects is presented in red and

the color of the defined search (results of the search) is presented in blue.

Figure 7: Learning object repository structure

The repository search is done through the authoring tool (mDita editor) which is developed at Belgrade Metropolitan University. The author of the teaching materials can search the repository using metadata (audience, object title, school year, author, goals, keywords, classification - navigation path as explained in Fig.5), goals). It is possible to search the repository also by part of the text in the learning object.

The initial search for a repository is based on the selection by the author of the teaching material, depending on the choice of how the author wants to perform the search. The author of the instructional material may define a search that requires that the metadata or part of the text is strictly matched in the learning object or that there is only a specific part of it (that part of the text entered in the search exists in some learning object and not the text entered completely in the search box). The same goes for other metadata, the author can only enter part of the classification of the learning object and thus obtain all the learning objects that have the specified part in their classification. Figure 8 gives an example of selecting metadata by which to search repositories.

Figure 8: Selecting metadata to search the repository of learning objects

The example in Figure 9 shows a defined search within which to find a part of the learning object text that contains the words "*use case diagrams*", then that the learning object contains the classification "SEP-PIC-MPIC" and that there is an abbreviation for ATM in the name of the learning object.

Figure 9: Defining Metadata to Begin Searching for Learning Object Repositories

When the search for the repository of learning objects is complete, the search result represents the learning object "ATM System Development", which is shown in Figure 10. The learning object has in its name the word "ATM", in its classification "SEP-PIC-MPIC" and in the text of the word "*use case diagrams*" The author of a teaching material can enter a learning object directly from the displayed search results in his lesson and make changes to the learning object if necessary.

Figure 10: Repository search result obtained
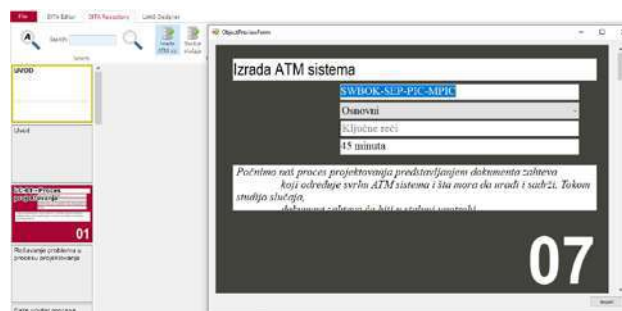
When the author of a teaching material saves a new lesson in which a learning object has been added that was found through a search of a repository of learning objects, a new version of the learning object is remembered in the repository as modified by the author. The old version of the learning object also remains in the repository.

5. CONCLUSION

Development of e-learning materials based on reusable learning objects has been in implementation at Belgrade Metropolitan University since academic 2011/12 year. During these nine years, BMU has been actively

improving this development process, by improving its specialized authoring tool (mDita replaced QDita) and experimenting with personalization of e-learning materials.

In this paper we presented the use of reusable learning objects stored in BMU LO Repository for development of learning materials for the short-cycle program "Programming in Java" that use existing LOs developed previously for courses of BSc program "Software Engineering". We developed learning materials for 13 new courses of short-cycle program "Programming in Java" very easy and fast, as we mostly used already developed LOs stored in our LO Repository. We identified two major benefits of using reusable LOs:

1. Development of learning materials for new courses was easy and fast, lasting one to three days, depending of the duration of new courses. For each courses we had to select needed LO from our LO Repository and import into new learning materials. Our mDita authoring tool and mDita Repository gave us all needed functions.

2. As short-cycle program "Programming in Java" required a specific "step-by-step" learning methodology, sequencing of LOs in each online lesson was done by creating small learning step, each providing 3 sub-steps: learning a new concept, implementation of it through eaxmples and given tasks, and finalizing with assessment of achieved results. The realization this learning method, normally not used in academic programs, was easy and fast, due to the use of fine-grained reusable LOs.

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RAISING THE SKILLS OF BUSINESS ANALYSTS - THE BENEFITS OF ELEARNING TECHNOLOGIES IN CORPORATE EDUCATION

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Abstract: *A Learning for an employee during working hours, is challenged by limitation of work to deliver, and working timeframe. Accordingly, educational training for employee development should have an efficient impact and a frame for learning. A course for business analysts, UML, covers a wide range of employee profiles who will learn from it. This one covers basic and expanded levels of knowledge, including understanding a variety of cases, using the eLearning platform, to cover elementary knowledge of UML through different employee profiles. Here we describe how to find the measurement for course content, scope, volume, examples, estimated learning time, and how to evaluate knowledge, so employees can learn among their working obligations, to spend fewer hours for more knowledge, to learn online from different locations.*

Keywords: *E-Learning, Corporate education, Design, and development of online courses, microlearning.*

1. INTRODUCTION

Motivation

Comtrade Digital Services (CDS) is a software company that provides strategic software engineering services and solutions. The market for software development has the highest demands in expertise and specific skills. One of the most critical expertise is software solution architect and software, business analyst. The company needs to have a structured deep understanding, certified knowledge, and experience in the field of business analyses and software architecture. The company needs to apply that knowledge and experience in the process of solutions creation, including designing, development, and verification.

Challenge

Comtrade Project management Office (CT-PMO) realized the following:

- In a history of the company business development, in different phases, it had different approaches to clients and the market. Causes were company adjustments to market changes and internal reorganizations [1]. To keep up with required structured knowledge for accepting market challenges, it needed to educate employees to respond to these demands promptly and to be continuously ready [1];

- Within the company, there were more than 100 employees who had a business analyst related role at some project, and more than 700 software engineers [1] who needed a deep understanding of software architecture;

- In general, inside this kind of a company, there is a constant need for continuous employee development. Every day some project has a demand for new knowledge. It is a must for an employee to expand skillset and to be able to adapt to a rapidly changing environment easily [1]. For the employee, it is important to learn continuously.

Response to challenge

As a response on these challenges, CT-PMO intended to create training for software engineers which would include programmers, developers, testers, analysts, architects, project managers, system engineers, and anyone else who needs to specify, design, build, or understand complex software systems. That was a part of the strategy of its education section, to develop PM tools and PM academy curriculum to have quality trained employees [1].

One of the dimensions of software architecture demand is familiarity, understanding, and deep knowledge of UML. It is the first step in common understanding of definition and meaning of requirements for the software inside communication between client and project team, and between members of the project team. It is necessary for all phases of software development life cycle (SDLC), from planning to deployment.

By definition, Unified Modeling Language (UML) is a general-purpose, developmental, standardized modeling language in the field of software engineering enabling software engineers to specify, visualize, construct and document a software system, to provide a standard way to visualize the design of a system [2].

As the UML is a language, it has a lot of syntax definitions, complex semantic rules, and it could be difficult material for learning [2].

During 2014-2015 CT-PMO organized three inhouse pieces of training at one location. Engineers were trained to learn UML. Trainings occurred for seven weeks, for three hours, divided into two sessions. Main benefits were as follows:

- Fifty engineers were trained;

- Understanding of UML was raised among engineers in one location;

- Along with the training, they interacted with the teacher, with questioning and practicing sessions.

CT-PMO identified significant disadvantages to overcome:

- Time consumption of a large number of engineers dedicated to project;

- An engineer should invest a lot of time to attend, and learn later;

- Only engineers from one location were trained, and organization of a similar training on all other locations was more complicated;

- It was a real challenge to find teacher ready to prepare such training for engineers, working on real software development, instead of for faculty students, with knowledge related to real project examples;

- Predicted costs of training other engineers within all locations, and cost for engineers' absences from projects were significant for the company;

- Changes in the working project for an engineer may be frequent in one software company. For that reason, these training should be continually organized for engineers in new positions.

Factors of success

According to this intention and experience, CT-PMO had the following objectives for success achievement:

- To make documented, systematic and repeatable learning method and content, which implies that every business analyst or engineer has an equal education opportunity and the same attitude about the subject;

- To be a useful reference to the UML, in different level of details, related to needs by roles (from programmers and testers to business analysts);

- To facilitate learning during working hours and among project activities;

- To improve employee skills and practice knowledge in this field [1];

- To increase the number of employees who are learning about a topic, within all locations, close to 50% of engineers (350 of them).

To meet the challenge, these courses should achieve the following requirements:

- Not to jeopardize working performance and time dedicated to project tasks;

- To optimize training and learning costs;

- Access to courses for employees should be from multiple distant locations inside the company and not limited by time;

- To be self-driven and self-paced;

- To speed up employee learning among fast-paced project environment;

- To be easy to read in small chunks;

- To make it easy for the teacher to create a course;

- To provide digital records and administration;

- To evaluate employee knowledge;

- Give immediate feedback and recognition;

- To have measurable results and reporting.

Research focus

The company was faced with similar difficulties of education, inside the recruitment process between 2009-2013., after which it had a successful application of e-learning portal for new candidates. This action resulted in raising the quality of recruitment and quality of knowledge of newcomers [3]. As a Learning Management System - LMS platform of choice, in that case, was Moodle, designed according to pedagogical principles [3]. Due to accomplished results, this was considered to be the best practice, and CT-PMO implemented e-learning principles, using Moodle as a platform, to the PMO Education portal. It became the PMO tool for software engineer's internal education, and skillset strengthening [4].

Based on these experiences, to meet set goals and requirements, CT-PMO decided to use the following concepts to create e-courses:

- *E-learning*: By one of definition, it is „a part of the new dynamic that characterizes educational systems at the start of the 21st century, resulting from the merge of different disciplines, such as computer science, communication technology, and pedagogy " [5];

- *Distance learning*: Is describing an „effort of providing access to learning for those who are geographically distant" [6];

- *Microlearning*: A Teaching method which suggests dividing knowledge and information into small chunks for learners. This method facilitates understanding of learning subjects and makes it be in memory for a longer period [7];

- *Bite-sized learning*: This approach uses relatively small learning units with short term focused activities, it is focused on outcomes and usually just on one key objective [8];

- *Moodle platform*: By its creators, Moodle is a learning platform designed to provide educators, administrators, and learners with a single robust, secure, and integrated system to create personalized

learning environments [9]. Tools such as Moodle and web courses provide easier access to information and knowledge exchange.

Using these principles, in 2017., CT-PMO created two levels of courses for employees regarding their profiles and project needs:

- The first level of courses is for all engineers, developers, testers to recognize and read UML diagrams;

- The second level of courses is for business analysts, architects, and other engineers who should be able to define and create solutions to write/draw diagrams and to design solutions.

2. METHODOLOGY

Course frame

Courses are created using the company PMO educational portal, based on the Moodle platform, developed by CT-PMO. It is reachable from every location within the company and every engineer [4]. E-learning materials are stored online, so employees can access important resources any time they encounter the need for the skill, a question or difficult situation, whenever they have spare time, to learn at their own pace. After an engineer enrolls into the course, it enables asynchronous communication between teacher and engineer.

Every course is described by *summary; Audience; Learning Objectives; Duration*: expected to last 8 or 20 hours, depending on course; and *Completion*: To complete this course engineer will need to go through all its content (open pages and read the content) and pass the final test. An employee can enroll as a student on any of these courses, without prior knowledge or background on subject content. On the end of course employee, now student may read references used for course creation and further references.

Learning objectives for courses of I and II levels of knowledge:

- I level course "*UML Introductions*" has objectives to understand the basics and concept of UML; get familiar with basic architecture and mechanism of UML; know more about main relationships, recognize some UML diagrams;

- II level courses "*UML Behavior diagrams*" and "*UML Structure diagrams*" has objectives: understand the basics and concept of UML diagrams; get familiar with their elements and usage; know more about main relationships usage; recognize and draw UML structure diagrams.

Course structure

The course is delivered in smaller portions. The motivation was to prevent the employee from getting bored, to get him/her interested in course, to give the employee opportunity to learn using the short time between project activities, during some short breaks, in the after work-free time, or during dedicated work time.

Image 1: Course structure

The core of the course includes eight lessons broken into six mini-lectures, predicted to be read between 5-15 minutes. Microlearning and bite-sizing learning principles are applied in designing the lesson structure. Examples then follow it for practicing, within every lesson, and after all, mini-lectures. There is no limitation for lectures reading the order so that student may read them by self-interest.

Image 2: Lesson structure

After all lessons with mini-lectures, there is a lesson with examples, where a student can learn about designing complete system by technology/application domain, on several complete examples, which include the application of knowledge from all lessons and their mini-lectures.

Image 3: Example structure

When a student read the material, it is automatically marked, by filled checkbox beside it. Only when all lessons,mini-lectures, examples, and other materials are

marked as read, student, at his/her own paced when feels ready enough, could start and go through the test. The test will be marked as complete and passed only after the student receives a passing grade, which is 80% of correct answers for 12 of 15 questions. The student is allowed to take the unlimited test number of times until he/she gets the passing grade. After test completion, the student may see the feedback on his/her knowledge as correct and incorrect answers of the test.

After the student passes the test, he will be offered an option for ordering a certificate of completion and an option for answering a survey for the course. If a student sends a request for the certificate, it will be issued from CT-PMO, on the test passing date, signed by the teacher and the CT-PMO director, assigned to a student, and sent to the student email. This certificate is short evidence of recognition.

Image 4: Certificate of completion as a recognition system

After passing the test, student-employee will still have the opportunity to read all materials, by own interest.

Course progress tracking

Student-employee can keep track of his learning progress because materials are being marked once they are opened and read.

Image 5: Tracking the progress of learning for a student

A teacher has an overview of the activity completion for every user and every activity.

Image 6: Activity completion for a teacher review

Test Structure

The test is created to give feedback to the student after it is completely answered. It offers the possibility to flag some question and to return to answer again, before the final test submission. Every question, even if they are of different complexities, carries the same rate of the final grade, to make simple feedback of results in the end.
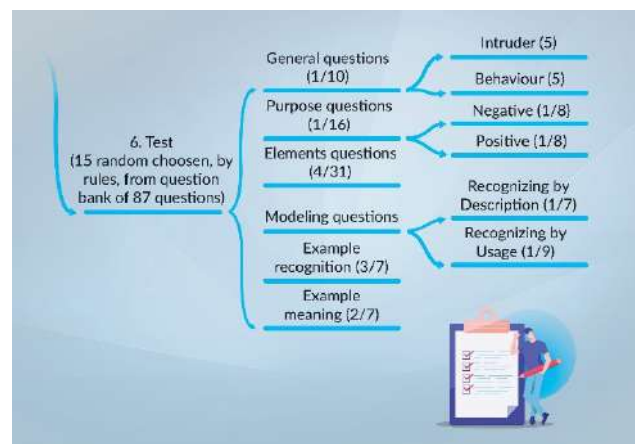
Image 7: Test structure

All 87 questions are defined inside question bank, grouped by six categories and six subcategories. While test occurring, 15 questions are chosen, by defined rules from question bank. Randomly inside question category. For example, there are eight predefined questions at category "Purpose questions." They are randomly selected in the following manner: one from the subcategory Positive, one from the subcategory Negative, and one from any of these two as it will be chosen from category. Questions demand selection of proposed answers but are still a lot different.
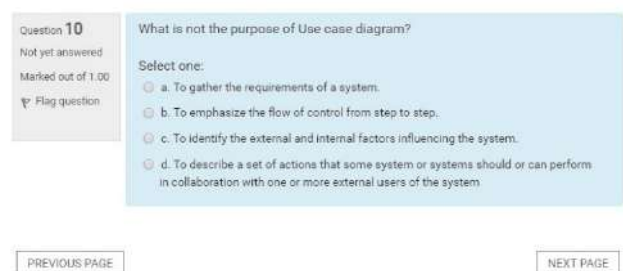
Image 8: Test question example

Student can navigate through the test questions forward and backward, may change answers, flag and unflag

question, and all this can be done until the test answers submission.

Survey as feedback

The purpose of this survey is to help CT-PMO to understand how well the online training on this topic enables the employee to learn. Considering responses, it can improve the way this training is presented online in the future. The survey consists of 11 questions with five offered responses: (5) strongly agree, (4) agree, (3) neither agree nor disagree, (2) disagree, (1) strongly disagree.

Table 1: Survey questions

	Questions
Q1	This online training covered the content I was expecting?
Q2	The learning objectives were set and met.
Q3	This kind of training could be valuable preparation for deeper classroom learning on a related topic.
Q4	I feel very confident about my knowledge of the course subject.
Q5	The content of the training was focused on issues that interest me.
Q6	What I have learned is important for my professional practice.
Q7	I think critically about ideas in the readings and probably will do some more research on the topics.
Q8	Presented examples and additional materials helped me gain a clearer understanding of the subject.
Q9	The test gives additional value to the course material (not too easy or difficult to answer).
Q10	The test appropriately tested the material presented in the course.
Q11	The content of the training was organized and easy to follow.

Twenty-one employees were answering the survey.

Table 2: Survey responses

Q	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	14.29%	71.43%	0.00%	14.29%	0.00%
2	0.00%	100.00%	0.00%	0.00%	0.00%
3	0.00%	100.00%	0.00%	0.00%	0.00%
4	0.00%	71.43%	14.29%	14.29%	0.00%
5	0.00%	85.71%	14.29%	0.00%	0.00%
6	42.86%	57.14%	0.00%	0.00%	0.00%
7	0.00%	57.14%	14.29%	28.57%	0.00%
8	14.29%	85.71%	0.00%	0.00%	0.00%
9	28.57%	71.43%	0.00%	0.00%	0.00%
10	42.86%	57.14%	0.00%	0.00%	0.00%
11	0.00%	100.00%	0.00%	0.00%	0.00%

Questions with the most positive feedback are indicators that learners are aware that content is important for their professional practice, that course helped them to gain a clearer understanding of the subject, that test gives additional value to the material, and the test appropriately covers that presented material from the course.

Questions with the most negative feedback indicate that some learners do not feel very confident about their knowledge on the course subject, are slightly less interested in doing some more research and finding that content is not aligned with their expectations.

Teacher administration

Using characteristic of Moodle for material administrations, with predefined material types and easy to use editor, the teacher has facilitated course editing environment. After the course is created, Moodle offers a wide range of administration and tracking user activities functionalities [9].

3. RESULTS

Comparing traditional vs. e-learning training CT-PMO has the following results:

- 50 engineers participated in traditional sessions during 2014-2015, while 217 read a part or complete material from e-learning courses during 2017-2019;

- Traditional courses were held at one location, for employees at that location, while e-learning courses accessed employees from 8 distant company locations.
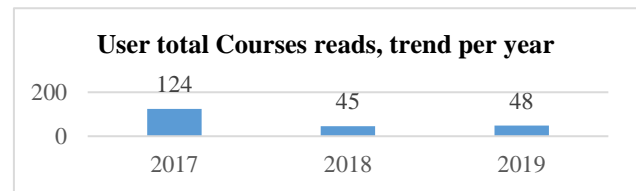
Image 9: Learners per year
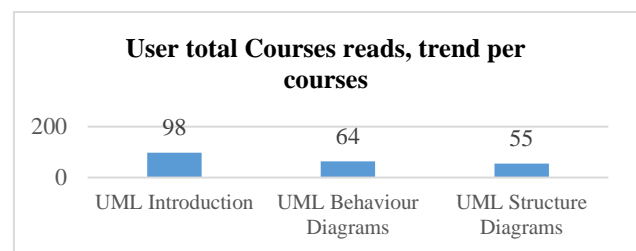
Image 10: Learners per course

4. CONCLUSION

This approach led CT-PMO to accomplish set objectives:

- We made documented, systematic and repeatable learning method and content, and every business analyst and engineer have an equal education opportunity and the same attitude about the subject;

- Created courses are a useful reference to the UML, in different level of details, related to needs by roles: I level – introduction and recognition for all engineers, and II level – advance details for drawing diagrams for business analysts;

- It facilitated learning during working hours and among project activities, due to its accessibility any time from anywhere;

- It gave a framework for improving employee skills and practice knowledge in this field;

- By e-learning, CT-PMO increased the number of employees who were learning about a topic, within all locations.

Also, CT-PMO courses achieved all the requirements:

- Applied microlearning and bite-sized learning concepts enable easy reading, from small chunks;

- There is no need for leaving a working space for the learning, and employee can learn in portions during breaks, waiting's, leaking hours. Thus, e-learning with microlearning does not significantly affect working performance and time dedicated to the project;

- For employees, access to online courses from CT-PMO educational portal, is possible from all points at the corporate network, all distant locations within the company and it is not limited by time;

- E-learning concept enables self-driven and self-paced learning;

- As a consequence of all these characteristics, CT-PMO has speeding up of employee learning;

- Online courses decrease training and learning costs;

- Using the chosen platform, it is easy for the teacher to create a course;

- Electronic database of online education provides digital records and administration;

- Using testing within course allows employee knowledge evaluation;

- The employee gets immediate feedback after testing, and CT-PMO certification of completion as a recognition system;

- We can measure results by having all necessary data recording inside educational platform database. These data also allow sufficient reporting.

CT-PMO recognized the following challenges and pitfalls of e-learning in the described case:

- If a high level of learning activities is expected, it is not enough to create an e-learning course and leave it at an educational portal for learning. The company needs to motivate employees to start using it, as it requires a high-level of self-motivation, self-discipline and personal time management;

- An example is that CT-PMO did not reach the goal completely to increase the number of employees who are learning about the mentioned topic, to 50%;

- Interaction between student and teacher is minimized, which makes distance and decreases interest and inner motivation of engineers for learning such a rigid topic;

- Inside observation of results, there is no methodology for measuring the impact of e-learning method on employee real project performance.

To overcome that, further actions inside CT-PMO education could be to improve these e-learning training, and is directed to the following:

- Exploiting more interactive sessions, include videos and online workshops;

- Engaging blended learning, as a combination of classroom and online learning: it can be more effective than both traditional face to face instruction and entirely computer-mediated instructional approaches. Students can collaborate remotely through emails, cloud applications, and blogs. Instructors can integrate online chat rooms to encourage students to have a threaded discussion or debate on a topic covered previously in class; [10]

- Expanding training offerings to the third level of related topic learnings, for business architects, to learn about design patterns.

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BIG DATA ANALYTICS:
LECTURES FROM THE LAMBDA NETWORK

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Abstract: *Big Data Analytics is crucial component of the Big Data paradigm and corresponds to the knowledge extraction from enormous amount of data. As the number of Big Data related methods, tools, frameworks and solutions is growing, there is a need to systematize the knowledge about the domain. Hence, in the LAMBDA project framework an effort was made to develop a new set of lectures based on the education materials and courses offered by the University of Bonn and University of Oxford. This paper provides an overview of the LAMBDA training infrastructure and the open education contents developed so far, as well as initial evaluation about the possibilities for adoption of lectures at high-education institutions in the West Balkan countries.*

Keywords: *E-Learning, Big Data Analytics, open education, platform, lectures*

1. INTRODUCTION

Big Data refers to data sets which have large sizes and complex structures. The data size can range from dozens of terabytes to a few Zettabytes and is still growing [1]. While more than 800,000 Petabyte (1 PB= 1015bytes) of data were stored in the year 2000, this volume will reach 35 Zettabytes (1 ZB= 1021bytes) by end of 2019 [2], and is expected to grow 61% and exceeds 175 zettabytes by 2025 as per International Data Corporation IDC expectations [3]. Big Data Analytics, hence, refers to the strategy of analysing large volumes of data that gathered from a wide variety of sources, including social networks, transaction records, videos, digital images and different kind of sensors.

Challenges [4] related to the European ability to exploit the potential of Big Data are fragmentation of the data ecosystem, due to different national policies, languages, and sectors involved; fragmentation of data research efforts and lack of effective exchange of results; shortage of highly skilled persons for data-related jobs; and the complicated process of updating legislation. In an attempt to support the European data economy policy [5], in the LAMBDA project framework, the LAMBDA consortium proposed a training approach and established the infrastructure for collaborative work of LAMBDA teachers/trainers (see Figure 1, providers) with PhD students and other interested parties (see Figure 1, Consumers).

This paper describes the infrastructure that was established to reinforce organizational learning and capacity building at the Institute Mihajlo Pupin (PUPIN) and to facilitate teachers-trainees cooperation in the larger network of experts in the field of Enterprise Knowledge Graphs (EKGs), Semantic Big Data Architectures (ARCH), and Smart Data Analytics (SBDA).

The paper is structured as follows. Section 2 introduces the LAMBDA project, the learning approach and the learning infrastructure. Section 3 provides an overview of the newly developed lectures on topics from the Big Data Analytics domain. Section 4 presents the first evaluation of the lectures from PhD students and professors perspective, while Section 5 concludes the paper.

2. LAMBDA OPEN EDUCATION APPROACH

LAMBDA Project

The overall objective of the project is to stimulate scientific excellence and innovation capacity, to increase the research capacities and to unlock the research potential of the biggest and the oldest R&D Institute in the ICT area in the whole West Balkan region, turning the Institute Mihajlo Pupin into a regional point of reference when it comes to multidisciplinary ICT competence related to Big Data analytics. In July 2018, the LAMBDA consortium started activities for improving the skills and competences for smart data management through a set of actions including:

- development of a Knowledge repository (Learning and Consulting Platform) that shall facilitate spreading excellence and exchange of learning materials and best practice between the international leading organizations and research institutions and Industry from the West Balkan countries;

- organization of international events (training, workshops, webinars, conferences) in the West Balkan countries for raising awareness about future trends in Big Data, Semantic Tools and Technologies, standards and applications (or adoption) in the industry;

- forecasting exercises about future trends of data services in Europe.

Organizational learning and capacity building approach

The capacity building approach [6] introduced into PUPIN with the LAMBDA project is based on the document *Strategic Capacity Building Plan[1]* that serves as a model and articulates how research institutions of low performing Member States and regions can reach the level of internationally-leading counterparts such as Fraunhofer Institute, University of Oxford and University of Bonn can support low performing Member States and regions can to reach the level of internationally-leading counterparts. Hence, in order to support the transfer of institutional knowledge and expertise to PUPIN staff, but also to other relevant stakeholders in the region, the *LAMBDA Learning and Consulting Platform* was established using the Drupal content management system (CMS). The platform facilitates collaboration including joined paper and deliverable writing, information sharing, and stakeholders' data-base management. The learning materials that were produced in the first project year are free, stored in the LAMBDA repository and are available online via the SlideWiki.org, an OpenCourseWare platform. The SlideWiki platform has been selected based on its collaborative features partially developed by LAMBDA researchers in SlideWiki framework.

LAMBDA Platform Customization

LAMBDA platform was configured for the needs of the future newcomers and professionals in the BDA domain. Currently, 3 different user roles have been defined:

- *Partner*, full access to the private pages of the portal.

- *Associated Partner*, full access to the Stakeholder database (restricted) and contents in the Knowledge Repository.

- *Administrator*, for managing the whole content management system.

The LAMBDA Knowledge repository (Learning and Consulting Platform) aims at facilitating the exchange of learning materials, tools, project results and best practice between the international leading organizations and research institutions and Industry from the West Balkan countries.

SlideWiki and LAMBDA platform integration

Initial activities related to providing access to the SlideWiki system on the LAMBDA platform were oriented towards analysing the most efficient approaches for the implementation of this feature on the LAMBDA CMS system. The following two approaches were considered and analysed:

- Embedding the SlideWiki within a Drupal page, on the LAMBDA platform, using an IFrame (Inline Frame). An Iframe represents a nested browsing context, embedding another HTML page into the current one.

- Creating a page in PHP, within the LAMBDA platform which would access the API of the SlideWiki micro-services, using the HTTPS secure protocol and display the results using the custom-made UI created in Drupal using PHP.

So far, the first approach has been fully implemented while we continued to work on the second approach. One very important feature of an OpenCourseWare system like SlideWiki is the ability to import and export data from/into different data formats [7]. The main data format used in SlideWiki is HTML. Instead of starting from scratch, SlideWiki users can import existing presentations, created using other applications and platforms, when creating new decks. Currently, SlideWiki supports direct import of content from .pptx files (mainly used by Microsoft PowerPoint) and .odp files (mainly used by LibreOffice/OpenOffice).

3. LAMBDA LECTURES

Systematizing the knowledge about the Big Data domain

Currently, main providers of lectures relevant for LAMBDA are the University of Bonn (UBO), The University of Oxford (UOXF), the German National Library for Science and Technology (TIB) and the Institute Mihajlo Pupin:

- UBO is working on the cutting edge technologies related to Big Data, Intelligent Analysis and Information Systems. The concerned team at the Smart Data Analytics (SDA) group is active in specializing applied research in intelligent data and knowledge analysis and teaching activities of the relevant topics.

- UOXF is working on cutting edge technologies related to Big Data and analytics. The concerned team at the VADA ("Value Added Data Systems")

[1] https://project-lambda.org/Action-Plan-2018-2020

group is active in research and teaching activities with regard to these topics.

- TIB is working on development of cutting edge technologies semantic data processing, knowledge engineering and information systems in different domains.

- PUPIN is working on development of novel data analytics algorithms for different industrial domains including the energy sector[2].

Introduction to Knowledge Graphs

[EKGs-Lecture-1] This module introduces the topic of Knowledge Graphs, the similarities and differences between "world" Knowledge Graphs and Enterprise Knowledge Graphs, as well as theory and practice in the area. Knowledge Graph is [8]

- Fabric of concept, class, property, relationships, entity descriptions.
- Uses a knowledge representation formalism (RDF, OWL)
- Encompasses holistic knowledge (multi-domain, source, granularity):
  - **instance data** (ground truth), open (e.g. DBpedia, WikiData), private (e.g. supply chain data), closed data (product models),
  - derived, aggregated data,
  - **schema data** (vocabularies, ontologies)
  - **meta-data** (e.g. provenance, versioning, documentation licensing)
  - comprehensive **taxonomies** to categorize entities
  - **links** between internal and external data
  - **mappings** to data stored in other systems and databases.
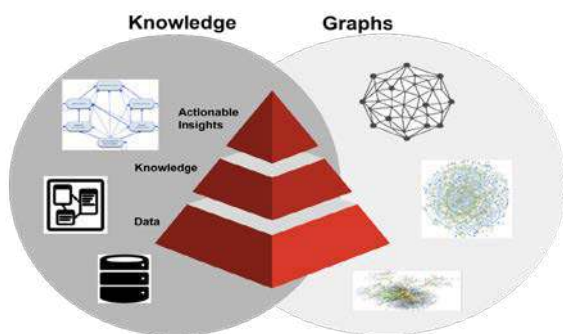
Image 1: Knowledge Graph (definition)[9]

Reasoning in Knowledge Graphs

[EKGs-Lecture-2] This module discusses reasoning in Knowledge Graphs. Reasoning is essential to gain value from Knowledge Graphs by deriving insights, and making available new implicit data from existing data. It covers the theory and practice of reasoning in Knowledge Graphs, and provides a number of easily accessible examples based on Oxford's Vadalog system [10].

Extraction for Knowledge Graphs

[EKGs-Lecture-3] This module discusses the topic of extraction for Knowledge Graphs. It focuses on web data extraction process that is essential for making the information available on the web accessible and usable by Knowledge Graphs.

Introduction to Big Data Architecture

[ARCH-Lecture-1] This lecture covers the existing advanced Big Data architectures following a bottom-up approach. In this lecture, the important knowledge to design and architect scalable solutions for challenging problems is introduced. The primary components in the architecture of such systems and their architectures is presented and discussed including "inter alia distributed kernels" and cluster managers, distributed file systems and storage systems.

Big Data Solutions in Practical Use-cases

[ARCH-Lecture-2] This lecture focuses on architecting Big Data solution. It discusses the role and importance of the components in realizing system architectures. The application of the introduced concepts and components is discussed in real-world example of practical use-cases.

Distributed Big Data Frameworks

[ARCH-Lecture-3] The "processing frameworks" are one of the most essential components of Big Data systems. There are three categories of such frameworks namely: Batch-only frameworks (Hadoop), Stream-only frameworks (Storm, Samza), and Hybrid frameworks (Spark, Hive and Flink). This lectures also one of the major Big Data frameworks, Apache Spark. It covers Spark fundamentals and the model of "Resilient Distributed Datasets (**RDDs**)" that are used in Spark to implement in-memory batch computation. Furthermore, essential parts of the important practical techniques are introduced such as Hadoop Distributed File System for the data resiliency, and the "lineage" property of "Directed Acyclic Graphs (DAG)" to achieve resilience for the computation resiliency, or use of catalyst for code optimization.

Distributed Big Data Libraries

[SBDA-Lecture-1] In the practical level, the Big Data frameworks use different APIs for graph computations and graph processing. In this lecture, the important libraries built on top of Apache Spark are covered. These include SparkSQL, GraphX and MLlib. The audience will learn to build scalable algorithms in Spark using Scala.

Distributed Semantic Analytics I

[SBDA-Lecture-2] This module covers the needs and challenges of distributed analytics and then dive into the details of scalable semantic analytics stack (SANSA)[11] used to perform scalable analytics for knowledge graphs. It covers different SANSA layers and the underlying

principles to achieve scalability for knowledge graph processing.

Distributed Semantic Analytics II

[SBDA-Lecture-3] This module covers the setup, APIs and different layers of SANSA. At the end of this module, the student is able to execute examples and create programs that use SANSA APIs. The final part of this lecture is planned to be an interactive session to wrap up the introduced concepts and present attendees some open research questions which are nowadays studied by the community.

4. EVALUATION

The possibilities for wider adoption of LAMBDA lectures was analysed with participants of the first LAMBDA Big Data Analytics School[3] that was organized in June 2019. Overall, more than 60 participants gathered at the PUPIN premises to exchange knowledge and expertise in Big Data technologies. The objective of the summer school was to give the PhD students and experts from Serbia and abroad and PUPIN researchers an opportunity to learn about the newest technologies and trends in this and related fields from respectable professors, as well as to hear about use cases from influential tech companies such as OntoText, SAS Institute, CISCO, Meltwater, and DeepReason.ai. The Feedback questionnaire was distributed to participants of the School and in-person interviews were conducted with selected participants. Twenty-tree (23) participants answered the questionnaire, for instance, parts of the answers are presented in Table 1. The feedback will be used to better plan the next-year summer school and to communicate the LAMBDA recommendations to relevant stakeholders. The *LAMBDA Foresight Exercise and Policy Recommendations* document will be prepared by June 2020.

5. CONCLUSION

The potential behind the exploitation of data (Open, Linked and Big) to boost economies and growth has been in the focus of many EU initiatives, the most recent of which is the Digital Single Market, which highlights the need to make sense of Big Data, since this is considered to be a fertile ground for innovation in both technology and development. Thus, the main topic of the European Union funded project LAMBDA (Learning, Applying, Multiplying Big Data Analytics) is Big Data Analytics and the semantics-based approach to processing data (Linked Data, Open Data, Big Data).

This paper presents some of the results achieved so far in the LAMBDA project, in particular, the ones related to the

- publishing of open educational resources (Big Data & Analytics lectures) via the LAMBDA portal and the SlideWiki OpenCourseWare platform;

- the organization of the Belgrade Big Data Analytics Summer School, for more than 60 participants from PUPIN, industry and other universities from Serbia and the West Balkan Region.

The exploitation of Big Data in various sectors has a potential socioeconomic impact far beyond the specific Big Data market. The foreseen activities in LAMBDA (open education, research-industry collaboration) will strengthen the digital skills of professionals and improve the technologies and services of the involved stakeholders (PUPIN and other stakeholders from West Balkan), thus contributing to national and regional sustainable development.

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Table 1: Feedback collected during the first Big Data Analytics Summer School

Organization	Feedback collected
PhD student, University of Belgrade	*I would like to see the lectures presented at the School integrated in one of the master courses organized at the School of Electrical Engineering, for instance 'Data Mining and Semantic Web', 'Natural Language Processing' and other.*
PhD student, University of Niš	*The courses organized at the Electronic Engineering Faculty (AI, Knowledge Discovery, Data Warehouse) are related to the lectures presented at the School. What was interesting in the last 3 days were the Use Cases presented.*
Expert from public administration	*For someone with my interests and duties, this was in every sense an extraordinary experience (equally, the first, more general day, and the second day of a more technical nature). Probably all other participants, like me, are impatiently waiting for news from the consortium.*
Expert from Bank sector from Serbia	*I think that mentioned projects and Data analytics tools will be more useful to colleagues interested in the academic perspective to Data analytics and Big data in general, than to us who work in industry, but I believe that the information I get about them will be very important in the future.*
Professor from Romania	*The LAMBDA lectures are good candidates to be reused as support material within the curricula of Big Data master program: Introduction to Big Data and Architectures, Distributed Big Data Frameworks, Big Data Solutions in Practice. The courses that may benefit are: Data Warehouses and Big Data Technologies.*
Professor from Germany	*I would like to see more interactions between the teachers and participants.*

E-LEARNING, ARTIFICIAL INTELLIGENCE AND ONE OLD TEACHER

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Abstract: *Concern about artificial intelligence is increasingly expressed in public discourse. We are warned about the redundancy of human beings in creative and productive processes. E-learning, by contrast, evokes little concern, and yet trends in e-learning are leading to the elimination of teacher-student interaction and thus to the erosion of education and literacy. On e-learning platforms, teachers do continue to create and communicate content, as they did in traditional settings. Lectures are tested, and students form learning communities. E-learning can also be adapted to the students' individual schedule and rhythm of studying. However, since e-learning often does not take place in real time and the available technical means make possible the delivery of content to mass audiences, a critical element of education is missing: the direct communication between the teacher and student. To elevate e-learning beyond mere training, e-learning platforms must not overlook the importance of immediate interaction between teacher and student.*

Keywords: *E-Learning, Artificial Intelligence*

1. INTRODUCTION

What is "e-learning" and what are its advantages and disadvantages? The term e-learning is used commonly to mean a combination of "distance learning" and "computer-assisted learning". E-learning courses usually include video lectures, bibliographies, material for self-tests, controlled and graded tests, forum platforms for students' interaction and support by teaching assistants. Though e-learning does not preclude real-time online seminars, the trend is towards pre-recorded videos and delivery of content to mass participants. Indeed, the value of e-learning is that by exploiting available technology, it can bring new knowledge to large, geographically dispersed audiences.

To analyze the usefulness of e-learning, we need to decide whether the goal is "training" or "education" and "literacy". This distinction in the German language is captured by the concepts "Ausbildung" and "Bildung" and, in Serbian, by "образовање" and "odgoj".

Drawing on personal experience, I argue first that successful e-learning shares the same characteristics as good conventional training and education. I then consider the potential role of artificial intelligence in e-learning in terms of the extent to which it can promote the goals of education and literacy.

2. PERSONAL EXPERIENCE

I feel very ambivalent towards e-learning. Early in life, before the age of personal computers, I viewed the prospect of electronically assisted and innovative learning methods enthusiastically. I was a fan of science-fiction literature. I looked forward to computers, robots and artificial intelligence. E-learning was envisioned in that literature by various methods including hypnopedia or sleep learning. It seemed fantastic to me to learn by repetitive training and bypass exams, tests and tedious methods.

I enjoyed learning in school and university and am thus positively disposed to traditional classroom learning. I studied also remotely via a "Distance University".[1] Throughout my career, I took advantage of various e-learning possibilities to enhance my knowledge, such as in "deep learning", "quantum computing" and several mathematical disciplines.

Being not just a receiver, I have taught as well. I gave lessons to colleagues at school and university. Early in my career, I taught courses in the instrument usage of measurement devices. Eventually, I taught "Software Architecture for Large Business Enterprise Solutions"[2] at universities in Vienna and Leipzig, and most recently I delivered courses for certification in software testing and requirements writing.

3. CHARACTERISTICS OF SUCCESSFUL E-LEARNING

E-learning has recognized advantages. It liberates learning from the fixtures of time and space: one can learn anywhere in one's own time. It may also be without cost on certain platforms if one does not need or aspire to certificates of completion or attestations of test performance. Based on my experience of e-learning, I believe the learning experience can be differentiated in terms of quality due to certain factors. Here I describe some course examples and highlight the key factors.

Very positive and helpful courses

One of the best courses I ever attended is "Introduction to Mathematical Thinking" by Dr. Keith Devlin[3] of Stanford University. This course is intended for high school graduates who want to study subjects that require mathematical knowledge. On the very challenging tests, one is required to grade the performance of other students using six quality attributes (yielding a total of 24 points).

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[1] Fernuniversität Hagen, BRD

[2] International Insurance and Banking companies

[3] https://de.wikipedia.org/wiki/Keith_Devlin

One earns points if one's answer varies by no more than four from the teacher's answer. Each test is discussed later in a lecture. Here, the grading by and of peers, enabling one to see and engage deeply with the steps and methods of others, followed by a summative discussion is very effective.

In the videos of the course Dr. Devlin conveys his empathy and consideration of high school students who are thrown into the more rigorous and less supportive environment of universities. He writes his text slowly on the slides as if he were writing on a chalk board, making it easy to follow his talk. Crucially, Dr. Devlin demonstrates a deep enthusiasm for the subject.

Another excellent learning experience was the courses in music given by Professor Jonathan Biss of the Curtis Institute of Philadelphia.[4] Aimed at music listeners, not active players, the courses covered the structures and wider understanding of Beethoven piano sonatas. It was quite easy for him to show enthusiasm as he was teaching from a position sitting at the piano and supporting his text by playing sections of music examples. Seeing the pianist and his emotions while playing illuminates the technical and theoretical content of his lectures and serves to sustain the information learned.

Good courses with some drawbacks

A similar enthusiasm and communication of the joy in learning was achieved by the lecturers of the courses I took on machine learning and quantum computing. The videos were addictive: I wanted to watch the next one straight away. However, to answer some of the questions, I found it necessary to refer to books not on the syllabus. I had to invest considerable time referring to these outside sources. The lack of opportunity to ask the teacher these questions and have them answered directly in a human conversation lowered the efficiency of the learning.

E-learning with a bad taste

To fine-tune my own teaching of "Requirements Writing" for people who wish to obtain certification in the field, I attended a course on this topic. The content conveyed via videos was nothing more than typical frontal teaching. I believe no one would be drawn to the subject by such dry and formal lectures. Be it via electronic means or direct lecturing in a hall, if the teacher inspires no joy in learning, it is a grave deficit.

4. LEARNING FROM A HUMAN TEACHER

What are the limits on dispensing with human teachers entirely? Though artificial intelligence has little to do with e-learning at present, it is the nature of human beings to improve and explore the limits of its own limitations. Submitting education to "intelligent helpers" appears inevitable in the context of e-learning. Which subjects are amenable to teaching via artificial intelligence? Which ones are not?

Morals and Ethics

Artificial intelligence could be much more objective in teaching contestable topics that resist "absoloute statements". Human teachers reflect cultural, religious and majoritarian biases as well as changing standards over time and may, by contrast, be less objective in conveying ethical content.

However the artificial intelligence may also be handicapped by intrinsic contradictions of rules. Consider "the Categorical Imperative" of Immanual Kant. Introduced in his 1785 *Groundwork of the Metaphysics of Morals*, the concept is a means of evaluating motivations for action.[5]

According to Kant, moral action is categorically right, and it must be followed in all circumstances: "Act only according to that maxim whereby you can, at the same time, will that it should become a universal law." [1]

Kant's rule seems to be an over-simplification. There are many cases when the rule is of no help at all. Two people are in danger of drowning; you know you can save just one. Whom do you save? Could an artificial intelligence apply a rule that conforms to Kant's easy formula?

Kant was of the 18th century. In the 20th century philosophy has changed. Analytical philosophy, practiced by such figures as Bertrand Russell, Ludwig Wittgenstein, (2) G.E. Moore and Gottlob Frege, makes use of formal logic and emphasizes the clarity and precision of arguments. One could conclude that if problems may be mastered by applying the formal argumentative methods of analytical philosophy, artificial intelligence may be a good teacher. However, when Kurt Gödel's Incompleteness Theorems[6] are taken into account [2], along with successor theorems that claim that formal systems, such as algorithms, cannot prove all truths [7] [8] [9], we must be sceptical of the ability of artificial intelligence to to solve value-based problems or ethical dilemmas.

Many similar examples could be invoked to argue that an artificial intelligence is unable to teach uncertainties. What about teacher-administered e-learning? Can ethical questions and philosophical problems be taught adequately on e-learning platforms? If e-learning is confined to large, anonymous mass courses, I claim that it cannot. To teach philosophy – that is, to draw out new ideas, to interrogate assumptions and to foster the ability to think critically – direct interaction between teacher and student is necessary, as Socrates and Plato practiced. To learn, you cannot memorize blunt statements and rely on logic alone. After all, even Wittgenstein, who in his "tractatus logicus" argues for step-by-step reasoning from simple

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4 https://en.wikipedia.org/wiki/Jonathan_Biss

5 "Handle nur nach derjenigen Maxime, durch die du zugleich wollen kannst, dass sie ein allgemeines Gesetz werde."

6 https://en.wikipedia.org/wiki/G%C3%B6del%27s_incompleteness_theorems

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9 https://en.wikipedia.org/wiki/Halting_problem

assumptions, or better axioms, to a whole building of logical truth, ends by saying: if you have come here, forget everything and destroy the ladder by which you came. [2]

Intellectual Freedom

Another compelling thesis for the necessity of a human teacher is found with Gottlieb Fichte [3]. In *Grundlagen des Naturrechts* Fichte tries to deduce the necessity of a system of social rights and institutions from the idea of personal freedom. Vice versa the human being needs rights and institutions in order to become "free persons". This is a situation of the chicken and the egg. Which comes first? How does a finite subject achieve an awareness of itself as a free person? The thesis states that only in connection with other people whom one considers free can one develop one's own consciousness of freedom.

Currently, most people would reject the thought that an artificial intelligence could be considered free. Hasn't it been programmed by humans and isn't it therefore confined to rules and static limitations? Or, if artificial intelligences were to become free-thinking – sufficient to inculcate in students an awareness of their own intellectual freedom – would society welcome it? The prospect of artificial intelligences thinking freely is still considered a threat to our civilization. Popular culture is saturated with the theme of artificial intelligence running without human control.

Arts

The absolute necessity of a human teacher is apparent in the arts. Whether with regard to creative or reproducing artists, every student of the arts requires in-time feedback and inspiration through personal attention. We can appreciate the indispensability of human teachers by studying the biographies of famous artists and consulting concert programs. Integral to the musician's artistic profile is the information about the teacher with whom she has studied. One cannot play well by just listening to the videos. One needs real-time feedback and interaction as well as the enthusiasm, empathy and inspiration that are the keys to good teaching.

5. CONCLUSION

Successful e-learning requires the same key teaching capabilities as in conventional learning settings: empathy, enthusiasm and the ability to inspire. Thereby, learning is made enjoyable. E-learning is useful for training mass audiences and for conveying "uncontestable knowledge" in technical subjects, such as programming languages, physics or chemistry and specialized fields of instrumentation. But where the goal is to educate students to think freely, and to answer questions that are contestable, filled with uncertainty and logical contradictions or to resolve ethical dilemmas, e-learning platforms that sever the real-time connection between the teacher and student are inadequate. Philosophical understanding requires interrogative intercourse between students and teachers. Artistic development requires a connection to a human mentor. I conclude that e-learning can be useful as a means of training (образовање) of mass audiences, but not for education and literacy (odgoj).

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IMPLEMENTATION OF MACHINE LEARNING BASED METHODS IN ELEARNING SYSTEMS

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Abstract: *Machine learning methods can be used in various ways in order to improve e-learning systems. These methods can be used to recommend future actions in e-learning system, implement advanced evaluation methods, discover student preferences, identify learning content and resources, create automated tutoring systems, create comprehensive curriculum, implement crowdsource and collaborative learning, etc. This paper investigates how machine learning and its techniques can be used in e-learning platforms and styles of learning. With machine learning, e-learning systems can be designed to be more efficient, for both students and instructors. Students can gain more personalized learning content, which increases students' motivation and learning experience, while instructors can benefit from automatized tasks, which reduce time for learning content organization, visualization and preparation. By analyzing the collected and processed data, instructors can quickly identify "at risk" students, while machine learning algorithms can adjust course content to help each student overcome their weak points. Machine learning models analyzed in this paper are Bayesian Networks (BNs), Decision Tree (DT), Artificial Neural Networks (ANN), Deep Learning (DL), Association Rule Mining (ARM) and Clustering methods (CM).*
Keywords: *E-Learning, machine learning,*

1. INTRODUCTION

In the recent years e-learning has been utilizing vast spectrum of technologies to enhance learning and teaching experience with different applications, learning methods and processes [1]. Researchers have been using different approaches to improve content delivery in e-learning systems. One of the approaches that has been used to shape e-learning system, methods and approaches is machine learning. In cases where "learning by doing" is preferential, machine learning can be helpful in order to improve experiential learning [2]. For example, Pilot Support System collects and analyzes aircraft (i.e. flight path, immediate environment around the aircraft, the weather and terrain information) and pilot data (provided by eye tracking and biological monitor), which are used for pilot and air traffic controllers simulation training. Real set of data helps in conducting experiential learning in simulated environment with the aim for trainees to learn to take appropriate actions on time [3].

E-Learning has also been used: (i) to access extensive educational resources such as MOOCs and internet libraries [4][5], (ii) for online tutoring [6][7], (iii) to allow learning and teaching collaboration [8][9]. These are some of the technological advances that have unfolded in the past decades. One of the candidates to improve these systems and to take them to another level of learning and teaching experience is by incorporating artificial intelligence and machine learning (ML).

Most of the before mentioned systems generate large amount of data (learning contents, assessments, e-learning log files, academic data of students, etc.) that can be useful for ML algorithms integrated in e-learning systems [10]. Incorporating technology and ML techniques in the e-learning represents a complex, but a promising field, with the aim to shift the paradigm of the learning process and discovering meaningful patterns for successful learning [10][11]. For example, ML classification techniques can be used to classify students based on their learning style, discover student preferences, identify learning content and resources, create automated tutoring systems, create comprehensive curriculum, implement crowdsource and collaborative learning, etc. [12][13].

This paper aims to provide a comprehensive view of using ML techniques in the field of eLearning. Specifically, the focus is put on ML models such as Bayesian Networks (BNs), Decision Tree (DT), Artificial Neural Networks (ANN), Deep Learning (DL), Association Rule Mining (ARM) and Clustering methods (CM).

This paper is organized as follows: Section 2 presents an overview of related works. Section 3 describes the method for data collection and analysis of used ML techniques in e-learning. Section 4 discusses found results. Finally, Section 5 concludes this paper.

2. BACKGROUND

Many researchers have identified the need to improve e-learning platforms, tools, processes and methods in order for these systems to take more informed decisions and become more intelligent, with the aim to improve learning and teaching processes [14]. Some of the areas where e-learning has been enriched with ML algorithms include:

- Delivery of learning content
- Personalization
- Collaborative learning
- E-Learning support tools.

ML techniques can play a significant role in identifying discouraged or disgruntled students based on their posts in the discussion forums, real time facial expressions or similar techniques that can help instructors to identify students that need more attention and motivation. Furthermore, ML techniques can be used to automate e-learning and to make decisions about changing learning materials and activities [15]-[18]. Some of the e-learning systems monitor real-time facial expression in learning environments in order to detect demotivation or decreased concentration during the learning process [19]. For example, Facial Emotion Recognition System (FERS), recognizes the emotional states and motivation levels based on student facial expressions captured in video-conference systems such as Skype. Different ML methods (Support Vector Machine (SVM), k-nearest neighbor (kNN) classification method, Random Forest (RF) and Classification and Regression Trees (CART) algorithms) use facial detection, features and attributes, along with changes of emotional state of learners in order to determine motivation level of learner during the learning process [20].

Personalization represents a topic that is gathering significant attention within the e-learning field and it attempts to not only customize the learning environment, but also to personalize all aspects of the entire learning experience [21] – [24]. Personalized e-learning, therefore, encompasses the ability to customize aspects such as classification and recommendation. E-Learning systems can recommend different content based on student clustering, content classification, learning styles, skills, prior knowledge, and learning preferences, such as: (i) new courses/books to take [25][26], (ii) course format [27], (iii) additional learning material and resources that caters to learner preferences [28][29], (iv) learning content presented to learner [28][30][31], (v) assessments based on student learning pace, etc. [32] - [34]. Recommender systems are only part of personalized systems, which can also be used to: (i) predict students' final grades and classify them into different groups based on their performance [35] - [38], (ii) identify weak students that may need help in the course [39][40], (iii) identify concepts or learning outcomes the students seem to be struggling with [41], etc.

Working in groups and collaborating with peers has shown its benefits in learning and retaining the knowledge [42] [43]. Collaboration on the common project can encourage students not only to be more motivated in learning and accomplishing the common goal, but can also encourage students to effectively communicate with each other and to collectively analyze and discuss possible solutions for the assigned problem. ML can enhance such learning experience in the following manner: (i) analyze the level of collaboration between students in the group projects [44] – [46], (ii) make better decisions in assigning students to groups based on their learning styles and preferences with assumption that students with similar learning styles can cooperate better and share the information among them in a better way [47] – [49].

Benefits of including ML techniques in the e-learning support tools can be used for load forecasting such as traffic throughput and the speed of content delivery, which can both help to determine necessary infrastructure resources. For example, decisions that the course format is modified from video streaming to material in the form of text in order to reduce the traffic load can be made based on the patterns and models developed using ML [50] – [52].

In this work the aim is to:
1. Investigate the status of implemented ML techniques in e-learning.
2. Conduct the cross-analysis among the used ML techniques and identify possible relationships between them.

The following research questions are addressed in this work:

Q1: What machine learning methods have been used in e-learning systems?
Q2: What are the main indicators used by ML techniques in e-learning systems?
Q3: What kinds of tools were used?
Q4: What are the common assumptions and conclusions?

3. DATA SOURCES AND PAPER SELECTION

In order to address the research problem, papers related to using ML techniques in e-learning systems, published from 2010 to 2019 were considered. Papers were searched from the Web of Science (WOS), Google Scholar (GS), Research Gate (RG), and Academia (A) databases. Papers were searched based on the keywords that included: (intelligent OR adaptive OR customized OR machine learning methods) AND (eLearning OR education OR tutoring) AND (system OR software OR application OR tool) AND (evaluation OR assessments). Collected papers were evaluated and screened based on the following criteria:

1. Only journal research papers were included in the present study. Book reviews, conference papers, book chapters, abstracts, news, editorials, and reviews were excluded.
2. The papers that were considered were closely related to ML algorithms and their implementation and usage in the e-learning systems, tools and methods.
3. The papers that were considered reported details about the used ML methods, tools, and indicators. Conceptual papers that did not

describe the details of ML techniques were excluded.

4. Considered papers were published from 2010 to 2019.
5. Only papers reported in English were considered.

This systematic review is given in Figure 1 and it was conducted based on the preferred reporting items for systematic reviews and meta-analysis (PRISMA) [53].
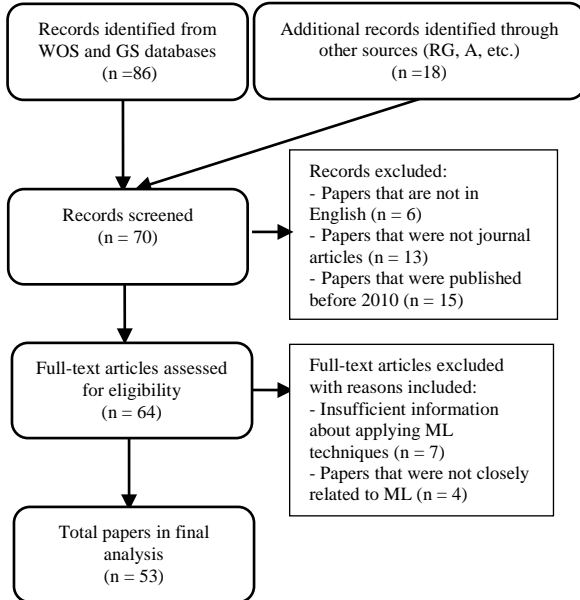
Figure 1: The process of PRISMA for data collection/analysis

4. RESULTS AND DISSCUSSION

In order to answer posed research questions, based on data sources and paper selection, five variables were extracted: (i) the name of the system, (ii) ML techniques that were used, (iii) purposes of applying prosed system/ML methods, (iv) used indicators and (v) software tool that has been used for ML analysis.

4.1. What machine learning methods have been used in e-learning systems?

The most commonly used ML methods to enhance e-learning platforms, tools and methods are listed in Table 1. It can be seen that Bayesian Networks and Artificial Neural Networks are most common. On the other hand Deep Learning is researched in the least amount of papers.

Table 1: Frequency of used ML techniques in the analyzed papers.

ML methods	Percentage
BN	55%
ANN	38%
DT	21%
ARM	17%
CM	11%
DL	9%

4.2. What are the main indicators used in ML techniques in e-learning systems?

ML methods typically use different indicators in its algorithms. In selected research papers indicators used for eLearning, such as learner preferences, behavior, knowledge, skills, and interactions, were analyzed. All learning indicators (behavioral which are derived from the raw data or course achievement) are summarized and explained in Table 2. It can be seen that the indicator *Assessment/Tests* and *Grades* are most common because they were mostly used as a metric to predict learning success. Indicator *GUI and user interactions* help e-learning systems to be improved from the point of human-computer interaction. These indicators were mainly used to determine how and where to display learning resources (i.e. determining what to display first based on the student preferences, video or text). *Learning session* indicator and *Participation in the forum* can represent metrics to determine student motivation, while *Web links viewed* indicator can suggest to tutors what additional resources are needed and what requires additional explanation.

Table 2: Summary of used learning indicators

Indicators	Description	Percentage
Assessments / Tests	- The number of assessments student has started - The number of assessments student has completed - An average score of all assessments which student has completed - A degree of how early student completes assessments	85%
Grades	- The final grade of the prerequisite exams - The exam grade in the end of the semester	35%
GUI and user interactions	- Number of clicks, position of click, etc.	15%
Learning sessions	- Total number of accesses to the e-learning system - Total time spent in learning/reviewing learning content - The frequency of logins (number of logins per day, continuity in logins - every day, several logins per week, etc.)	10%
Web links viewed	- History of accessed web resources as an external links	5%
Participation in the forum	- Total forum discussion messages read/posted (new and replays)	2%

4.3. What kind of tools were used?

It is of interest to analyze various applications and tools used to support collection and analysis of data for ML algorithms. These tools are used for data mining tasks such as data preparation, classification, regression, clustering, association rules mining, and visualization. List of identified tools that were used are summarized in Table 3. Unfortunately, most papers do not report on used tools and these are listed as "N/A." It can be seen that from the identified tools WEKA is the most used (23%), followed by MATLAB (11%), and other software Python

/ R / TensorFlow (7%). WEKA and MATLAB contain collection of ML algorithms for data mining tasks that provide: (i) tools for training and comparing different ML methods, (ii) and commonly used classification, regression, and clustering algorithms. Python, R, and TensorFlow also contain large library repository and allow for easy integration with other programming languages such as C, C++ or Java.

Table 3 - Summary of learning indicators

ML tools	Percentage
WEKA	23%
MATLAB	11%
Python / R / TensorFlow	7%
SPSS	1%
N/A	58%

4.4. What are the common assumptions and conclusions?

Common assumptions and conclusions can be analyzed from a positive and negative point of view.

From a positive perspective, the ML methods applied in e-learning could be a foundation of further support for individuals during the entire learning process. Reviewed research works have achieved and displayed numerous successful results in this domain. Used indicators analyzed by ML methods at the early stage of learning could be used to categorize learners and identify "at risk" students based on their online activity. For example, the students who are categorized as procrastinators could be periodically reminded to access the online materials at the remaining stages. At the end of learning, these measures are helpful to use for evaluation of learner learning behavior.

Although the present analysis demonstrates the benefits of identifying significant indicators and applied ML methods, several negative assumptions should be noted. The prediction could be too prescriptive. For example, just because a learner prefers a certain type of learning it does not mean this is a constant preference as it may change with time or situation. Also, the e-learning examples used in this research were quite diverse including both mandatory and elective courses, which also may effect learners' motivation and decision-making. Some of the background information such as online learning experience has not been sufficiently explored and considered, although this information may be useful to increase the predictability of students' performances. Finally, applying an adequate learning style does not necessarily mean success in completing the course, and as such, course achievements should be interpreted with caution.

5. CONCLUSION

Growing amount of data collected in e-learning systems have led to the need to analyze and extract useful information from them. Machine learning techniques have been proposed as a means to satisfy this need, as it was shown productive in other fields such as healthcare,

business, and energy. This work analyzed various machine learning methods used e-learning in order to deal with different challenges, such as personalization, content delivery, collaborative learning and used support tools. This work included 53 reviewed journal papers. It was concluded that the most used ML technique in e-learning are Bayesian Networks, while the most used indicators were the ones relating to assessments and tests. Even though many researches (58%) do not report tools used for ML analysis, from the ones that did report it, it was concluded that WEKA is the most used tool. Finally, the paper concludes with positive and negative findings of the used ML techniques in e-learning systems.

Future work will analyze a larger number of papers with greater emphasis on comparative analysis of the results achieved. The aspect of cross evaluation of the obtained results has been neglected in this paper, and it should be a part of future analysis.

Acknowledgements

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WEB AUTHORING TOOL – DEVELOPMENT AND IMPLEMENTATION

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Abstract: Any software, or collection of software components, that authors can use to create or modify web content for use by other people, is an Authoring Tool. Authoring tools, at their best, should allow all of us to publish to a universal space of web content, read by people from all over the world, in many different programming languages, on many different computers, using many different input and output devices. Web authoring tools are used to create Web content, and cover a wide range of software programs you can download to your computer or access online. The tool developed here has its specifics and enables the author to form different variants of one HTML page, to satisfy the needs of different user groups. A comparison of the new tool with other tools, its application, use in e-learning and advantages, are described in the following text.

Keywords: E-Learning, Conditional text, Contenteditable div, Web authoring tool

1. INTRODUCTION

Any software, or collection of software components, that authors can use to create or modify web content for use by other people, is an Authoring Tool [4], [7]. Web authoring tools are used to create Web content, and cover a wide range of software programs you can download to your computer or access online [1], [2], [5], [3]. The basis of these tools is the application of WYSIWYG technology (What You See Is What You Get), i.e. a system in which the content (text and graphics) that is edited/written is presented in the form similar to that obtained as the end result in print or in another form of presentation [8]. The advantages of using these tools is saving time and simplicity of use, because knowledge of HTML is not necessary for making a functional web-site [6]. The term "conditional text" is used within the tool that is described here, and it represents text that may differ from version to version, e.g. it may appear in one version and not in another. The tool that is developed here has its specifics and enables the author to form different variants of one HTML page, to meet the requirements of different groups of users.

2. SIMILAR WORKS

There is a great number of authoring tools [10] which contain only some of the characteristics of the tool developed and described in this paper. For example, some have the possibility to marking certain segments of a text or listing selected items, some enable the forming of pages by simply copying certain parts of selected text. Some tools allow to create a variety of questions and responses, comments, and various kinds of articles. Some provide the ability to complete document management in terms of entering, correcting, and deleting text. Displaying changes in a given tool requires generating a new URL. Some of them offer the possibility of limiting the test duration, as is the display of success of tests, for example percentage.

The web authoring tool developed here was created on the basis of a tool called Zone Administrator, which is intended for forming Word-Adaptive documents. Since the main purpose of that tool is the creation of different Word versions on the basis of one Word document, the tool developed here has similar characteristics, i.e. creating different versions of HTML on the basis of one HTML page, depending on the needs of users. For example, if the administrator side is opened, it is possible to perform a complete control: deleting, displaying, correcting all views given by the selected paramaters. In already existing tools, it is possible to manage only once opened HTML page variants, ie. to manage all of the variants of an HTML page, it would be necessary to open as many documents as a given side variant. All variants of one side can be clearly observed by enabling the display with colors which in this case clearly separates the corresponding marks and zones.

3. THE NEW TOOL

The tool described here belongs to the group of web authoring tools and it has some content that is visible on the Internet. Primarily HTML and Java were used in its forming [5]. The basic characteristics of this tool are:

- Forming and presenting different variants of one HTML page.
- Possibility to correct formed documents
- Easy searching of documents on the basis of content and vice versa
- Coloring of documents and contents and their easier connecting on the basis of color
- Possibility to comment on the documents

4. CAPABILITIES OF THE NEW TOOL

The tool can operate as an independent system or be installed into other systems in the form of template. It has been developed to be as simple as possible to use and enable all additional expansions to be performed with ease.

The basis of the new tool is one, and only one HTML page. The future appearance of all variants of one HTML page is created by defining individual documents by one group of users - authors, on the basis of needs of another group of users, i.e. by selecting particular user-selected categories. Within the document, it is very easy to add certain parts from the relevant online text, by simply selecting the desired section and selecting the categories of interest, with the use of the simple WYSIWYG technique. It is possible to present the documents highlighted in the relevant colors. The edit option enables the correction of the document, entering of text, deleting of a part or entire text and entering the title. An additional option is added for the complete removal of the document.

The content of a given document can also be displayed. Every item in the table of contents is a link to the title in the relevant document, and every title in the displayed document is a link to the corresponding item in the table of contents. With the option Background Color on, it is easy to visually observe the connection between the documents and contents, because they are in the same color.

Besides text editing, it is also possible to view the created documents, which is also the view of the variants of the HTML page which the other user group, i.e. students, would see. Each user group can place comments on the selected document.

Note:

All documents used in this tool are blank on first use. For the purpose of describing certain functions, some documents have the relevant data entered in advance. The categories on the basis of which selection is made are marks and zones, because the tool is primarily intended for professors as the authors of future variants of the documents, and students as the users of the created documents. The categories themselves can also be easily modified for any other purpose or for a category count. In case of errors, an adequate error message is displayed.

5. HELP IN DEVELOPING THE TOOL

The tool has been developed with the help of PlayFramework in the Intellij IDEA environment, using Java, HTML5, CSS3, JavaScript, the relevant libraries, Jquery-based plugin: Bootstrap Multiselect [9], for selecting multiple options.

6. DESCRIPTION OF THE TOOL'S FUNCTIONS

Since the tool is intended for two types of users, primarily professors and students, there are two basic views for presenting one HTML document, depending on which user is logged on.

6.1 DESCRIPTION OF FUNCTIONS THAT APPLY FOR BOTH USERS

6.1.1 VIEWING THE DOCUMENT

By selecting the appropriate categories from the relevant drop-down list, i.e. mark and zone, a user can view the desired document **Image 1**. In this stage, there is the option to select all documents by simply checking the option ALL on the drop-down list of marks **Image 2**.

Image 1: Selecting mark and zone for displaying document content
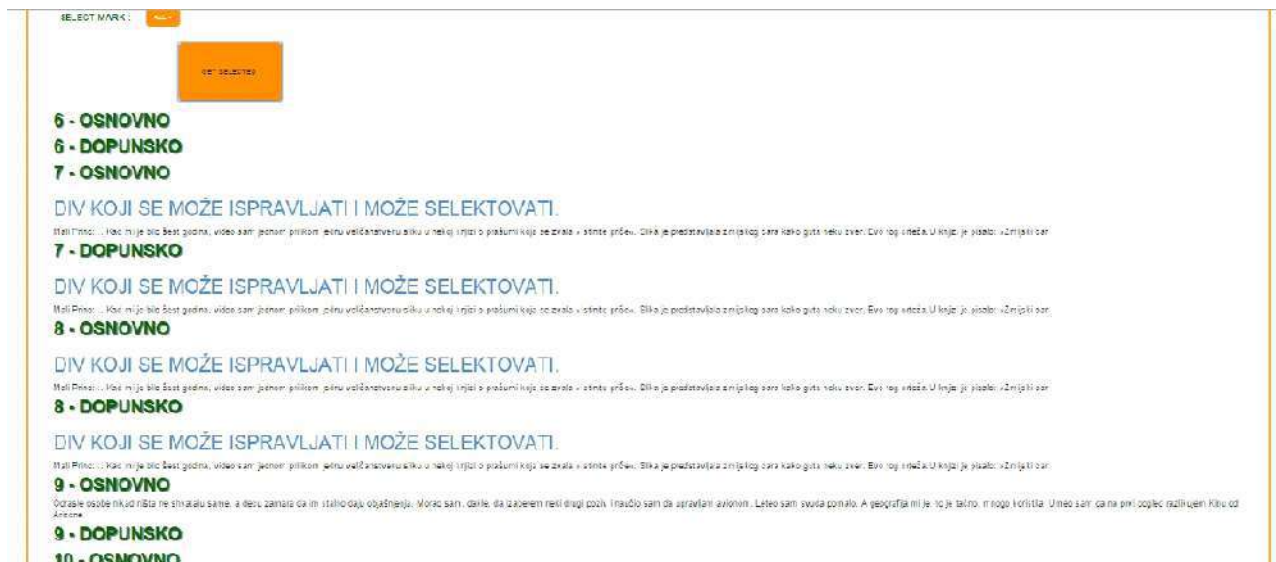
Image 2: Displaying all documents

Image 3: Link between table of contents and documents

Within the document view, there is the option to display a table of contents which link to the corresponding titles in the displayed documents **Image 3**. In this, the titles and contents are connected as links, so clicking on one leads to the other and vice versa. This view can also be much cleared by turning on the option Background Color which provides a visual connection between the contents and the relevant documents **Image 4**. The documents without a title will have no content, either.

Image 4: Display of all the contents and documents in one place with Background Color on

Within the document view, there is also the option to place comments on the text **Image 5**.

Image 5: Comments

6.2 DESCRIPTION OF FUNCTIONS INTENDED FOR THE USER GROUP THAT EDITS THE OFFERED CATEGORIES - AUTHORS

6.2.1 CORRECTION OF SELECTED DOCUMENT

By selecting the relevant field for correction Document Correction and the ensuing simple ticking of the relevant mark and zone on the drop-down list, **Image 6**, the document is displayed within the contenteditable div which can be corrected and saved after changes **Image 7**. It is also possible to select all documents by ticking the field ALL. During the correction of the text, it is also possible to enter a title and select font size, where this is possible to apply on all documents by ticking the option ALL.

Image 6: Selection of mark and zone for correction

Image 7: View of the document selected for correction

The option Delete Document enables the marking of documents that should be deleted on the basis for selection of marks-zones, without the deletion having to be performed within the contenteditable div.

6.2.2 COPY TEXT TO SELECTED DOCUMENT

Adding selected content is done by simply selecting the selected content and selection of documents on the basis of marks and the zone in which the text is copied **Image 8**. It

is possible to make use of the possibility ALL options or copy the text in all documents **Image 9**.
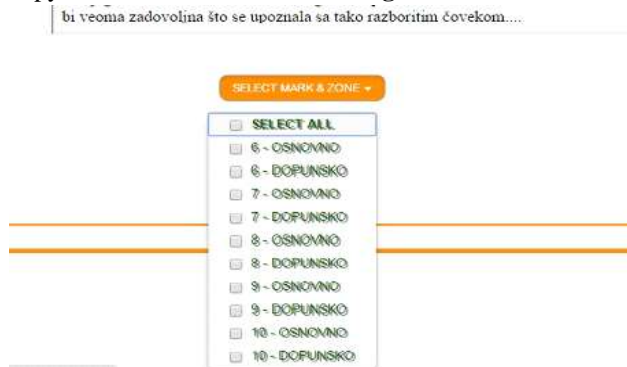
Image 8: The selection of mark and zone in which the selected text copy

Image 9: Copy the selected part of the text in all documents

Image 10: View all documents with titles, including the colors of the background and content

Documents with included ALL option provides a very interesting presentation of the same. Already using color can be linked to the appropriate document with the appropriate content. **Image 10**.

7. APPLICATION WEB AUTHORING TOOL IN E-LEARNING

Today's students are living in a multimedia world that increasingly requires use of new digital technologies. The connection between literacy and technology is increasingly important [3]. Web authoring tools provide the ability to take on a very entertaining, stylish and modern approach to enable students to easily overcome the material and help in e-learning. Now a days there is the new breed of web based e-learning authoring tools that enable development of interactive learning module in a web based collaborative environment [12]. Access to these applications is easier, users have more opportunities to collaborate using these tools. Web authoring tools are similar to word processing programs as they allow users to choose from a variety of windows for composing, editing, and formatting their texts. Discovered positive effects from using such tools which include improving communication with other users,

supporting and enhancing students' learning in the content areas, providing authentic and engaging reasons for integrating the new literacies into classroom learning, showcasing students' work, and helping them connect with the world, allow faster delivery, more effective learning, learn whenever and wherever they want, self-paced learning, lower costs and etc.

8. CONCLUSION

Web authoring tools are time and cost effective and always up to date. They can create anywhere and anytime and they easy to publish, update, and translate [11]. Today there are lot of software technology-based Web authoring tools software. Each of the tools has given its users, or features for which individuals decide. But in today's sea of tools need to develop new tools is not stopped due to advances in technology every day.

This is an attempt to develop a new tool that was designed primarily to two groups of users: authors and other users. Selection based on categories and receive multiple versions of one HTML page can still be expanded and applied in many other areas. The number of categories and their names and purposes are easily removable and adaptable. Due to the fact that the tool developed in today's most popular languages, Java, HTML5, CSS3, JavaSrcipt using the available library and application of appropriate technology this tool can be used both independently and as part of a more complex system.

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AN ONLINE PLATFORM FOR SUPPORTING LOGISTICS TEACHERS

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Abstract: *This research aims to answer how logistics teachers can be supported by a purpose-built online platform. The research takes place within the "Research and Education on Transport Logistics" (RETrans) initiative. The initiative's mission is to build a competence centre for transport logistics in cooperation with stakeholders from research, industry, and the public sector to promote logistics professions. The heart of the project is its open online platform, which provides information and learning materials on various subjects in transport logistics. Different instruments, such as curricula analysis, expert workshops, surveys and analysis of secondary data, have contributed to the online platform's design. This work presents the ongoing RETrans initiative and discusses future requirements for transferring logistics knowledge through an open online platform.*

Keywords: *online platform, future competencies, logistics*

1. INTRODUCTION

Digitalization and the so-called "Industry 4.0" represent major challenges for the transport and logistics industry. The media, academia, research and industry discuss the future implications of digitalization and Industry 4.0 as being controversial. On the one hand, potential future key technologies and some improvements to working conditions are expected. Smart assistance systems will release workers from having to perform routine tasks, enabling them to focus on creative, value-added activities. In view of the impending shortage of skilled workers, this will allow older workers to extend their working lives and remain productive for a longer time. On the other hand, job losses and further de-industrialization are feared to the same extent [1].

Transport and logistics are likely to become some of the most important application fields for digitalization. No other industry is facing fundamental changes to this extent caused by actual rapid technological progress in the near future. This is because almost all significant technological and societal challenges are directly or indirectly linked to logistics and efficient supply chain management [2]. In summary, training on the competences and skills essential for creating transport and logistics processes becomes increasingly important to secure a transport company's long-term success. Consequently, the challenges mentioned above, along with globalization, increased complexity, rising customer demands, advancing competitive pressure and a rougher market, will require appropriate training methods and learning systems. Those are to address not only the different needs of the various skill levels but also the varying requirements of the broad and extremely diverse transport and logistics sector.

2. OBJECTIVES AND METHODS

Logistics is no longer mainly based on routine procedures. The advent of new technologies, digitalization, the increasing complexity and dynamism of markets as well as the economic environment are putting new demands upon logistics companies, in turn making them increasingly dependent on the skills of its current and future workforce [3]. Employee skills and competences play a central role in the long-term success of companies and supply chains [4] [5]. In order to increase the transport and logistics industry's attractiveness for future employees, companies must present themselves as attractive employers and stand out from other logistics services providers on the labour market [6]. On the other hand, another possible approach is to arouse interest in logistics as early as possible and to address pupils with appropriate instruments. Consequently, how can knowledge be transferred to the secondary sector, so that topics such as sustainable transport and innovative logistics can be taught with high quality and to create a positive approach to the industry? Hence, the Research and Education on Transport Logistics (RETrans) initiative was developed on the assumption that suitable teaching materials and additional offerings, which teachers can easily integrate into their education, can provide a basis for the high-level training of future employees and simultaneously support the attractiveness of field logistics occupations.

A multi-stage approach was used for this project's research design. Initially, methods relevant to logistics education that are particularly suitable for conveying logistical content were identified in a literature analysis. In the following, curricula were analysed by comprehensively gathering detailed information about logistics training at Austrian secondary schools (general education and vocational secondary schools). The derived information forms a starting point for the design of individual teaching materials. A concept for transferring logistics knowledge in the secondary school sector was created based on

appropriate teaching methods for transferring logistics content and on content-related requirements resulting from the curricula analysis.

A Web-based learning platform on transport logistics (www.retrans.at) was developed with four independent sub-pages containing detailed information on road (www.reroad.at), rail (www.rerail.at) and inland waterway (www.rewway.at) transport as well as eco-friendly transport (www.reecotrans.at).

The core target groups are teachers as well as individuals who are either undergoing professional reorientation or are already working in the logistics field (lifelong learners). Teachers have a wide repertoire of teaching methods at their disposal, ranging from smaller staging techniques, such as the integration of video contributions, the use of newspaper articles or the discussion of practical problem situations, to larger offerings in order to enable varied, participative teaching. Other forms of teaching and learning can also be used, such as lectures by teachers, lectures by pupils, artistic forms of work (e.g. creating collages), forms of documentation and research (e.g. Internet research) and learning games [7]. In logistics training, too, using diverse teaching methods can have a non-negligible influence on the lessons' success. For example, methods such as simulations, business games, case studies and smaller practical projects can be applied. Pupils should come into early contact with practice or with practical incidents or problems as part of their logistics training in order to adequately prepare them for later professional activities or training. For this reason, methods such as case studies, small business games, presentations by practical experts and excursions for logistics training are highly important. Business games and case studies in particular can significantly contribute to the acquisition of technical, social and methodological skills due to the planned group work [8].

Therefore, three approaches were chosen to effectively pursue the objectives of RETrans: the provision of various teaching materials, teacher training and different kinds of support from the logistics industry. Various teaching materials are made available on the online platform, which can be used and passed on free of charge, such as presentations, lecture notes, case studies, exercises, videos, and links to relevant homepages. The provided materials can be used by different school types and adapted to the specific requirements of educational institutions. Bearing in mind that adolescents and young adults show varying knowledge levels about transport logistics, the platform was divided into a general-information main page on transport logistics and professions in logistics as well as four sub-pages with specific information and teaching materials.
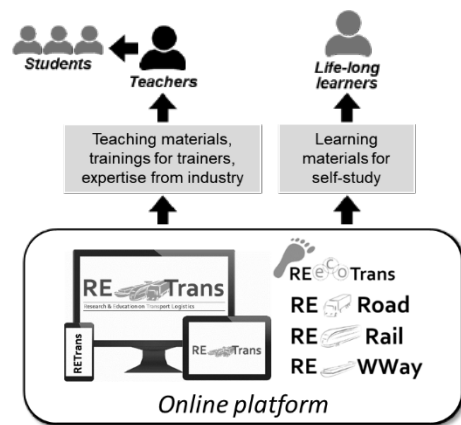
Image 1: Online platform RETrans

The "Train-the-Trainer" instrument is implemented in two ways. First, an online manual provides an overview of the contents offered on the Web platform and in the four mentioned information areas. In addition, this handbook also contains recommendations for integrating the content into teaching based on the curriculum analysis carried out. In the online handbook, teaching and competence objectives were derived from the curricula and compared with the content of the various teaching-material packages.

In addition, workshops are offered for teachers in which the content is adapted to the teachers' respective needs and content knowledge, and, above all, in which the handling of the content and its integration into the classroom are demonstrated. The workshops can also be attended in combination with a train-the-students workshop held by logistics teachers from universities of applied sciences or by practitioners from industrial or logistics companies. In this way, teachers should be given as flexible access as possible to the corresponding train-the-trainer offerings, thus promoting the broadest possible integration of the available materials into the classroom. A third possibility to support teachers in teaching logistics content in class is to invite practice experts to the school for an expert lecture or to organize an excursion with the pupils to a logistics company.

E-learning can be defined as access to learning using technological tools that are Web-based, Web-distributed or Web-capable; in a wider sense, e-learning not only covers content and instructional methods delivered via CD-ROM, the Internet or an Intranet but also by audio- and videotape, satellite broadcast and interactive TV [9]. An extensive range of software and tools exists to enrich digital learning and teaching. RETrans does not aim to provide a learning environment or organize online events, as other online learning platforms do, but primarily to provide freely available teaching materials and support for their use. A further distinguishing feature from platforms such as Moodle is that it is not primarily the learners themselves who are directly addressed. The core target audience is those who impart learning content, to offer them support in transmitting the content.

3. FUTURE DEVELOPMENTS

As previously described, the logistics industry is undergoing a dynamic transformation, driven by technological and business innovations as well as a changing economic, ecological and social environment. More specifically, the megatrend of digitalization strongly affects the logistics sector. Examples of such transformations range from electronic marketplaces to big data analytics, robotics, automation and self-driving vehicles. This ongoing transformation is having significant impacts on the required competencies of labour. Existing job profiles are changing, and new professions are arising. Consequently, the online platform RETrans has to take changing requirements into account to effectively support future-oriented training. In other words, it is essential to know which competencies will become more important for graduates of logistics-oriented school educations. This should facilitate the further development of RETrans.

It can be assumed that logistics teachers have expertise about trends in logistics as well as a good knowledge about the typical jobs of their graduates. Thus, in January 2019, teachers from Austrian schools focusing on logistics were invited to a workshop. The nine participants have been asked which competencies will be most important for their graduates in the future. The Transportation, Distribution, and Logistics Competency Model of the Employment and Training Administration (United States Department of Labor) was applied as a framework with which to answer the question in a structured way [10]. The competency model describes the required competencies for successful performance in the transportation and logistics industry. Image 2 shows the slightly adopted model, which consists of five tiers.
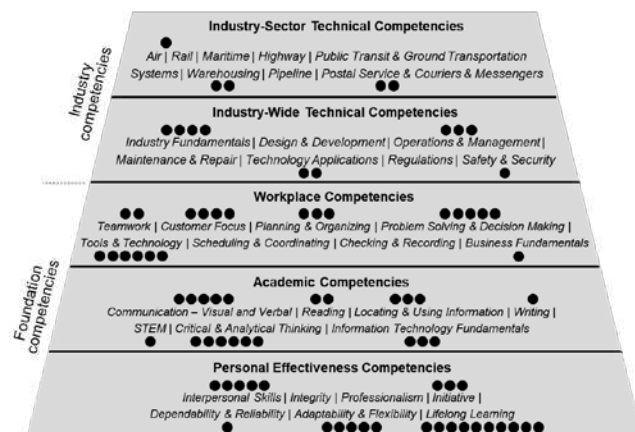
Image 2: Future requirements

A higher tier represents a higher level of specialization in the application of skills. The lowest three tiers contain the foundational competencies required to enter the workplace. The tiers of the foundational competencies refer to personal skills, the ability to learn and the ability to work. The top two tiers comprise industry competencies, which are specific to the logistics industry or its sectors. Each participant was asked to distribute nine points among the model's competencies according to his or her assumption about the relative increase of each competence's importance in the future. Different weights could be expressed by assigning zero, one or several points to a

particular competence. The results are illustrated in Image 2, with the black dots showing the teachers' assigned points. These results cannot be considered as a concluding assessment but should be seen as initial guidance. The following conclusions can be drawn.

(1) The point distribution clearly favours the foundational competencies. Only 19 percent of the points were assigned to the industry competencies. At the moment, the online platform RETrans primarily addresses industry-specific competencies. In the future, content related to foundation competencies may become more important.

(2) Lifelong learning was the highest rated competence. The platform's main focus is to support teachers with teaching materials for their courses. Additionally, the platform can be used for self-study. The platform's focus may shift to self-study activities in the future, in order to increasingly support lifelong learning.

(3) "Problem solving and decision making" together with "critical and analytical thinking" accounted for almost 14 percent of the points, for a relatively high proportion. Such competencies can be effectively developed through case studies. The online platform already offers a choice of case studies, which may be further extended.

4. CONCLUSION

Among other domains, logistics in particular is facing new information-technology challenges due to increasing digitalization. Meeting customer requirements in the B2B and B2C sectors in terms of deliverability, delivery reliability and availability put increasing importance on IT in logistics. Traditional companies, but also logistics start-ups, need well-trained staff at all levels. The competition for these (the "war for talents") is expected to intensify over the course of digitization, with initiatives such as RETrans gaining importance. It can be assumed that an earlier transfer of logistical knowledge is desirable to arouse interest in the transport and logistics sector and to position companies as future attractive employers. This can be realized by providing easy-to-use, high-quality teaching materials for teachers, expert lectures at schools, workshops and visits, as well as for train-the-trainer activities.

Despite this project's potential benefits, its limitations also need mentioning. The RETrans project is still in its infancy, and no quantifiable evaluation has yet been made on it.

Nevertheless, work is being done to further develop RETrans, such as based on the workshop described in this article and on feedback discussions with teachers who use RETrans learning materials in their classes. The focus here is on expanding the platform by further developing learning materials that strengthen problem-solving and decision-making competences, critical and analytical thinking as well as foundational competencies. Additionally, the platform's self-study activities can be further developed to increasingly support lifelong learning.

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SUPPORT FOR KNOWLEDGE ASSESSMENT IN STEM EDUCATION USING ELARS RECOMMENDER SYSTEM

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Abstract: *Education in STEM disciplines (Science, Technology, Engineering, and Mathematics) is very important for today's students since they will have to be able to successfully deal with the challenges of technological society in the future. In the context of courses related to the STEM, practical application of theoretical knowledge often involves the implementation of complex mathematical procedures and calculations. To enhance the assessment of students' knowledge of such procedures in STEM courses, technology support can be provided to teachers within e-learning systems. This paper presents an approach to support teachers in assessment of learning outcomes in STEM education. The approach is implemented within the educational recommender system ELARS. The system enables teachers to design online assessment activities and monitor students' results, and provides formative assessment support. The paper also presents results of using the ELARS system to support the assessment process in a higher education course.*

Keywords: Educational recommender system, ELARS, STEM, formative assessment

1. INTRODUCTION

Educational recommender systems (ERS) are mostly used to support the learning process by helping students to focus their learning activities on the specific parts of the subject content. In order to do that, ERS could be combined with other digital and pedagogical resources [1].

Educational recommender system ELARS (E-Learning Activities Recommender System) is used to promote the advantages of using digital tools for collaborative learning [2] and STEM education [3], to personalize e-learning activities [4] and motivate students to actively participate in e-learning activities [5]. Since recently, the support for online assessment is implemented within the ELARS system.

Evaluation approaches (such as online assessment) can be either formative or summative. Formative evaluation is generally used in order to create quick feedback to both students and teachers during the semester [6]. Summative evaluation is used at the end of an instructional period (midterm and/or final exam) in order to grade students work and verify the overall effectiveness of the learning process [7], [8]. Using online systems for formative and/or summative evaluation can enhance their effectiveness by providing quick feedback regarding students' success,

especially when a great number of students needs to be assessed at the same time [9].

In STEM (Science, Technology, Engineering, and Mathematics), theoretical knowledge is usually transformed into the practical implementation through the use of mathematical procedures and calculations that students need to master [10]. Use of online evaluation systems for conducting formative and summative assessment can help in avoiding surface-approach to learning among STEM students which can result in a lack of deeper understanding of the course content [11]. Also, research results show that students prefer to have access to online evaluation systems because they allow them to organize their study obligations according to their personal preferences [12].

This paper presents an approach to support teachers in assessment of learning outcomes in STEM education using the educational recommender system ELARS. Using the system, the teachers can design the flow of course learning activities that includes online assessments. The system enables teachers to monitor students' results achieved by solving online assessments and provides formative assessment support by generating automatic feedback to students. The paper also presents results and experiences from a higher education course during which the ELARS system was used to support the assessment process.

2. SUPPORTING ASSESSMENT IN ELARS RECOMMENDER SYSTEM

The ELARS recommender system is designed to foster personalization of online learning activities by recommending optional activities, possible collaborators (student peers), and digital tools [2]. In addition, the system offers advice during participation in online activities with digital tools. Recommendations are generated based on students' personal data and achievements during the e-course (preferences for digital tools and learning styles, knowledge level, activity level) as well as on well-defined course learning design where course activities are grouped into learning modules. Students and teachers interact with the system using the ELARS web application [13].

The system was designed, built and tested in real educational environments [14], [15], [5]. Since recently, the functionalities of the system have been amended to support evaluation in STEM education. The part of the system for supporting online evaluation is based on the idea that intermediate results in math-based tasks solved by a student can provide additional information regarding the student's knowledge [16]. Therefore, for each math-based task, the teacher defines as a set of subtasks (several intermediate results and a final solution) and relates each subtask with one or more concepts from the course learning domain. Mistakes in calculation of intermediate results can indicate which concepts were not mastered by the student. Incoorrect answers can also indicate that the student lacks expected foreknowledge about concepts from preceding topics of subject matter.

In the teacher interface, the teacher first defines the tasks for a module. The teacher specifies task text, uploads an image, and lists all subtasks. To enable students to solve tasks, the teacher defines online assessment activity within course learning design. When defining an online assessment activity, the teacher should link a set of tasks, define the maximum number of attempts, and the duration of one attempt. At each attempt, the student have to solve a random task and has limited time (defined by the teacher).

After the task solving attempt, the student can see the analysis with correct and incorrect answers (Image 1). Students can also view summarized feedback on their performance for the assessment activity in which he/she participated regarding solving tasks related to each concept. Presented performance (Image 2) is determined based on the ratio of the number of successful and unsuccessful attempts to solve subtasks associated with a particular concept.

The teacher can get insight into the distribution and the number of attempts made by students (Image 3) and their results. The performance data regarding the concepts of subject matter is also available to teachers.

Image 1: An example of practical problem

3. DESCRIPTION OF THE CONDUCTED RESEARCH

The main aim of this research was to evaluate the effectiveness of the developed formative assessment support within a STEM course. The e-course "Electrical Power Networks" which is performed at University of Rijeka was chosen.

Course content and grading components

"Electrical Power Networks" is part of the curriculum in the third year of university undergraduate study program Electrical Engineering (single major) at the Faculty of Engineering University of Rijeka. The course is given 7 ECTS.

The course objectives, in terms of content, are achieving a physical understanding of the electrical parameters of components in electrical power networks, calculation of electrical parameters under particular operating conditions and capability to model and analyse electrical settings in electrical power networks. Finally, objectives include the ability to implement optimal advancements in electrical power networks.

The course is designed in the form of face-to-face (f2f) classes in which the students are expected to actively participate in analysing and solving the presented problems in the field of electrical engineering. Based on the acquired theoretical knowledge, students are expected to gain the ability to use this knowledge in practical applications (in the computational analysis of electrical phenomena and later in the practical work). The course materials used in the classroom, as well as additional materials, are available via LMS system Merlin – Moodle based system used at the University of Rijeka.

The course activities are organized in the following learning modules:

- Quadripoles
- Equivalent model of power lines
- Equivalent models of transformers
- Per Unit Method
- Admittance matrix
- Short circuit calculation (Per Unit Method)
- Electrical distribution power networks
- Reliability of electrical power networks

Regarding the grading components, students can collect up to 4 points on course attendance, 10 points on short tests during the f2f lectures, 16 points on construction projects and up to 40 points on two tests (Test 1 and Test 2) during the semester (20 points for each).

When the semester ends, students should take the final exam and collect up to 30 points. After totaling all points earned, the final grade is given according to the following scale: A (90-100), B (75-89.9), C (60-74.9), D (50-59.9). Students with less than 35 points fail and must retake the course.

The introduction of formative assessment support with the ELARS system

The most important component of the assessment within the course "Electrical Power Networks" are Test 1 and Test 2. By taking those tests students can collect up to 40% of the points for the course. Therefore, activities for formative assessment were introduced before the two tests in order to motivate students to practice solving practical problems to the greater extent as well as to enable students to get insight into their level of success in solving problems similar to those expected in the tests.

Students could use the system for 10 days prior to taking the tests. Within each learning module, students could solve tasks in the pre-set time limits of 30, 45 or 60 minutes, depending on the complexity of the tasks. Also, they could make between 10 and 20 attempts, depending on the overall number of available tasks within each of the learning modules.

Research method and participants

The purpose of presented research was to determine is there any significant difference in students' results after the introduction of formative assessment support. In addition, the aim was to gather students' comments that will guide further improvements of the system.

A comparative study was used. For the experimental group, activities for formative assessment were included in the course, just before the Test 1 and Test 2 (that are part of the summative assessment and conducted in a paper-based form). Course points awarded from the Test 1 and Test 2 were collected for the students from the control and the experimental group and compared since they indicate the extent to which students achieved the expected learning outcomes. To select the appropriate test for comparison of two independent samples, the D'Agostino-Pearson test of normality was previously performed. For both Test 1 and Test 2 normality was concluded for the control group but not for the experimental group. Thus, the Mann-Whitney U test for nonparametric independent samples was used. Comments from students from the experimental group regarding performed activities for formative assessment and the ELARS system were collected using a couple of open-ended questions in an anonymous paper-based questionnaire.

The control group of participants consisted of students who participated in the course during the academic year 2017/2018 (N=39). The experimental group consisted of students who participated in the course after introduction of assessment support with the ELARS system, during the academic year 2018/2019 (N=58). The students from the experimental group participated in two activities for formative assessment.

Koncept	Broj točnih pokušaja	Postotak
Množenje matrica	19 / 64	29.69 %
Prijenosne jednadžbe	9 / 32	28.12 %

Image 2: ELARS system - List of concepts with progress results (available to students and teachers)

Image 3: ELARS system - Data regarding the number of attempts made by students (available to teachers)

Results and discussion

Table 1 shows results of comparison of average results (points). A statistically significant difference is present in the case of both Test 1 and Test 2. From this, it was concluded that experimental group students who participated in the activities for formative assessment using the ELARS system achieved significantly better results.

Table 1: Comparison of average results (points)

	Control group AVERAGE	Experimental group AVERAGE	p
Test 1	9.99	13.95	.0003
Test 2	8.32	11.72	.0021

The results shows that ELARS system was useful in supporting the formative assessment during a STEM course. Students were motivated to practice solving practical problems before the test included in the summative assessment. By reviewing the performance data regarding solving tasks related to concepts, students could get insight into their level of success and focus their learning on the specific subject content (both from previously finished and recently taught learning materials).

In their comments, students expressed satisfaction with the system. The majority of them said that they would recommend it to other students and that they would like to use it in the future. Also, they pointed out that they would like to receive recommendations from the system in a form of written or video online materials related to the content of each task within learning modules, colleagues for joint work as well as simple tasks to be solved using digital tools that could help them to master the subject matter.

Student comments provide motivation and guidance for future work and system development toward defining rules for generating recommendations based on the results of online assessments.

5. CONCLUSION

The presented research contributes to field of computer-supported assessment by development of an assessment systems for STEM education within educational recommender system ELARS. The evaluation of the developed functionalities confirmed the effectiveness of the system in a real setting and students' satisfaction with it. In the future research, additional experiments will be carried out to confirm these findings.

In the next phase of the research, students' results collected during assessment activities will be used to generate individual recommendations for students. Recommendations will be based on students' feedback results from already conducted research, thus incorporating online written and video materials, the recommendation of colleagues for joint work and tasks that require the use of digital tools. Each of these recommendations will be tested in a real learning environment.

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TEACHING AND LEARNING ACCOUNTING BY ELEARNING TOOLS

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Abstract: Accounting embraces a variety of subjects, like financial, cost, and managerial accounting, all of them perceived as competencies for business and management practices about business. A general characteristic of these subjects is that they demand much hard work and are full of details that influence the approach and the solution to the perceived issues. Modeling business transactions and business cases by using the Microsoft Excel spreadsheet program shows excellent results in learning and teaching accounting. Student use models in two primary ways: To gain an understanding of the phenomena and to assess their knowledge of understanding the process and managing process results. This article aims to present how to use simple models developed for the accounting lectures in practice, as a teaching and learning tool, how to define their objectives and how to use them in the assessment of attained knowledge. These models are also convenient tools for distance learning.

Keywords: Modeling accounting topics in Excel, blended, student performance and satisfaction

1. INTRODUCTION

Information and communication technology provides a large variate of tools to support learning and teaching. Among those, the Excel program appears to be very convenient, as it offers a lot of features convenient to make various E-models that simulate business issues. Like other types of visual tools [1], E-models help students to understand given business transactions, gain knowledge about it, and critically assess findings and results, as well as capabilities to apply attained knowledge in practice.

At ALFA BK University (the University), all students take the first subject on accounting fundamentals in the second year. Third-year students of accounting already selected accounting for their major field of study. Although the majority of students regularly participate in classwork, many other of them are employed and therefore have difficulty attending the formal session. Moreover, many students of accounting find out the way to attain some form of business practice. Students also vary widely in their aspirations and modes of study. Students generally wish to get a useful introduction to the worlds of business and finance for work within a broader career of business and management, and very few of them want to qualify as accountants or auditors.

In addition to traditional teaching practices, the University has introduced e-learning since a long time ago, mainly for teaching information and communication technology (ICT), including developing skills in using Word, Excel, and PowerPoint, writing their CV. Students attain most of IT skills during the first and second year of their studies. Lecturers also continually develop e-classrooms with a lot of information, PowerPoint presentations, and online tests. E-learning and online resources enables a higher degree of flexibility in providing teaching and learning resources for all students. Over time, the University developed online studies for a few academic programs, which combined face to face communication and e-learning. This blended learning lecturer runs within a continuum of primary ICT usage to e-focused one, which consists of discussion boards, online assessment tests, and interactive learning material [2].

The University has a clear statement of learning outcomes and a description of how accounting knowledge and skills are attained and assessed. The primary learning outcome of the accounting study is „knowing how to do something," and the specific result for some topics is "being able to do something. The first a few weeks of lectures and tutorials are predominantly theory-based. The remainder of the semester is used for more challenging practical and numerical content. The e-learning content of each session is prepared in the form of PowerPoint Presentation. Traditional teaching method for most accounting subjects is based on teaching by examples and exercises, using pencil and paper (and board). Interim and exams comprise online tests and discussion on simple case studies. The final exam usually consists of written exercises, an assignment in the form of short research work and presentation, and analysis of results. The pass rate of accounting students is moderate, and they frequently take their accounting exam two to three times. Students often perceive accounting as a course with a significant number of various rules with a focus on numerical content, and it is generally tough to attract them to these courses. The perception of accounting as the content of many rules with a focus on numerical values was an incentive for the introduction of a new way of teaching accounting by modeling accounting principles and rules in Excel, to help students understand the content more effectively.

2. DEVELOPING MODELS ON ACCOUNTING TOPIC – EXAMPLE OF TWO LESSON

Model is an online resource for the course, which is as simple as possible, easy to modify, and does not require sophisticated building skills [3]. Introductory units use elementary models, based on the clarified business problem, real-life applications of accounting principles and practices within a business context. For example, the basic accounting equitation is easy to learn by the usage of an Excel model designed to compare if the sum of assets equals the total of equity and liabilities. The model also includes a table for analysis of results for given inputs and outputs, with the space for a short explanation of the basic rule

Inputs	Output / Result				EXERCISE: How do you calculate a company's equity?				
Statement of financial position									
Assets	10	Equity	6			Var 1	Var 2	Var 3	Var 4
		Liabilities	4		Assets (A)				
Total assets (A)	10	Total equity and liabilities (E&L)	10		Liabilities (L)				
Control formula - do not touch!					Equity (A-L)				
A - E&L = 0		If different than ZERO, check inputs once again!	0		By varying assets and liabilities values in Accounting equitation MODEL, calculate the value of equity. Enter the values in the table above. Explain how do you calculate equity.				
					Explanation:				

Image 1: EXCEL MODEL: Accounting equitation

The on-line form of this accounting topic is useful both to face-o-face delivery and for distance learning. In the case of face-to-face delivery, the lecturer gives additional explanations during the exercise. Students also prepare a presentation of inputs, processes, and results using the figures of real-world companies, which they can find on the internet. For long-distance learning, additional explanation is given in the written form. If these explanations are too detailed and lengthy, students seldom read them thoroughly. Writing this additional information is a highly demanding task for the lecturer. The process is often facilitated by posting a few best exercises done by students during the face-to-face delivery in the e-classroom next to the model, to let students compare their results with the given examples. The model is usually presented to students during the lectures, and students work on a model during tutorial sessions.

Although very simple, this model is beneficial for a few reasons. It helps students to apply the ICT knowledge gained during the previous two years in the economy. Students also learn efficiently, and almost by heart, accounting, and financial terminology. It enhances teacher's communication with students and communication among the students. It also helps students to develop their presentation skills. Finally, it increases student's self-reliance, as an attribute of capability [4] and enables the teacher to get immediate feedback on lessons learned.

Excel models are beneficial teaching and learning tool for subjects like cost accounting and cost management. The creation of the virtual business model helps students to understand and manage the business issues and encourages them to research real-world data. The creation of a business model is done by Excel functions and complemented by charts and figures to visualize the results. The learning outcomes are better if the model contains a series of input and output data, and so enables comparison of results. Students are also requested to make their comments on predetermined questions. Students who already work or have some work experience in their parent's company usually prepare a small assignment, the so-called "mini-seminar paper," by using real-world data, which provide practical contexts in which the theoretical knowledge becomes relevant. The results of such assignments are often surprising, as students usually recognize that they "learned something, and they now understand what they have to do" [5].
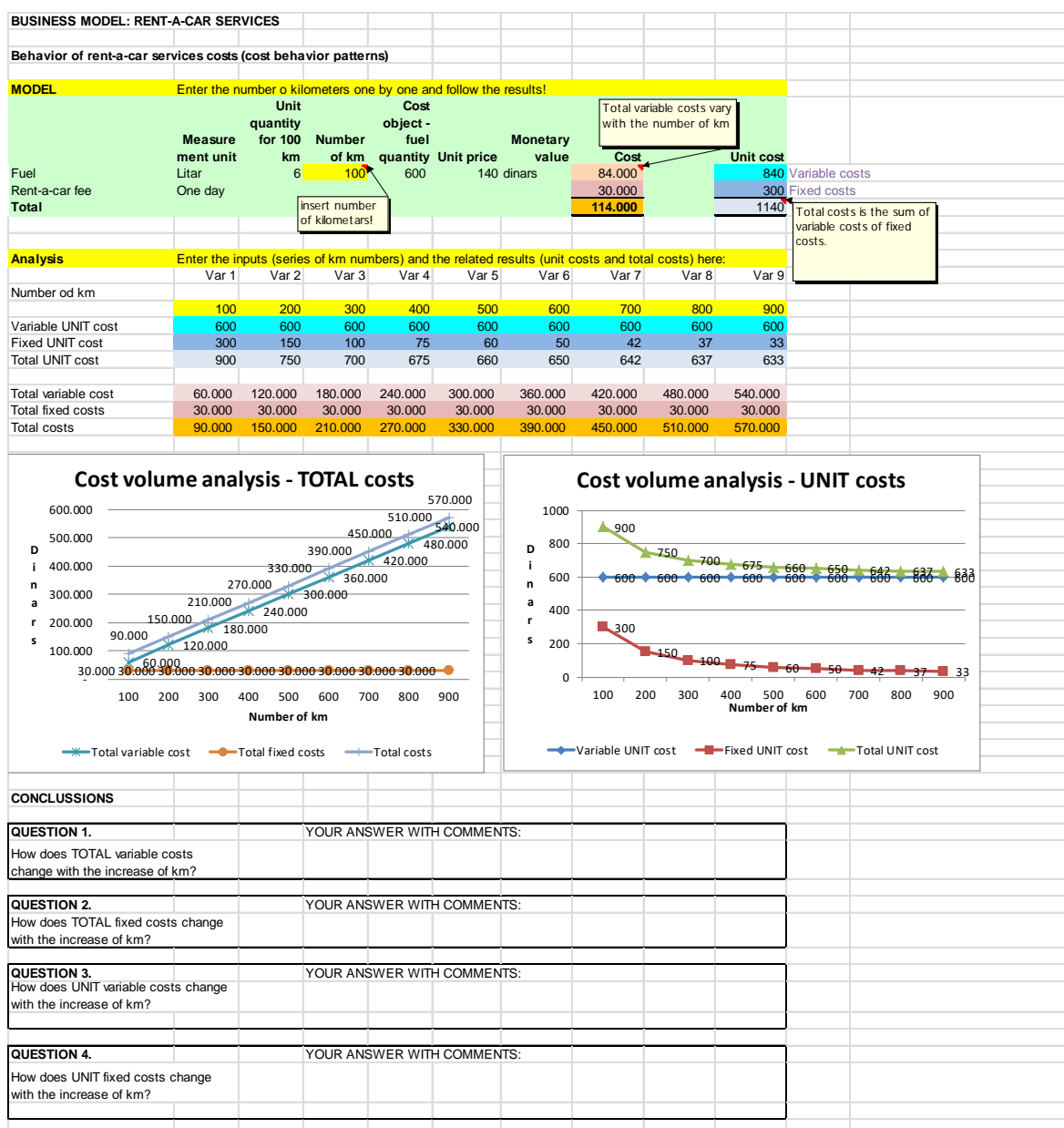
BUSINESS MODEL: RENT-A-CAR SERVICES

Behavior of rent-a-car services costs (cost behavior patterns)

MODEL — Enter the number o kilometers one by one and follow the results!

	Measurement unit	Unit quantity for 100 km	Number of km	Cost object - fuel quantity	Unit price	Monetary value	Cost	Unit cost	
Fuel	Litar	6	100	600	140 dinars		84.000	840	Variable costs
Rent-a-car fee	One day						30.000	300	Fixed costs
Total							114.000	1140	

Total variable costs vary with the number of km

insert number of kilometars!

Total costs is the sum of variable costs of fixed costs.

Analysis — Enter the inputs (series of km numbers) and the related results (unit costs and total costs) here:

	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Var 8	Var 9
Number od km									
	100	200	300	400	500	600	700	800	900
Variable UNIT cost	600	600	600	600	600	600	600	600	600
Fixed UNIT cost	300	150	100	75	60	50	42	37	33
Total UNIT cost	900	750	700	675	660	650	642	637	633
Total variable cost	60.000	120.000	180.000	240.000	300.000	360.000	420.000	480.000	540.000
Total fixed costs	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000
Total costs	90.000	150.000	210.000	270.000	330.000	390.000	450.000	510.000	570.000

Cost volume analysis - TOTAL costs

Cost volume analysis - UNIT costs

CONCLUSSIONS

QUESTION 1.	YOUR ANSWER WITH COMMENTS:
How does TOTAL variable costs change with the increase of km?	

QUESTION 2.	YOUR ANSWER WITH COMMENTS:
How does TOTAL fixed costs change with the increase of km?	

QUESTION 3.	YOUR ANSWER WITH COMMENTS:
How does UNIT variable costs change with the increase of km?	

QUESTION 4.	YOUR ANSWER WITH COMMENTS:
How does UNIT fixed costs change with the increase of km?	

Image 2: EXCEL MODEL: Costs behavior

3. HOW STUDENT LEARN BY USING THE MODELS?

Models appear useful tools in a few ways. A combination of online resources with face-to-face teaching is a very efficient tool, as it enables interaction between students and teachers and among the students during the face-to-face learning. Models are available in e-classroom, and student uses them later, for preparing their assignment work and further education. The examples of best assignments are also available in the e-classroom. This experience concurs with findings that "the online and traditional classroom teaching methods should be seen as an extra dimension in education which can facilitate the lecturer's learning objectives while benefiting the students" [6].

Models are also convenient for long-distance learning, as many students choose this option for various reasons [7]. Due to the lack of face-to-face communication, it is necessary to incorporate much additional information into the model to make them useful for students who choose this learning option. The model learning objective, step by step procedure, quality control issues, and assessment of results of own work are given at the very beginning of the model. Additional information related to model work is usually provided by using the Excel comments (Insert comment). If the scope of the assignment is more comprehensive, a student may work in groups of two or three students. This active learning technique is especially suitable for long-distance learning groups of students. Ultimately, the most illustrative description of learning by models may be found in this Chinese proverb *(Confucius, 551- 479 BC): "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand."* [8].

The number of students who select accounting as a major field of interest is relatively small, and it is easy to track their work in detail, from generation to generation. The overview of these details reveals that many more students attend face-to-face lectures and tutorials if the accounting topics are delivered in computer labs using e-learning.

Moreover, the number of students' assignments based on the Excel model is much higher than the number of these with the traditional, ordinary topic based on the textbooks. The same applies to long-distance students, except that the average passing grade of a long-distance students is lower than the one of students who regularly attend the lectures and tutorials. Long-distance students have the opportunity to participate in face-to-face sessions and increase their interaction with lecturers and their fellows from time to time, to provide a higher level of richness to their learning [9].

4. CONCLUSIONS

Traditional teaching method for most accounting subjects is based on teaching by examples and exercises, using pencil and paper (and board). The perception of accounting as the content of many rules with a focus on numerical contents was an incentive for the introduction of a new way of teaching accounting by making Excel models for analyzing the application of accounting principles and rules on business phenomena. Excel models are posted in a virtual classroom and used for on-line sessions of face-to-face delivery. The presence of a lecturer at the face-to-face delivery session, facilitates the work of students, as all necessary explanations are given during the exercise. Models are also convenient for long-distance learning, but due to a lack of face-to-face communication, it is needed to incorporate much additional information into the model. To be effective, the Excel model needs to offer students instructions on how to work, personal communication, and feedback.

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DIGITAL TEXTBOOKS FOR ENGLISH LANGUAGE INSTRUCTION IN THE REPUBLIC OF SERBIA

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Abstract: The Government of the Republic of Serbia, Ministry of Education, Science and Technological Development, and Institute for the Improvement of Education launched in 2018 a pilot project "2000 Digital Classrooms – Digital classroom/Digitally competent teachers – implementation of electronic textbooks and digital educational resources", in line with their systematic approach to promote digital competencies as one of the key competencies for life-long learning. The aim of the project is to contribute to the development of digital competencies of both teachers and students by means of using digital textbooks and digital resources. This paper provides an overview of accredited digital textbooks and resources for English language instruction in primary schools: from pdfs and electronic textbooks to different solutions of learning management systems.

Keywords: digital textbooks, educational resources, English, language learning, language teaching

1. INTRODUCTION

Digital Competence nowadays is both a requirement and a right of citizens [1]. It is defined in the Law on the Fundamentals of the Education System as one of the key competences for life-long learning (Article 11) [2]. The Government of the Republic of Serbia, Ministry of Education, Science and Technological Development, and Institute for the Improvement of Education launched in 2018 a pilot project "2000 Digital Classrooms – Digital classroom/Digitally competent teachers – implementation of electronic textbooks and digital educational resources"[2], in line with their systematic approach to promote digital competencies. The aim of the project is to contribute to the development of digital competencies of both teachers and students by means of using digital textbooks and digital resources. A part of this project is using digital textbooks in the classroom. In 2018 there was a public call for publishers to develop digital textbooks for primary grades 1 and 5, while in 2019 it was broadened for primary grades 2 and 6. This paper provides an overview of accredited digital textbooks and resources for English language instruction in primary schools: from pdfs and electronic textbooks to different solutions of learning management systems.

2. DIGITAL TEXTBOOK – DEFINITION AND TYPES

A digital textbook is a digital and didactically designed teaching tool that is used in educational work in school to acquire knowledge, skills, attitudes and beliefs. It can be defined as "textbook material in a digital learning environment which retains the characteristics of the traditional (printed) textbook, but – in view of technological possibilities – also allows access to other learning resources, encourages active and collaborative learning, provides multiple paths to answers, and gives learners the option to monitor and assess their own learning progress" [3]. It replaces or (more often) complements the printed textbook and requires the use of ICT devices. The development path of e-textbooks is represented in Figure 1:
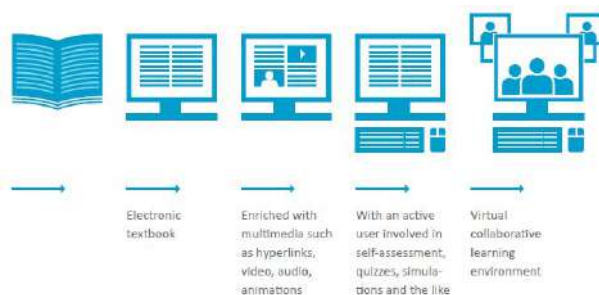

Figure 1 Development of e-textbook [3]

Printed textbooks are at the core of our educational system. However, with the advancement of technology and ICT tools, electronic textbooks (e-textbooks) appeared. Their first form was a pdf file or similar, sometimes only scanned with very few multimedia (usually only with audio elements added). Nowadays, there are plenty of textbooks which are at least enriched with multimedia such as audio, video, hyperlinks, animations. We can also talk about interactive textbook with tests, simulations, games which encourage active learning. The most sophisticated form of an e-textbook is the textbook as a part of a learning management system, where students are provided not only with the content but also with learning analytics and collaborative learning environment. Virtual collaborative learning environment is beneficial both for students and teachers. Teachers get roles within the LMS which are as in a real traditional classroom: they can do almost anything

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[1] The author of this article is one of the certified teacher trainers in the project "2000 Digital Classrooms – Digital classroom / Digitally competent teachers – implementation of electronic textbooks and digital educational resources".

[2] More on the project https://digitalnaucionica.edu.rs

within a course, including adding or changing the activities and grading students, supervising, monitoring, getting precise learning analytics (the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs) etc.

Overall, there are three basic building blocks of digital textbooks: traditional (as in printed books: text and illustrations/graphics), interactive (games, simulations, interactive learning paths, tests with provided answers) and multimedia elements (audio, video, animations). The quality of digital textbooks can be analysed based on technical, user-related, organizational, content-related and didactic criteria.

3. METHODOLOGY

In this paper the analysis of the textbooks will be carried out only on the technical, user-related and organizational criteria. The framework for this analysis is adapted from the Framework for the Design of Electronic Textbooks [3]:

TECHNICAL AND USER-RELATED CRITERIA

1. Installation/preparation for use (simplicity/complexity of installation – can it be successfully carried out by a layperson?, duration of installation, automatic installation process, registration, compatibility, list of required hardware and software)

2. Adaptability (compatibility with browsers, the option of choosing components, tasks, difficulty, speed)

3. Legibility and clarity of text (font size, font style, graphics, use of colours, contrasts…)

4. Quality of multimedia elements
   • images (illustrations, photographs, mapping or other cartographic content)
   • audio recordings
   • video recordings
   • animations and simulations

5. Level of interactivity
   • passive (no interactivity)
   • low (one-way communication)
   • moderate (one feedback loop)
   • high (multiple feedback loops or an unlimited number of feedback loops)

6. Navigation (allows clear navigation and orientation – do I always know where I am when I move from one menu item to the other?)

7. Support during use (availability of help during use)

ORGANIZATIONAL CRITERIA

1. structure of the e-textbook
   • cover page with logos
   • instructions for use
   • table of contents
   • chapters or thematic units
   • literature and sources
2. various options for classroom use
   • computer lab/multimedia lab
   • one or more computers
   • computer + interactive whiteboard
   • computer + projector
   • other
3. visible and simple navigation
4. different learning paths
5. adaptive content
6. use of resources and rights of use

For the time being 6 (six) publishers prepared digital textbooks for primary schools in Serbia: Eduka Klett - Novi Logos - Freska, Oxford University Press. and Pearson. Only their digital textbooks and resources will be taken into account. The analysis of these digital textbooks will be in alphabetical order and in no way does it imply the quality of textbooks one over the other.

3. OVERVIEW OF DIGITAL TEXTBOOKS FOR ENGLISH LANGUAGE INSTRUCTION IN SERBIA

Eduka

Digital textbooks by Eduka [4] are to be found on two different platforms: Eduka Digital and Eduka Moodle. There is no need to install these platforms since they are available online with a simple registration in few steps. At the moment there are following digital textbooks available on Eduka's platforms:
   • Grade 1: Let's play English 1 (Eduka Digital)
   • Grade 2: Let's play English 1(Eduka Digital)
   • Grade 5: Over the Moon 5 (both Eduka Digital and Moodle)
   • Grade 6: Over the Moon 6 (Moodle).

Eduka Digital is primarily for teachers for classroom use. The content is enriched with multimedia and interactive

elements: audio, embedded video, extra activities, key to exercises.

Figure 2 Multimedia elements

It is easy to navigate and go through the units. It is also possible to go back, zoom in/out, refresh, underline the text, hand draw, enter full screen, highlight the text and undo.
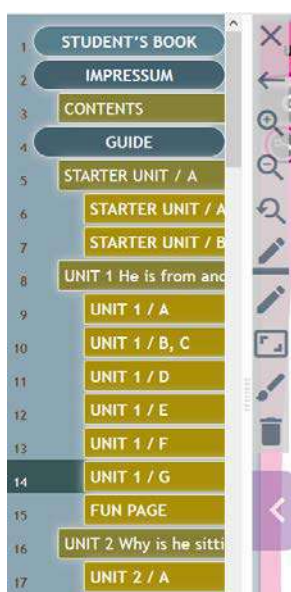

Figure 3 Navigation and tools

Complementary to this digital textbook, there is the same textbook "Over the Moon 5" on Moodle as well. Moodle is compatible with different browsers, especially when using Moodle App from Play Store. The content in Over the Moon 5 and 6 is organized in units, each of which consists of lessons, tests, assignments, ask-your-teacher forum, authentic videos embedded from external sources. There are four self-checks throughout the course (checking vocabulary, grammar and communication) plus one final test in the end.

The text is clear and legible. Units are full of images, audio recordings and videos. Throughout the course students are expected to participate actively since the level of interactivity is very high. There is a constant feedback for students of whatever task they do.

Navigation is easy and visible, and the organization of units is clear. Students can see their progress in the gradebook, edit profile, manage their user settings, and communicate both with the teaches and their classmates via direct messages.

Moodle is highly adaptive for teachers, which means that all teachers who know how to create content on Moodle can add their own resources and create their own personalized lessons for students.

Technical support for Eduka's digital textbooks on Moodle is provided by MMS (Moodle Mreža Srbije).

Klett, Novi Logos and Freska

Klett, Novi Logos and Freska [5] prepared together the learning material at www.eucionica.rs. E-ucionica is a learning portal which does not need to be installed because only registration is required in few simple steps. It is compatible with various browsers, can be used off-line as well, but there is no a SCORM file for the material and it cannot be exported to other platforms. The text is legible with appropriate fonts, styles, colours and contrasts. There are many additional functionalities in the textbook which add to the quality of these digital textbooks: table of contents, chapters, video, audio, hyperlinks, glossary, writing/drawing tools (in order to personalize learning) and navigation.

Figure 4 Functionalities in a digital textbook an eucionica

Furthermore, all exercises are interactive, i.e. students get feedback, can try again, see all the answers or check their answers.

Figure 5 Feedback on eucionica

Additionally, there are also some benefits for teachers. E-ucionica is designed to provide teachers with good learning analytics (at the moment this is possible only for the teachers who participate in the project "2000 Digital Classrooms"). Teachers can see their students' performance in order to see their students' improvement. In order to do that, teachers create their "own" classroom where they get their students assigned. However, teachers cannot upload their own learning material.

Both synchronous (chat) and asynchronous communication (direct messages) are also possible. There is also a calendar and technical support section.

At the moment there are following digital textbooks available in the e-ucionica learning portal:
- Grade 1: Klett (Super Mind 1), Novi Logos (Family and Friends 1), Freska (Smiles 1)
- Grade 2: Klett (Super Mind 2), Freska (Smiles 2)
- Grade 5: Klett (Eyes Open 1), Freska (Right on 1)

- Grade 6: Klett (Eyes Open 2), Freska (Right on 2)

Oxford University Press

Oxford University Press [6] (distributed by The English book in Serbia) offers only iTools for teachers to use it in the classroom as digital resources for interactive whiteboards. At the moment students can only use online exercises provided by Oxford University Press. Students can access the exercises by activating the level using the code in their printed books. and are provided with further practice [7].

iTools presentation software is easy to install and comes on a cd separate for each level. It can be installed as many times as needed. There is a students' book and a workbook organized by unite, additional resources accompanying each unit, bookmarks and flipcharts (there functionalities are to be seen on the left vertical toolbar in Figure 6). The text is clear and legible, can be zoomed in and out, become highlighted, erased; the teacher can add text, erase, enter full screen any time they need (Figure 6, on the right).

Figure 6 Functionalities on iTools

Furthermore, each lesson is full with multimedia (audio, video, cartoon animations) together with answer key provided for all the tasks and activities given. There are also additional activities (the "star" icon) if the time allows (Figure 7):

Figure 7 Types of multimedia elements

Navigation is simple and the teacher can change pages and between the books in just one click together with many other functionalities:

Figure 8 Navigation on iTools

Students access their level and can choose in a simple navigation between the units and type of activities the want to do online. There are usually six units, word bank, tests (to generate from the test bank) and games. Each unit consists of activities to practice grammar, vocabulary, everyday English, audio (from the lessons from the textbook), and a test for that particular unit. All activities have online answer key and students will immediately know the correct answers.

For the time being, there is no possibility for teachers to check what their students do online.

Pearson

MyEnglishLab

Pearson [8] (distributed by Akronolo in Serbia) accredited only two workbooks as a digital textbook for state schools in Grade 5 and Grade 6. It is Wider World 1 and Wider World 2, respectively. These workbooks can be found in Pearson's My English Lab portal together with many other learning materials. The portal is very sophisticated and is a genuine LMS with almost all the features that one LMS needs to have. Furthermore, it can be personalized and customized to a great extent to suit the learners' needs. Registration is simple and is compatible with various browsers. On the other hand, it cannot be used off-line, and there is no a SCORM file for the material and cannot be exported to other platforms. The text is legible with appropriate fonts, styles, colours and contrasts. There are many additional functionalities in the textbook which add to the quality of these digital textbooks: table of contents, chapters (units from the book), exercises that cover vocabulary, grammar, four language skills with additional video, audio, hyperlinks, glossary, and easy navigation.

Figure 9 Organization of Units in My English Lab portal

Throughout the whole course teachers can personalize assignments for the students, organize the course both with

pre-set resources and personalized ones, have a clear view of students' advancement as in a formal register, communicate with students, and manage the courses, groups, personal profile and analytics in the settings tab (Figure 10).

Figure 10 Features of My English Lab portal

Since it is an LMS there is a possibility for the teacher to assign personalized tasks for students, create to-do lists, organize calendar with tasks and assignments for students to see as well:

Figure 11 Assignments and Events in My English Lab portal

Students can access all their courses in one step and choose from the list of offered courses which one they would like to attend:

Figure 12 Accessing courses in My English Lab portal

Learning analytics is always the best part of using an LMS and in this particular case both teachers and students can benefit a lot from Gradebook option since it offers not only student score but also diagnostics of time spent per unit, the average score for each skill, the average number of attempts:

Figure 13 Gradebook in My English Lab portal

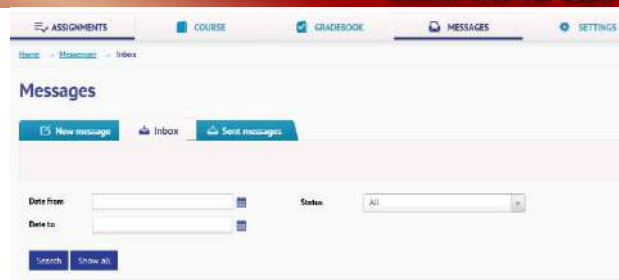Asynchronous communication is also possible via direct messages:

Figure 14 Messaging in My English Lab portal

Through the settings tab a teacher can manage different courses (join, create, add a product), create groups for students, edit personal profile info, set important notifications via email (to be notified: when students submit their assignments to be teacher-graded, 14 days before the course ends, and 30 days before subscription to product expires).
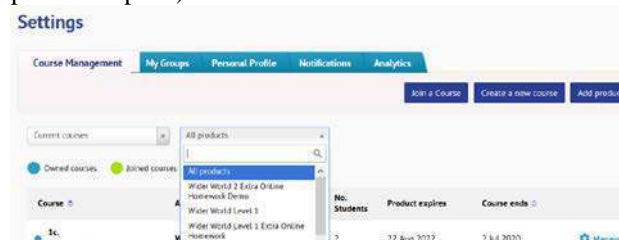

Figure 15 Settings in My English Lab portal

Unfortunately, there is only one accredited workbook available in such a sophisticated portal. There is much more in Pearson English Portal which offers a variety of presentation class software and activities to use on interactive whiteboard (through Pearson eText option), but they are all in line for accreditation.

CONCLUSION

The above overview of the digital textbooks for English language learning and teaching in Serbia shows that all the publishing houses in Serbia have come up to high standards when it comes to language learning. The analysed digital resources are as follows:

- Grade 1: Klett (Super Mind 1), Novi Logos (Family and Friends 1), Freska (Smiles 1), Eduka (Let's play English 1)
- Grade 2: Klett (Super Mind 2), Freska (Smiles 2), Eduka (Let's play English 2)
- Grade 5: Klett (Eyes Open 1), Freska (Right on 1), Pearson (Wider World 1), Eduka (Over the Moon 5), OUP (Project 3)
- Grade 6: Klett (Eyes Open 2), Freska (Right on 2), Pearson (Wider World 1), Eduka (Over the Moon 6), OUP (Project 3)

There are different approaches taken: some of the publishers used enriched e-textbooks with lots of interactive activities, some of them created virtual learning environments. Both technical/ user-related and organizational criteria have been fully met. On the other

hand, the implementation of digital textbooks is still in its infancy and the books lack in many accompanying components (for example, there is only a presentation software for teachers but no resources for students, or vice versa). It is now up to the teachers to choose the right textbook depending on the school resources, level of knowledge of their students, teachers' preferences and digital competence. It is a special assignment for publishers to move with the times and meet the challenge of new technology.

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COMPARISON OF MACHINE LEARNING ALGORITHMS FOR STUDENTS PERFORMANCE PREDICTION BASED ON LMS DATA

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Abstract: *Huge volumes of data created by students` activities on learning management systems (LMS) urged an opportunity to extract meaningful information from data. Development of data mining field yielded algorithms making possible to analyse data with the aim to improve quality of the educational processes. In this paper, we are comparing four data mining methods based on different machine learning algorithms to predict academic performance of IT students based on data about their activities at the LMS. Aim of the research were twofold: (i) to predict students' academic achievement and identify most important predictors of academic success, (ii) to compare different machine learning algorithms and identify which fits the best on LMS data. Research results indicated frequency of students` discussions as the most important predictor of success. Neural networks provided most accurate and reliable model.*

Keywords: *LMS data, data mining, CRISP DM, neural networks*

1. INTRODUCTION

Learning Management Systems today play a significant role in higher education learning models. The large amounts of data generated by such systems have opened up new research pathaways, especiall in an analysis of student behavior. The aim of such analyzes is to identify behavioral patterns for the purpose of improving the learning process and consecentually, enhance students academic performance. The large amounts of data and characeristics of such data also require new methodological approaches in analysis [1]. Educational Data Mining (EDM) is an emerging field developed with the aim of machine learning and data mining techniques application in educational domain. Results of such analysis are beneficial to both, students and teachers because they help in improvement of learning processes. Recent research trends in the EDM field are focused on massive open online courses (MOOC) [2]. This is in the focus of our research. Hereinafter, we used data for different students activities on one blended course using the Moodle platform. Machine learning techniques shown to be useful in the Moodle data analysis [3] . Majority of previous research papers analyzed activity logs [4-7] . Their research results indicated accurate predictive models of dropout based on the Moodle data.

This study aims to analyze activity logs of third year students at the course Knowledge discovery in data, which is tought at the IT faculty in Croatia. Data are collected from three generations in order to provide information regarding students' performance to the teachers and study programme management to help them in improving the programme and to help students improving the learning process. Furthermore, this research also focuses on the methodological aspects of activity logs analysis and tried to identified the best machine learning approach for LMS data anaylsis.

This study is structured as follows. In the next section we present relevant and recent research results regarding the research topic. Section 3 presentes research methodology: describes used data set and data mining standard used in the research: CRISP DM. Section 3 presents research results and section 4 concludes the paper.

2. RELATED RESEARCH

Academic performance of students serves as indicator of education system quality, so it is interesting research topic among scientific community. Nowadays, academic performance predictions are based on LMS data. LMS platforms offer different channels for teachers and students to communicate in a course, store files, share information, upload assignments, do the tests. LMS saves log data of the students' activities [8]. Romero and Ventura [9] were among first scientists to apply data mining techniques to LMS. They explored benefits of data mining techniques for LMS data analysis. Our research seeks to further advance their approach in terms of investigating which of the data mining techniques based on machine learning provides the best predictive models on LMS data. Other investigated topics are related towards students' satisfaction with the LMS [10] and gender differences in attitudes [11-13]. Yukselturk and Top [13] found out that females` participation was more intensive then males`. These results are in line with previous research results of Kimbrough et al. [12] which emphasized high females` engagement in communication on LMS. However, there are different evidence from Prinsen, Volman, and Terwel [14]. They found out high participation of male students. There is a need to investigate the impact of such participation on student course performance measured by students` grade. This paper presents a case study based on an undergraduate IT course. Hereinafter, we present the results of our research on this topic.

3. RESEARCH METHODOLOGY

The participants of this study were 105 undergraduate students who enrolled in a course Knowledge discovery in data at the University of Zagreb. Participants in this study used online learning to access course materials (a content page, web links, self-reports), to download presentations, to upload their assignments, to ask questions to the teacher, to solve tests. The online learning environment was developed in a Learning Management System (LMS), Moodle. This study used data about students` activities presented in Table 1.

Table 1: Variables description

Variable	Description
Files view	*Numeric* Frequency of files opening (Power point presentations, PDF files,…)
Forum view	*Numeric* Frequency of forum reading and posting
Student report view	*Numeric* Frequency of report opening
Folder view	*Numeric* Frequency of folder opening
Choice	*Numeric* Frequency of choice opening
File upload	*Numeric* Number of files uploading
System login	*Numeric* Frequency of system login
Test	*Numeric* Optional tests points
Assignment	*Numeric* Points for solutions of assignments
Gender	*Categorical/* Female or male
Grade	*Categorical* *Overall grade achieved at the course*

CRISP DM process model is applied in this research to analyze the data. CRISP DM stands for CRoss-Industry Standard Process for Data Mining [15]. CRISP DM implies six steps for data analysis (see figure 1).
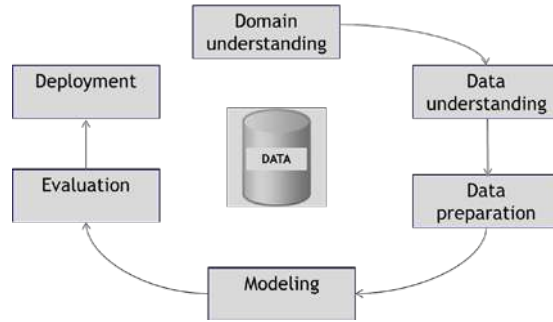
Image 1: CRISP DM process

First, data exploration and data preparation were performed. Modeling phase is in the focus of this research. Modeling consists of building and assessing the predictive models. Here, we are performing students academic performance prediction based on activity logs at the LMS. Prior, modeling technique should be selected. Four modeling techniques belonging to different machine learning approaches were selected and applied and their parameters are calibrated to optimal values. Those are:
(i) Classification and regression trees (CART) categorized as information based machine learning approach,
(ii) Neural networks categorized as error based machine learning approach,
(iii) Naive Bayes classifier categorized as probability based machine learning approach,
(iv) k-nearest neighbours categorized as similarity based machine learning approach.

Evaluation was performed and four models were compared based on two measures: accuracy of the model (Root mean square error, RMSE) and reliability of the model (RSquare).

4. RESEARCH RESULTS

To develop predictive models, four machine learning techniques were applied using the same data set. Results of accuracy and reliability for each model are given in table 2.

Table 2: Performance of ML models

ML Algorithm	Accuracy	Reliability
Neural network	86,53%	0,64
CART	83,21%	0,55
Naïve Bayes classifier	79,54 %	0,51
kNN	78,44%	0,48

As results demonstrate, neural networks yielded predictive model of highest accuracy and reliability, followed by Classification and regression trees. K-nearest neighbours, technique based on the similarity produced the worst results. T-test was further performed on the results in order

to see are differences among machine learning models statistically significant.

Table 3: T-test results

ML Algorithm	p-value
Neural network	-
CART	*0,003*
Naïve Bayes classifier	*0,01*
kNN	*0,01*

Based on pairwise t-test shown in Table 3, the overall accuracy of neural network algorithm is better than the overall average accuracy of all the other algorithms and the difference is statistically significant at 95% confidence level. It is interesting to note that neural networks and kNN are two approaches requiring only numerical inputs. Since all of our input variables were numerical, those results are not surprising. CART proven to work better on categorical inputs.

Since neural networks model is the best, we will interpret and discuss results of that model. First, architecture of neural network is presented at image 2.
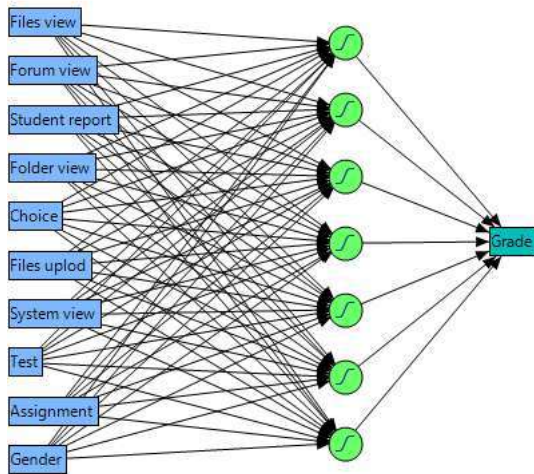
Image 2: Neural network architecture

Neural network architecture consists of 10 variables (neurons) in the input layer, 7 neurons in the hidden layer processing the data, and one neuron (grade) at the output layer of the neural network.

The results of sensitivity analysis based on NN predictive model is presented in Table 2. As shown in Table 3, from the total 10 variables listed for investigation, 2 variables emerged as the strongest predictors: Forum View and Test.

The predictive model tells us that having more forum views or having better results on optional tests will lead to the students achieving a better overall grade at the course.

Table 3: Sensitivity analysis results

Column	Main Effect	Total Effect
Forum view	0.107	0.437
Test	0.074	0.405
Gender	0.067	0.317
Assignment	0.076	0.252
Choice	0.034	0.217
System view	0.036	0.193
Files upload	0.032	0.189
Student report	0.024	0.144
Folder view	0.02	0.103
Files view	0.011	0.058

Neural network model indicated gender differences in academic performance. Variable Gender is third highest predictor of academic performance. This finding is in line with previous research which proved differences in attitudes and behaviour on LMS between male and female students. It is interesting to note that frequency of files and folder views isn't significant predictor of academic success.

5. CONCLUSION

Results of this research contributes to existing research on educational data mining in LMS data by demonstrating that machine learning approaches are effective for LMS data analysis. We have demonstrated that neural networks show greatest potential for LMS data analysis application, so we assume that if the characteristics of other data-sets are similar, then the performances of the machine learning approaches on these data-sets are similar as well.

The purpose of this study was also to examine based on which LMS activity student performance could be predicted? Neural network model has pointed out forum interaction as most important predictor. Students engagement into reading forum posts and interacting into discussions found to be indicator of overall grade at the course. Solving optional tests is the second highest predictor.

The results of this study could help students to focus on the LMS activities which would lead them to achieving academic success and to help teachers to identify students who could struggle. It will also give teachers the way to provide early guidelines for online learning activities configuration.

This study was limited by small data used in the analysis However, it was reliable enough to develop accurate predictive models and to give insights into students activities and their relation with academic success. In the future research we will include students of different courses and study programmes to see are there differences in patterns.

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APPLICATION OF E-LEARNING TECHNOLOGY IN CORPORATE EDUCATION - CASE STUDY OF COMTRADE'S PMO EDUCT PORTAL

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Abstract: The Comtrade Project Management Organization (PMO) engages over 200 experts on over 400 active projects with different roles in project management: Project Managers, Scrum Masters, Program Managers, Engagement Managers. Some of the critical challenges that PMO has in store are standardization of the process, the unification of project management tools, the onboarding of new PMs into the project organization and training them for Comtrade specific project practices, sharing knowledge and experiences from their projects. The Comtrade PMO EDUCT portal is a focal point, a landing page of all PMs in Comtrade. The separate segment is the sub-portal for internal education and certification(pmo.teslacloud.org), which contains over 150 training and educational content. This paper aims to present Comtrade experiences and practices in the implementation of eLearning technologies in corporate education aimed at increasing business excellence and excellence through Knowledge sharing, Knowledge acquisition, Collaborative learning, and Internal certification and standardization.

1. INTRODUCTION

The Comtrade PMO for years had in place dozens of strategical initiatives and regular activities to assure standardization of the PM processes, the unification of project management tools, the onboarding of new PM (Project Manager), sharing in-house knowledge and experiences as well as assessing PM community competences. There were live refreshment sessions held by external as well as internal experts, regular short meetings which gathered PM community in the purpose of sharing new knowledge and proven good practices from Comtrade projects, the highly regulated procedure for onboarding new Project Managers by tracking their progress daily [1]. Regardless of the numerous benefits of all these activities, additional problems occurred. Some of them are listed: live events covered low amount of community located only on one location, learning required whole PMO community's dedication to fixed timeslots, significant amount of time was invested in onboarding only one new employee, there was low level of flexibility in external events organization while hands-on experience shared on those events was not matching.

2. GOALS AND CHALLENGES

As history illustrated, technological progress would have generated a skill gap. Therefore, rather than resisting the digital transformation, PMO decided to prepare immediately and strategically for a skillset that would have perpetually changed and evolved. Instead of individual, mutually independent learning sessions, PMO encouraged both people and organization to consider learning and development as a never-ending cycle of continuous improvement. Individuals who stop learning to endanger their careers.

Having in mind this idea, the original question became more precise: how to deal with PMO challenges while assuring continues improvement independently on location? Continues improvement requires measurement of status and inspection of the next results. Having a standard learning approach could not provide this kind of comparison. Even if PMO had invented manual methods for teaching and measuring improvements this method still would have lacked objective and systematic approach for the valid praising of Project Managers who make progress in learning; and opposite, it would not have been a transparent tool to those who showroom for improvements and require additional assistance. Learning as an answer was still valid, and most comprehensive approach [2].

Comtrade PMO had the other task: to understand how our employees learning habits changed. Globally, learning happens everywhere. *Instead* of reserving dedicated long hours for learning learners *now,* invest several minutes while they are in transport, waiting at the doctor, between two meetings, etc.

3. PROBLEM-SOLVING FRAMEWORK

With an active role in the project success, during 2016, Comtrade Project Management Office was designing and conducting the PM Insights Survey about various aspects of project management practice and needs in our company [3, 4]. The goal of the Survey was to get the state of the project management and through analytics, gap analysis to identify priorities for improvements.

Our project managers have provided us with valuable information to be used in targeting challenging areas. With their willingness to share their opinions on important matters in project management profession and attitudes towards PM practice in Comtrade we were able to identify gaps, recognize key factors for improvements and define Roadmap for executing specific action plans.

Presented Radar diagram and Gap bars in *Figure 1: PM Insights Survey results - Radar* diagram. And *Figure 2: PM Insights Survey results – GAP* Analysis, show Survey results across seven primary categories compared to desired values. The most significant gap emerged in the "Education and knowledge" category, followed by "Methodology" and "Team" categories.
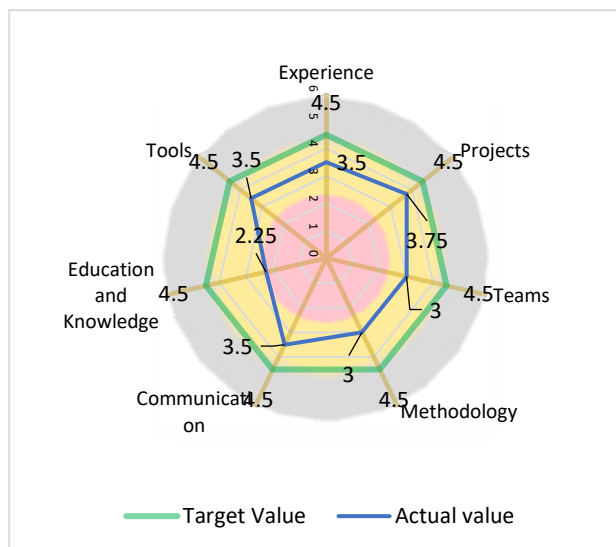
Figure 1: PM Insights Survey results - Radar diagram
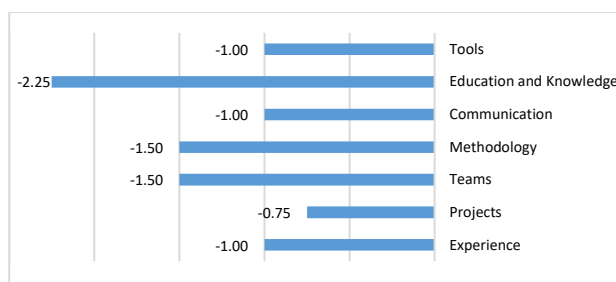
Figure 2: PM Insights Survey results – GAP Analysis

Table 1: PM Insights Survey – The most significant gaps emerged and improvement plans

| Category: Education and Knowledge	
GAP: -2.25	
Improvements	**How**
Focus on highly specialized educational content related to the latest methodologies or technologies. Accelerate PM, BA, SM, and project team readiness for new roles. Reduce time for project onboarding. Improve domain knowledge coverage. Create a systematic and consistent learning content for dislocated teams. Reduce Cost for learning and education. Fostering continuous learning and professional development.	PMO EDU portal, PM Newsletters, PM Coffee Breaks PM Community Competence Center, Mentorship and Coaching
Category: Methodology	
GAP: -1.50	
Improvements	**How**
Standardization - create a common language to be understood by all. Formal PM processes improvements. Best practice sharing. Agile delivery – Keep pace with technological rapidly changing. Create project resource libraries and repositorium.	Expert group (Delivery and Processes), PMO EDU portal, Seafile repository
Category: Teams	
GAP: -1.50	
Improvements	**How**
Improve team collaboration and communication. Foster is sharing knowledge and personal experience. Transparency of expertise, promote personal competences	PMO EDU portal PM Coffee Breaks PM Newsletters PMO Slack Channel

4. RESULTS

Taking survey results into consideration, PMO made a strategical decision about creating e-learning portal – PMO EDU portal as a focal point for sharing knowledge and experience, continues professional development, transparency of expertise, promoting personal competences as well as assessing a PM professional capability. It is an online communication platform for those who are or want to be involved in project management and also provides a significant resource library due to its ability to effectively shape and present existing and future company materials.

		PM Surveys

Besides PMO EDU portal, multiple PM Digital communication channels are available within our company, and their effectiveness and benefits for collaboration and teamwork depend on the type of communication and number of participants using them.

All communication channels [5, 6, 7] are combined and available while using PMO EDU portal. This approach facilitates unlimited reach, is cost-effective, and addresses
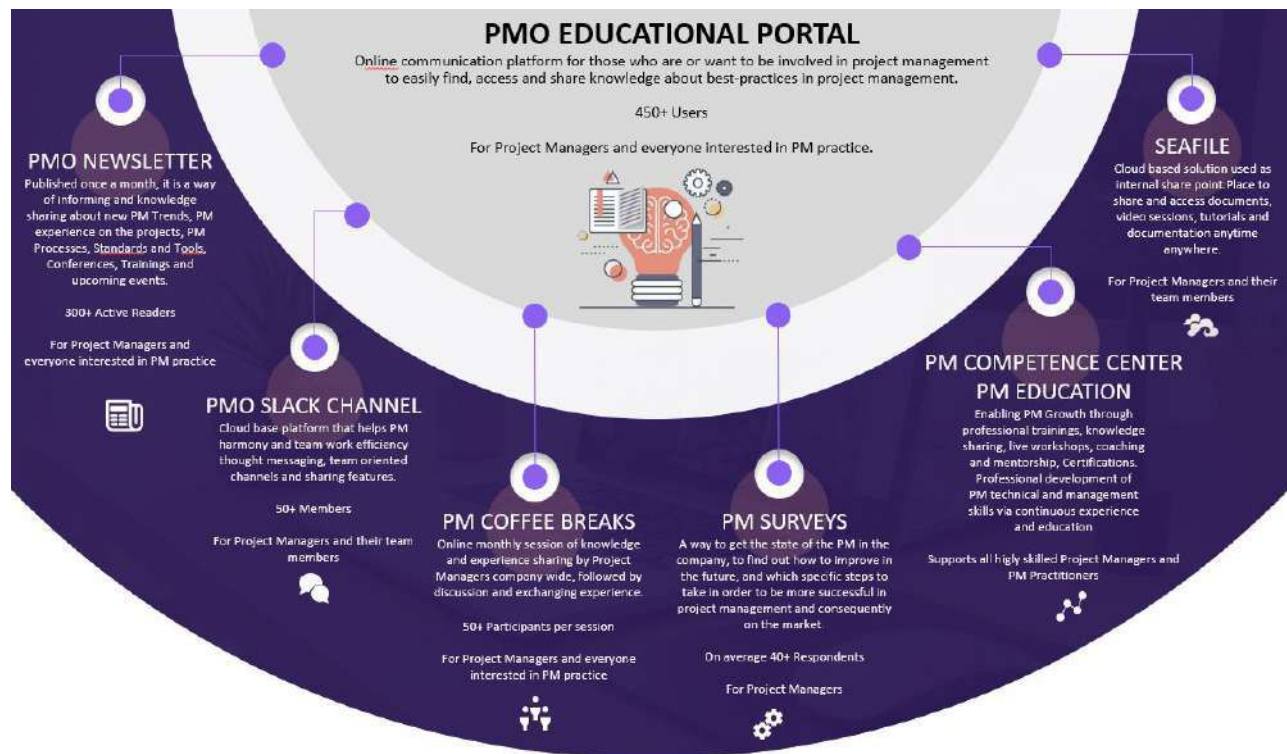

Figure 3: PM Digital channels of communication and Knowledge sharing

Table 2: Breakdown of PM Digital Communication Channels per type and # participants

the needs of varied and globally widespread learners, keeping us on track to achieve business and project goals.

Content format selection

Type of Communication

| # Participants		Synchronous - Online	Asynchronous - Offline
	One-on-one	PMO Slack channel	Business E-mail
	Project Team	Skype for Business Conference meetings	Seafile repositories
	Group	PM Coffee Breaks	PM Forums
	Individual		E-Learning lessons on PMO EDU portal PMO Newsletter
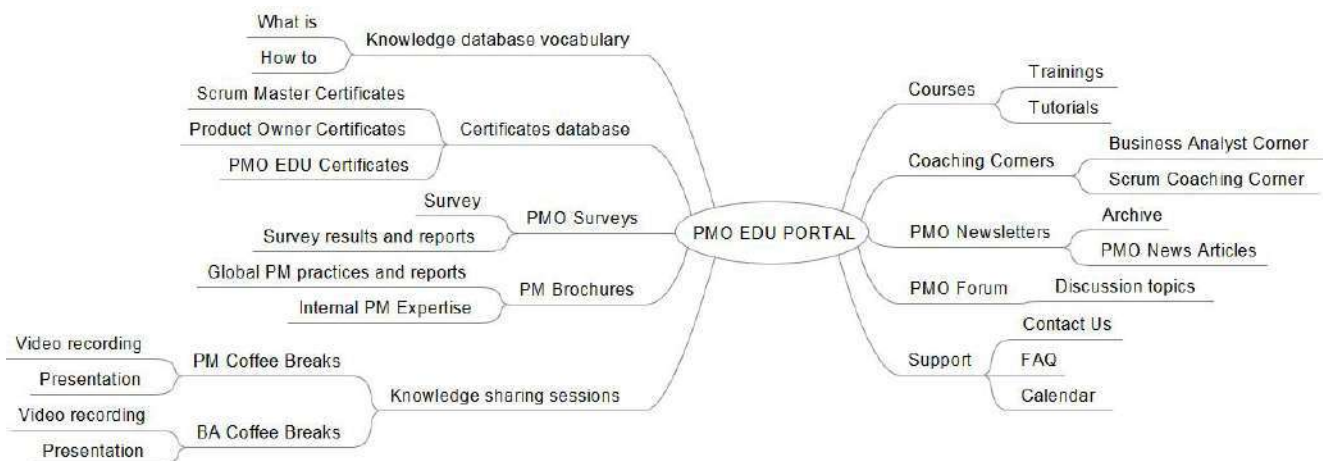
Figure 5: PMO EDU portal Mind map

To meet different expectations from learners depending on the amount of time available for learning, four main different content formats were selected and defined [8, 9]: 1) "What is" format, 2)" How to" form, 3) " Training" format and 4) " Tutorial" format. All other forms are shown in Figure 5: PMO EDU Portal Mind map.

From an organizational point of view, eLearning organized
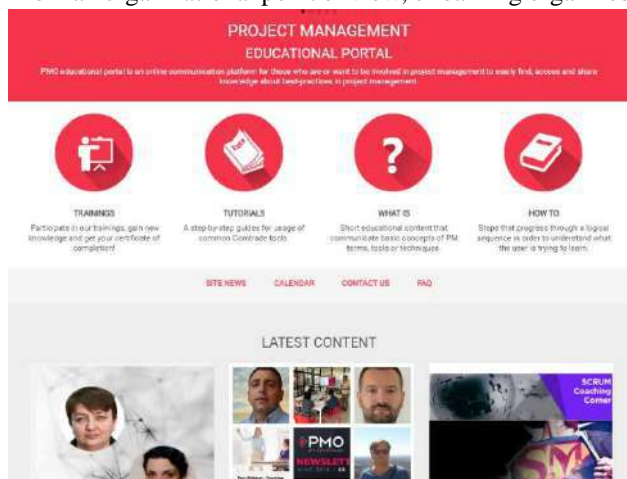
Figure 4: PMO EDU portal Home page

in this way on the portal was expected to decrease enterprise learning cost without sacrificing learning quality significantly. Content "to go" is implemented as short educational content, while detailed knowledge acquisition is accomplished by "training" and "Tutorial" formats. Definitions for each form are listed below:

"What is" type is Short educational content that communicates basic concepts of project management terms, tools, or techniques. The specific subject is explained in simple terms to help PM practitioners to understand and apply new knowledge quickly. By regular reading, this kind of content user is up to date with all new words in the PM domain and keep pace with rapid changes and innovations.

"How to" format refers to steps that progress through a logical sequence to understand what the user is trying to learn. This format is primarily reserved for company hands-on experience and should contain proven steps

already applied in practice by company project managers. Besides sharing knowledge, this type of education provides in-house experts promotion. Author of such educational form summarizes his expertise and experience in the format available for the whole community in aim to inspire, educate, or help not only company PM community but also potentially other stakeholders and therefore increase own visibility. While containing precise steps that might be applied in practice, it also extends collaborative learning since content necessary have contact person details.

"Training" format is the most detailed compared to other forms and has the most significant value for portal users and overall company efficiency. Its author must be a company resource recognized by her/his expertise and skills. Other portal formats are mainly intended as content "to go," but "Training" format with its precise structure offers in-depth knowledge validated by company resources. Despite training for a wide range of project management skills are globally available in different LMS (Learning Management Systems), this specific in-house created training is precise and focused on areas common for Comtrade Project Managers and particular circumstances typical for industry our company covers. Also, global LMS systems are mostly intended for individual users. Spreading them in the company would result in increasing unique PM skills, but community collaboration would not benefit. Moreover, it might have been decreased because one may invest significant effort and time in searching for proper training and therefore sacrifice time for community collaboration. "Training" as the most demanding format consists of next parts: detailed explanation about the author, learning outcomes, audience, duration, training topics quick quizzes, references, and additional readings, final quizzes, feedback, and certificate.

Content development for enterprise eLearning

Portal primarily had to address PM challenges, but in the spirit of Comtrade culture, every knowledge is shared and accessible by all employees. Content provided for such a big group must meet high standards in terms of accuracy, relevance, and application-focus. Instead of setting rigid, fixed criteria that might additionally limit the process of creating content, portal Editorial Board introduced a "peer-

review" approach. Every training must be reviewed and approved by the enterprise expert in the training domain. Different portal features and diversity of editing modes provide plenty of possibilities for training administration.

Employee's engagement in the company learning system

Availability of relevant, validated content to employees is the most crucial premise for corporate education, but it is not enough to assure that expected learning outcome will be achieved. Research has demonstrated that engaging learners in the learning process increase their attention and focus, motivates them to practice higher-level critical thinking skills, and promotes meaningful learning experiences. It turned out that eLearning in the format of PMO portal offers mechanisms for affecting users' engagement. As one of the most effective approach, gamification of learning was used in the first place, as typical an online marketing technique to encourage participation with the portal. The definition from Gartner states, "Gamification is the use of game mechanics and experience design to engage and motivate people to achieve their goals digitally." This definition highlights gamification's reliance on digital technology and the design of the user experience. Having personal scores and detailed portal statistics about user activities gave a useful source for making "Leader Board" with a similar purpose as "Wall of fame" - a tribute to notable individuals.

Evaluation of eLearning

Table 3: Main pain points of Education & Knowledge, Methodology and Teams, Taken actions and their results

Category: **Education & Knowledge**		
Problem	Taken actions	Results
Globally widespread learners	Establish online PMO EDU portal	Simultaneous education of globally distributed employees.
Verify PM, BA, SM readiness, and domain knowledge coverage.	Training exam and certifications on PMO EDU portal	Improved knowledge validation.
Turn Knowledge into Practice knowledge	Labs and sandboxes for exercise and assignments like real project tasks	More competitive employees in new roles and enhanced productivity.
Rapid project onboarding	Coaching corners on PMO EDU portal	Accelerated onboarding cycle

Continuous learning	PMO EDU portal	Easily find, access, and share knowledge. Retrieve and review learning materials whenever employees want.
External training is expensive and last too long	Establish online PMO EDU portal	Significantly reduced costs with self-paced learning. Optimized degree of employee time utilization.
Be in align with the employee's personal goals	Create personal careers paths on PMO EDU portal	Personalized and Targeted custom corporate eLearning content.
Employees do not have much time to learn	PMO EDU portal mobile version	Microlearning concept - access to bite-sized chunks of learning Illustrations and short videos allow education just in time.
Have systematic and consistent learning content	Knowledgebase with vocabulary on PMO EDU portal	Have a universal language that everyone understands.

Category: **Methodology**		
Problem	Action	Results
Keep pace with the latest methodologies and technologies	The highly specialized educational content on PMO EDU portal	Training on PMO EDU portal is built prompt and on-demand, enabling rapid adaptation to changes in digital transformation.

Category: **Teams**		
Problem	Action	Results
Enhancing cooperation and trust among employees	PM Collaborative learning and community	Strengthens team connectivity and reinforce

		communication and openness.
Encourage sharing of personal experience and know-how	PM Coffee Breaks PM Newsletters	Bringing employees together leads to debates and discussions that lead to innovation, too.
Encourage team collaboration and communication	PMO Slack channel PMO Forum on PMO EDU Portal	Improved peer to peer communication, fostering discussions, and further knowledge sharing.
Personal/team knowledge and experience transparency	PM Newsletters PM Coffee Breaks	Improved clarity of expertise. Promotion of personal/team competences.

Corporate eLearning must satisfy high standards usually highly regulated by institutions in a particular domain. It also must meet user needs to be defined by real case examples. To shape content toward those needs, PMO uses the portal ability for instant feedback. In the case of class learning, feedback is usually obtained at the end of the learning session. Therefore, changes affect only future learners. Immediate feedback in eLearning directly implies immediate reaction and thus shapes content promptly. Every "Training" format has a mandatory "Feedback" part where users give inputs for training advantages or disadvantages. Those results and insights were analyzed regularly and represent the input for Content development step in the second iteration. The portal has the "Forum" section where every logged user can set the topic and initiate discussion. Collaborative learning before PMOEDU portal was reserved for live events or eMail communication. "Forum" section on portal offers collaboration learning no matter on time, location, or invitation. It is intended for everyone in the corporation and provides a wide range of audience. As a result, questions, issues, or project management problems can be discussed from different perspectives in a short period.

As a natural process in Agile ecosystems, we performed inspection and compared initially identified problems with observed results. All the benefits described above are summarized in *Table 3: Main pain points of Education & Knowledge, Methodology and Teams, Taken actions and their results* show how identified pain points of PM Education, Methodology, and Teams were addressed.

5. CONCLUSION

Corporate eLearning should provide a solution, which takes into consideration not only market changes and demands but also employees' needs as well as internally recognized area's for improvements. The solution itself must be flexible to provide proper aligning with frequent market changes while it measurably affects corporate efficiency. Self-paced learning is equally essential as easy and prolific collaboration. In the case of Comtrade eLearning solution, PMO EDU portal generated significant progress in all measured company's KPIs. As the focal point for all company's communication channels, it provides complete education coverage for different corporate profiles (Project Managers, Business Analysts, Scrum Masters, and other roles in every business segments) and different needs. Research shows that PMO EDU portal, with its combination of different content and varies features, proved itself as an obligatory framework in agile ecosystems, which require constant competence building.

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FIRST EXPERIENCES WITH MOODLE AND CODERUNNER PLATFORMS IN PROGRAMMING COURSE

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Abstract: *Learning programming is one of the most important activities in electrical and software engineering education. Programming skills are best achieved through practical work which include laboratory exercises, projects, and homework assignments. For massive courses, online learning platforms play more and more significant part in achieving scalable learning process. At the University of Belgrade, School of Electrical Engineering, we introduced Moodle platform and CodeRunner plugin both for the teaching and assessment purposes in Programming 2 course at the Department of Software Engineering. Students write the code during auditory exercises and test them using CodeRunner on Moodle. The same platforms are used during examination. In this paper we present our first experiences with new course organization, used tools, as well as student' satisfaction through conducted survey.*

Keywords: *automated code assessment, CodeRunner, E-Learning, Moodle, programming course*

1. INTRODUCTION

Programming skills represent the most important outcomes of computing education. Good programming skills are essential for students to adopt computational thinking and the ability of solving real-life problems in software, as well as an important prerequisite for the courses at the later stages of the studies [1]. Beside traditional lectures, which are important for theoretical foundations, practical skills are best achieved through hands-on approach which include laboratory exercises, projects, and homework assignments.

Programming courses are usually massive courses with hundreds of students enrolled, which makes organizational aspects difficult to conduct, such as lectures, auditory classes, laboratory exercises, etc. At the University of Belgrade – School of Electrical Engineering (UB-SEE), there are two obligatory programming courses which are followed by more than 1000 students each year [2]. For that reason, many educational tools, simulators, and platforms have been used in teaching and examination process. Those tools include learning managements systems (LMS), such as Moodle or Blackboard [3, 4], assessment tools [5], as well as plagiarism detection tools to fight malpractices [6].

In our previous work [3], we had good experiences with transition of four computer engineering courses from computer networks, computer security, and algorithms and data structures domain to LMS supported teaching and examining. In this paper, we present our efforts to use LMS and related code assessment tools in a programming course. During 2018/2019 school year we introduced Moodle LMS and CodeRunner plugin in Programming 2

course at the Software Engineering (SE) department both in auditory exercises and examining.

The rest of the paper is organized as follows. Second section gives more details on programing courses at UB-SEE, existing practices, and rationale behind our choice to move courses to LMS and reorganize them. The third section describes our Moodle course organization, with emphasize on CodeRunner tests and examination. The fourth section discusses student achievement and satisfaction, as well as our experiences with new course organization. A short conclusion and directives for future work are given in the final section.

2. PROGRAMMING COURSES AT UB-SEE

Programming has become an integral part of the engineering education in many fields. At UB-SEE, it is present as a mandatory part of each student's education. UB-SEE offers two compulsory subjects that deal with programming fundamentals, called Programming 1 and Programming 2.

The aforementioned courses are taught to all freshman students at UB-SEE. In addition to advantages mentioned in the introduction, good programming knowledge is a desirable skill needed in their future career, regardless of the department they choose to pursue.

The majority of time at each of the two courses is focused on programming languages, basic data structures, code complexity and skills for solving ubiquitous programming problems. Languages that are covered are Pascal and C. In addition, both courses consist of topics regarding basic programming knowledge such as integer and real number

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representation in computer memory and basic operations with them, syntax notations, time complexity analysis etc.

Both courses consist of lectures and auditory exercises which are held in classrooms using PowerPoint presentations. Topics covered in lectures are explained again in auditory exercises through a plethora of representative examples. Exams include 4 to 6 short multiple-choice questions and 1 or 2 larger programming tasks. Exams are done in a traditional pen-and-pencil form with a slight modification which refers to the question answering process. Before the start of the exam students are given printed out exam forms. Each exam form has a dedicated area for filling in the answers of short questions. The dedicated area consists of a grid of circles where rows represent questions and columns represent possible answers to those questions. Such organization allows to automatize the exam grading process using an in-house developed TestARS tool presented in [7]. The overall look of the form and the grading process are shown in Figure 1.

Multiple-choice questions consist of short segments of code which represent theoretical concepts. In addition to the answer for each question, students are obliged to justify their answer in their exam notebooks. Students do not need to solve all questions to achieve maximum points – finding a solution to all but one question suffice in reaching maximum. The one extra question is used as a bonus question with the intention to mitigate the disbalance caused by negative points awarded for choosing the wrong answer. The other half of the exam consists of programming tasks. Programming tasks represent basic real-world problems, similar to those presented in auditory exercises. Students are required to solve these tasks in the exam notebook using one of the aforementioned programming languages.

"Computer programming is known as an art because it applies accumulated knowledge to the world, because it requires skill and ingenuity and especially because it produces objects of beauty", as Donald Knuth said [8]. But it is also a craft, and one cannot be a good craftsman without a practice. Knowing theoretical concepts is welcome but applying those concepts to create a fully working program that does what we intended it to do is a tougher problem. That was our main motivation when we decided to reform one of our courses – Programming 2.
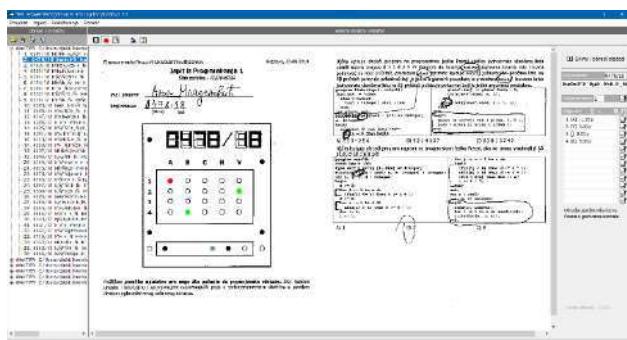
Figure 1: Grading of the form for questions

Programming 2 is one of the largest courses at UB-SEE which is attended by more than 1000 students each year. The course is taught at both UB-SEE study programs – Electrical Engineering and Computing (EEC) and

Software Engineering (SE). Considering the number of students attending the course, making even small changes in the course organization or manner of holding exercises without deeply contemplating whether the change was a good idea or not, can have a potentially disastrous effect. That is why we have decided to try to incorporate improvements on a rather smaller of the two study programs – Software Engineering. On the other hand, software engineering students are much more focused and interested in programming. For that reason, we deemed that changes will be better accepted at SE study program.

Our goal was to ameliorate all aspects of the course. The theoretical part of the course was refreshed, and elements from C11 standard have been introduced. During the lectures, short segments of code were explained by the lecturer using online IDEs. Auditory exercises have been completely rearranged. Rather than conducting exercises in an old-fashioned classroom way where we used PowerPoint presentations and blackboard to explain problem solutions we have established the rule that each student should type the code alongside the lecturer during the classes. Therefore, we moved auditory exercises from classrooms to the computer laboratories. In addition, we created a whole new set of exercises to accommodate the new teaching method we adopted. The number of programming tasks is smaller than before; however, they are more complex and better suited for exercises since they offer much more room to explain a variety of concepts.

However, the biggest change we incorporated was the new examining method. Since students now learn through practical work it is only logical to conduct exams on the computer. In such endeavor we found that the Moodle learning platform was the best choice. In addition to supporting course management, Moodle platform offers the lecturers the possibility of creating quizzes and automatizing the examining and grading process. However, the greatest assets offered by Moodle is a rather strong developer community and plethora of plugins available. In our case, we found CodeRunner plugin [9] which allows code compiling, execution and scoring. CodeRunner plugin allowed us to create tests that include questions in which students are required to write a small piece of code that meets the given requirements. Moreover, CodeRunner plugin offers students the chance to evaluate their answer through test cases, given by lecturers, which consist of the input data and the expected output data. That not only helped students to solve problems more easily, but also automatized the grading process.

To accommodate all changes, all course materials have been moved to Moodle LMS from course website: slides for lectures and auditory exercises, along with test examples. Also, we added a number of supporting materials, such as manuals for Moodle and CodeRunner, video tutorials for IDEs used in the course, programming tasks for preparatory work, different course information, surveys, etc.

However, changing the examination method so drastically can often have negative impact on the student performance. Recognizing this, we decided that it was best to introduce such change on a voluntary basis, i.e. students can choose

between the old-fashioned pencil-and-paper method and the newly introduced computer-based method of examination. Results were excellent and we are very pleased by the overall impression. We strongly believe that this transformation of our course was the correct choice and we hope to implement it on the whole student body in the future.

3. MOODLE AND CODERUNNER IN PROGRAMMING COURSE

The Programming 2 course is organized in three blocks, each covering different topics. The first block covers the representation of real numbers in computer memory and the basics of C language such as operators and data types, control-flow statements, standard libraries etc. The second block covers pointers, dynamic memory allocation, string manipulation and subroutines. The third block covers file management and processing and linked list data structure.

Each block consists of four lectures and four auditory exercises, each lasting two hours. Since lectures given by professors cover the theoretical part of the course, we decided that the auditory exercises should only include programming tasks. Each task was solved together with students. The simpler exercises were done using Visual Studio IDE, whereas the more complex ones were done on the Moodle platform using CodeRunner plugin through tests available on the platform. Moreover, through these tests, students were not only practicing, but they were preparing for the exam since it is conducted in the similar form.

The best example that illustrates the usage of the Moodle platform is the exercise that cover the topic of linked list. The topic consists of basic operations performed on linked lists such as insertion of elements, deletion of elements, search etc. Before we introduced these changes to the course, that particular topic was covered using a PowerPoint presentation consisting of one big programming task. The task itself was simple and demonstrated the aforementioned operations performed on a linked list of integers. However, it was very long and uninteresting, hence more often than not students would dose of and stop paying attention.

When we decided to change the course, we moved the task from the PowerPoint presentation to Moodle. But also, we have put the usage of linked lists in more interesting and practical concept, with a series of smaller tasks that accommodate the topic. The tasks were divided in three categories, easy, medium and hard. Easy task set consisted of commonly used linked list operations such as forming the singly linked list, printing its contents in the specified format, determining the list size, searching for specific data and deallocating space consumed by this data structure.

Easy task set functionalities are needed in our medium and hard task sets, as they are referred from them. That way our goal was to incrementally build and to teach students one of the most important programming principle – code reusability. Medium and hard task sets covered functionalities such as efficiently sorting, removing consecutive duplicate elements, merging two sorted lists,

checking if a loop exists in list and eliminating it and reversing the list.

With those changes, alongside additional checks regarding memory management which will be explained later, we were able to motivate the students since now they were actively participating in the class, i.e. they were doing the exercise alongside the lecturer, and preparing for the exam itself. Figure 2 shows the aforementioned task on the Moodle platform.

Moodle tests usually have a time limitation. However these exercise tasks do not since they are intended for practicing. For example, the task which is related to linked lists consists of 14 questions each covering one of the aforementioned operations. As can be seen in Figure 2, each questions has small table at the top of the page which contains the test input data and the expected output data. Below the test cases table there is a text area for the code itself. CodeRunner plugin also includes syntax coloring which is an additional advantage for the students since it can indicate errors which would be very hard to find in an exam notebook.

After the requested piece of code is written in the text area students can check its correctness by clicking on the check button. When the button is clicked the contents of the text area are sent to a server dedicated to checking and grading CodeRunner questions. The server first compiles the given code and executes it using the supplied test cases. After execution, the server collects the output and compares it with the expected output. The biggest advantage of that platform is that the whole process of checking the code is programmable. That is achieved through Python scripts which are executed each time student checks the question. Furthermore, the comparison of the expected and collected output can be graded line by line, therefore allowing the students to receive partial points for each test case which passed with success. After the outputs are compared, the result table, seen below the text area in Figure 2, is formed giving the students feedback, their score and pointing them to possible mistakes in the code.
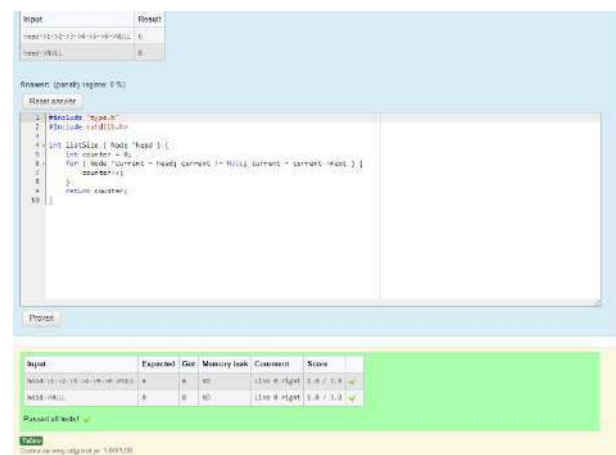
Figure 2: Task on the Moodle platform using CodeRunner with test cases shown in the bottom

In addition to standard output comparison, additional checks can be performed as well. One of the things we insist on in our courses is correct memory management, i.e.

we always award negative points for memory leaks or memory overuse. The analysis of memory management is usually performed with tools such as Valgrind [10].

However, the fully programable grading process allows for a different solution. Using *re* module in Python we preprocess the code before compilation by adding *m_* prefix to every allocation and deallocation function call and supply our own allocation functions with the aforementioned prefix, i.e. *malloc* becomes *m_malloc*. Those functions do memory management analysis alongside memory allocation and deallocation. If there is any memory mismanagement detected the student is given negative points and the feedback pointing in the direction of his mistake. That feedback is given as an additional column, such as the *Memory leak* column seen in the table in Figure 2.

The form of the exams is not much different from the form of the tasks used in auditory exercises. The difference is that in the exam students have a time constraint. Both the short questions and tasks were given as tests on the Moodle platform. Students had an hour for completing the questions and an hour for the tasks. However, there is one significant difference between the pencil-and-paper based exam and the computer-based exam. Students which took the pencil-and-paper based exam had both the questions and task in front them the whole time and can distribute their time freely. Students which took the computer-based exam did not have this freedom. In order to mitigate this disadvantage, we introduced two changes. First, we gave the students which took the computer-based exam the task text right after the exam started. However, they were unable to use any of the tools to solve it since the tools can also be used to cheat on the questions. Second, they had 30 minutes more in total to solve both parts of the exam.

4. TEACHER EXPERIENCES AND STUDENT SATISFACTION

In order to evaluate our effort to change the course and student satisfaction, we conducted several anonymous surveys using Moodle platform and performed statistical analysis of both surveys and student grades. Since the student had the freedom to choose between the method of the examination, one of the more import measurements was the comparison between average score of the students which opted for the pencil-and-paper method and the average score of the students which opted for the computer-based method. Our course has three colloquia during the semester which are held at the end of each block making one month apart from each other. Those colloquia are conducted in the form of tests, as described in Section III. The tests cover the topics taught in the previous lecture block. There is also an additional test used as a correction test which students can use to achieve better score than they did on the regular test or if they miss the test for some reason. The normalized average scores on questions and tasks are given in Figure 3 and Figure 4, respectively.
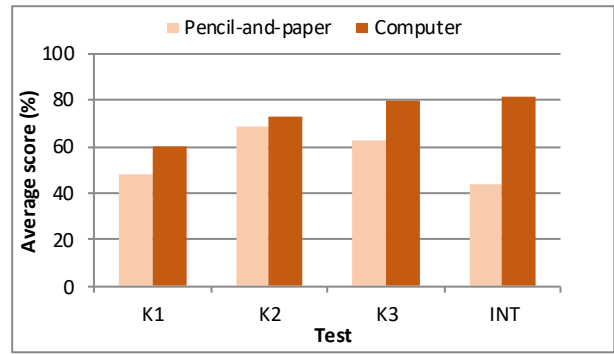

Figure 3: Normalized average score on questions
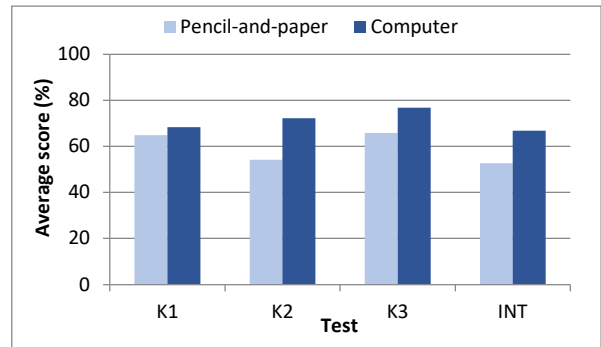

Figure 4: Normalized average score on programming tasks

As can be seen from the previous figures, the average scores had a significant improvement. In all of the tests average score for both the questions and programming tasks was greater, especially for the correction exam where the average score on questions almost doubled. Going further, we also investigate the grade distribution for both examination methods. This distribution is depicted in the Figure 5.
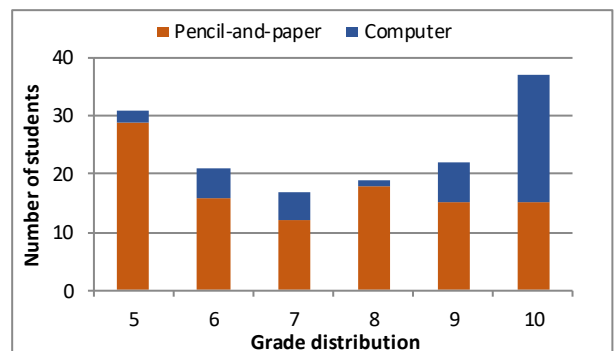

Figure 5: Grade distribution

Horizontal axis on the Figure 5 depicts the earned grade where 6 is the lowest and 10 is the maximum passing grade. Grade of value 5 means that the student did not pass the exam and was not able to fulfill the course requirements. The grade histograms up till this year followed the normal distribution, i.e. the majority of the passing grades were of value 7 or 8. However, here we can see that the introduced change caused a shift in the majority grade towards the maximum grade. We believe there are two reasons for such shift.

The first reason regards the number of students who were determined to pass the course using the computer-based exam method only. The number of students who chose this method was not great in the beginning and as the semester progressed that number gradually decreased. At the beginning of the semester 63 out 180 students (35%) chose the computer-based method. At end of the semester that number dropped to 42 out of 147 (28.6%). In addition, the students who decided to pursue such examination method were mostly in the top 30% of the class or had previous programming experience. Exact number of students per test can be seen in Table 1.

Table 1: Number of students per test

Test	Number of students	
	Computer	Paper
K1	63	117
K2	53	95
K3 + INT	42	105

The second reason regards the way we conducted auditory exercises and the enhancements brought by the Moodle platform. Since students were now able to test their solutions the number of errors decreased. Furthermore, test feedback regarding the memory and file management proved extremely helpful because these errors are hard to detect on paper. That resulted in fewer negative points for resource management which was the problem for certain students in the past.

The second measurement we took into consideration is the overall student impression of the modified course. To that end we asked the students who participated in the computer-based exam to fill in surveys after each colloquium and tell us what they thought of the newly improved course.

The overall impression was more than we hoped for. Students were very pleased. After each test we asked the students to state whether they would take the following test on the computer again. More than a half (62% after the first test and 74% after the second test) answered that they would. Keeping in mind that then number of students who opted for this kind of examination was low, the results were still pleasantly surprising.

Furthermore, after each test we also asked the students to state whether their results would be better if they chose the standard pencil-and-paper method. To our surprise, 63% average answered that they would not, even if their score was not as expected by them.

Lastly, at the end of the course, we asked all students to fill in a survey about overall course satisfaction. Students were very satisfied by our performance on the course. Not only was the majority enamored by the new format of auditory exercises, they were also very pleased with the knowledge they have acquired. When asked if they had improved their programming skills, 66% percent of the students answered yes. In addition, 70% of them taught that the lecturers made the contents of the course clearer and more understandable.

In our opinion, all those answers are a consequence of the newly adopted method of teaching and improved course materials.

5. CONCLUSION

In this paper, we have presented first experiences with Moodle and CodeRunner platforms in programming course. We have successfully moved Programming 2 course at Software Engineering study program to LMS supported teaching and examining. Moodle and CodeRunner are extensively used during auditory exercises in computer laboratory and examination. According to conducted survey, students reacted positively to introduced changes and overall success is higher than before both on exam questions and programming tasks.

In the future, we plan to develop more learning activities in Moodle, such as short quizzes with theoretical questions, as well to extend our coding exercises pool with more assignments. Also, we plan to move the rest of our programming courses to such type of learning and examining.

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ONLINE LEARNING: FROM INSTRUCTIONAL DESIGN TO LEARNING DESIGN

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Abstract: Institutions of higher learning continuously work to improve their teaching and learning methods by adopting online learning. Online learning is the open and distributed learning environment that uses pedagogical tools enabled by internet technologies to facilitate learning and knowledge building through meaningful action and interaction. Online learning faces the challenge of teachers simply dumping content online without endeavouring to improve on the learning process by making it motivating, challenging and engaging. Such instruction is based on instructional design principles, where learners are passive recipients of knowledge, always waiting for the teacher to transfer knowledge to them. However, learning design establishes pedagogical plans and sequences learning activities and resources to achieve given learning outcomes. Therefore, we argue that teachers need to change their role from content providers to learning designers, where they create innovative ways for learners to construct knowledge out of the wealth of available information.

Keywords: Online Learning, Instructional design, Learning design

1. INTRODUCTION

Institutions of higher learning continuously work to improve their teaching and learning methods by adopting online learning. Online learning is the open and distributed learning environment that uses pedagogical tools enabled by internet technologies to facilitate learning and knowledge building through meaningful action and interaction [1]. Online learning allows remote interactions among learners and permits the use of course content in ways that are not possible without the technology being used [2]. The course content and the learning activities therefore need to be presented in ways that favor the learners.

There are several ingredients that ought to be considered for online courses to boost the student interactions and engagement, so as to enhance student learning and lead to the achievement of the learning outcomes [3]. This means that online learning should go beyond digitization and uploading of learning materials in online platforms like learning management systems for students to access [4], since teachers and learners have access to the same sources of information through internet. It should adequately engage learners and include activities that enable learners to collaborate and create their own knowledge.

Online learning faces the challenge of teachers simply dumping content online without endeavoring to improve on the learning process by making it motivating, challenging and engaging [5]. Therefore, teachers need to change their role from content providers to learning designers, where they create innovative ways for learners to construct knowledge out of the wealth of available

information [6]. Learning design establishes pedagogical plans and sequences learning activities and resources to achieve given learning outcomes. Learning design consists of all the learning activities required of the students, the resources required and the support activities that teachers provide to facilitate student learning [7].

This paper presents the results of a study carried out to establish the learning designs used by lecturers in universities in Uganda and how this has impacted on adoption of online learning. The rest of the paper is organised as follows. Section 2 presents a literature review on instructional design and learning design, section 3 presents the methods used in the study. In section 4, the findings are presented, section 5 presents the discussion and the summary of the paper is presented in section 6

2. LITERATURE REVIEW

Instructional Design

through which knowledge and attitude are transferred to the learner [4]. It follows the principles of the behaviourist theory [8], and is concerned with the design and delivery of instruction according to instructional events and relevance to a given learning setting [6]. A number of instructional design models have been suggested, including ADDIE model, Dick and Carey Model, and the Pebble in the pond model, but the model that forms the foundation for other instructional design models as well as learning designs is the ADDIE model [9]. ADDIE is a cyclic model, with five phases of Analysis, Design, Development, Implementation and Evaluation, hence ADDIE [10].

Dick and Carey approach consists of a series of steps, with each step getting input from the previous step [11]. This approach considers learners' needs, emphasizes real world settings, assesses learners' prior knowledge levels, and integrates learning and performance context into the design [12]. The steps are sequenced so that the user can produce effective instruction. Evaluation at every step is carried out to correct any mistakes that could have been made. Pebble-in-the-Pond model is based on the first principles of learning, which emphasise creating a good learning environments rather than describing how learning can occur through those environments [13]. The process is problem-centred and involves the student at different levels for effective instruction. The model starts with identification of the task that students have to work on, and progresses with devising plans and strategies that can be used to solve the problem as the students acquire more skills. instructional design models do not allow for the evaluation of the extent to which the learning outcomes are met, they are fixed and linear in designing instruction and in some cases do not match what is done in the actual practice of instructional design [12, 14].

Instructional design has been criticized for being teacher-centered, focusing more on what teachers do to transfer knowledge to learners [15] and following a linear sequence with each stage building on the previous stage [4]. Instructional design views students as passive recipients of knowledge, which should not be the case in this era with abundant information through the Internet. Therefore, learners need to be active in the knowledge creation process using learning design principles.

Learning Design

Learning design is the creative and deliberate act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given context [6]. Learning design uses the constructivist theory, where learning involves the active knowledge construction by learners and thus goes beyond knowledge transfer [4]. Constructivism believes more in providing learners with activities that stimulate thinking and enforce collaboration. Therefore, teachers should be more of facilitators for students to create knowledge basing on the existing knowledge, new knowledge, their interactions and processes for this construction of knowledge [16]. Learning design defines the learning resources, activities, and support that a teacher plans for learners [17]. Learning activities are central to learning and the kind of activities that the learners engage in, together with the outcomes of these activities determine the effectiveness of the learning process [18].

Some learning design models have been suggested in literature including Integrative Learning Design Framework (ILDF), AACLOC, learning design taxonomy among others. The Integrative Learning Design Framework (ILDF) is a systematic, iterative constructivist-based design process that enables the learning designer to gain an understanding of the learners, design effectiveness and appropriate instructional strategies [19]. ILDF is composed of three major phases; exploration phase, enactment phase and the evaluation phase. The phases of ILDF are connected through the information gathered during exploration, which is synthesized into specific instructional strategies appropriate for the learners and learning context, then aligned with learning theory in the enactment phase. AACLOC model involves design, evaluation and continuous improvement of the learning design and learning outcomes in a cyclic manner [20]. AACLOC stands for Analysis of learners, Analysis of technological affordances, Course design, Learning support design, Ongoing evaluation and Constant improvement. The challenge with these models is that they do not mention the learning activities, and only consider changes to the learning design after a given cohort of learners has completed. Therefore, teachers ought to adopt the minds of designers for learning. Good learning designs should challenge, engage the learners and facilitate learner interaction and communication.

3. METHODS

This research used a questionnaire with both open-ended and closed-ended questions. Open-ended questions were used because they give the respondent the opportunity to answer in their own words [21], giving their opinions [22]. Closed-ended questions have a predefined set of answers from which respondents choose, and were also used to collect basic information from the respondents. A number of questions were thus presented to respondents, who answered both the open-ended and closed-ended questions. Data was collected from five public universities in Uganda, where questionnaires were issued by the researcher to lecturers who indicated that they had good knowledge in pedagogy. From time to time, the respondents needed guidance on some questions, which was promptly provided by the researcher.

The data collected was both quantitative (closed questions) and qualitative (open questions). The quantitative data was analysed using SPSS (Statistical Package for the Social Sciences). Data was first organised and checked for completeness and accuracy. Data that did not make sense was removed. Each questionnaire was then assigned a unique identifier. The data was then entered into SPSS for analysis to generate descriptive and inferential statistics.

The qualitative data was analysed using thematic analysis. Thematic analysis helps to identify patterns and themes from qualitative data [23]. The identified themes are used to gain a deeper understanding of the research question by helping to make sense of the data [24]. The answers from each question were first written down on a separate sheet to enable reading of the responses so as to get familiar with the data. The data was then coded, generating initial codes. Similar codes were combined to give the themes, and these themes were compared with the actual data to ensure that they represent the responses of the data collection process.

4. RESULTS
Study participants

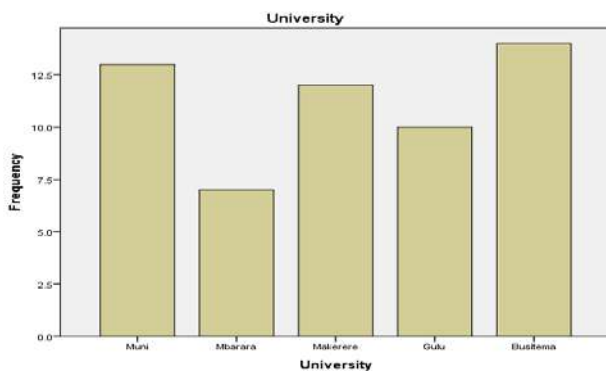The participants of the study were lecturers from public universities in Uganda, as shown in Image 1.

Image 1: Study participants

Knowledge of learning design models

The results show that majority of the participants (53.6 percent) did not know of any learning design model, shown in Image 2. This shows that learning design principles were still new to teachers in universities.
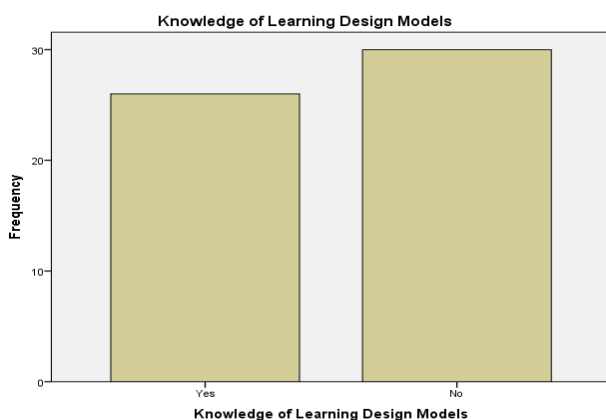

Image 2: Knowledge of learning design

Course design process

The results show that majority of the respondents design their courses by considering the course outlines, developing course materials based on the course outline and uploading the materials and assignments online for students to access. This is simply digitisation of course materials, without any design attributed to it. For instance, one of the respondents stated that "*I posted the course outline and course content on the web-based learning management system.*" However, there were few respondents who indicated that they start by analysis of requirements (business and training needs, learner's profile and branding, content, technology), followed by setting content objectives, writing of instructional content and assessments (design and develop), then implementing the course online and afterwards evaluating. This is in line with the ADDIE model (analyze, design, develop, implement and evaluate) of instructional design, shown in Figure 1.

These results indicate that teachers simply digitise course materials and upload online for students to access, and this does not align well with the essence of online learning. Even then, teachers that followed a model actually use the ADDIE MODEL, which is an instructional design model.

Instructional design is about preparing for knowledge transfer to passive learners. Therefore, learning design is not yet used in online learning, which also explains that the concept of learning design is still new to teachers.
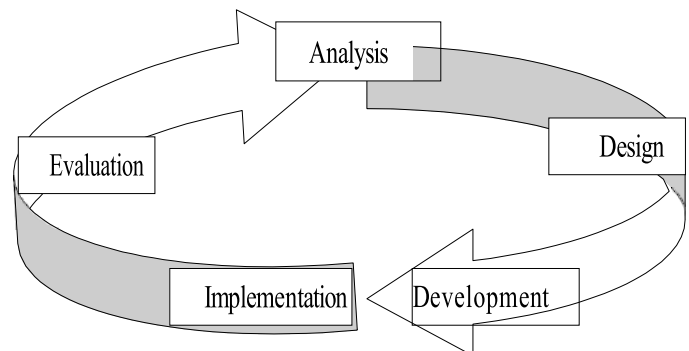

Figure 1: The ADDIE Model (Adopted from [10])

5. DISCUSSION

The results show that the concept of learning design is not well understand and learning design is not adopted for online courses. It is further shown by the fact that most teachers just digitize course resources and upload them for students to access. Those who follow an elaborate process actually use the ADDIE model, which is an instructional design model. However, instructional design is the process followed by the teacher as they prepare for knowledge transfer to the learners [4]. In this era where teachers and learners have access to the same sources of information, learning should go beyond digitization and uploading of course materials [5]. Teachers should also stop thinking in terms of knowledge transfer to learners and begin thinking of innovation ways through which they can support learners to create their own knowledge [6].

The study further shows that no teacher actually plans for support activities and feedback that the learners need in the online environment. Yet, a learning design should also include the different mechanisms that the teacher intends to use to adequately support the learners. Learning design consists of all the learning activities required of the students, the resources required and the support activities that teachers provide to facilitate student learning [7]. Therefore, a model for designing learning is proposed as shown in Figure 2.
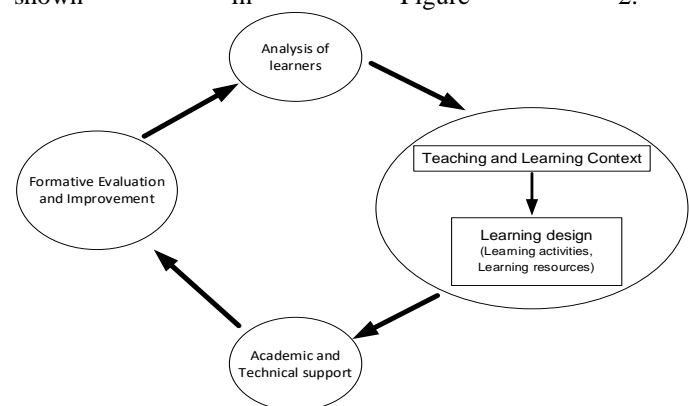

Figure 2: Model for designing for learning

The process for designing for learning starts with analyzing the learner characteristics and needs. Then, by considering the course outline, the teaching and learning context can be defined. Learning design in defined in terms of learning activities that learners are required to complete so as to actively co-construct knowledge, thereby learning. As the learning process progresses, academic and technical support has to be offered to the learners as may be required. Formative evaluation has to be done on the learning process, so that appropriate interventions are taken to ensure learning takes place.

6. CONCLUSION

The study shows that learning design concepts are not yet well understood by online learning developers in universities in Uganda. The majority of faculty simply upload course materials on learning management systems, without paying attention to the concepts of constructivist-based learning design. The main challenge that causes this to happen is that teachers lack the knowledge and skills that can be used to design online courses. Therefore, for online learning to be widely adopted, there is need for adequate training of faculty and enforcement of policies and mechanisms that ensure that faculty use pedagogically designed online courses for conducting their classes. This will make online learning engaging and motivating for the learners.

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TESTING AND VALIDATION OF ADAPTIVE E-LEARNING SYSTEM BASED ON VIDEO GAME TECHNOLOGY

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Abstract: The evaluation of e-learning applications deserves special attention and evaluators need effective methodologies and appropriate guidelines to perform their task. In this paper, we present a result of testing and validation of an adaptive e-learning system based on video game technology. After the describing the instructions for using the system and after specifying the target in testing, students tested the created adaptable e-learning system. This paper also focuses on the formal aspects of validation and presents a taxonomy of various aspects and steps of formal model validation for e-Learning system.

Keywords: Testing, Validation, Video Game, Learning systems, E-Learning, Adaptive E-Learning systems,

1. INTRODUCTION

One of the key things about adaptive learning system (ALS) is to stimulate students to use that kind of system in order to have more successful learning, and we must test that. Computer games are very often used to motivate students and this is one of the reasons for using computer game technology when designing an ALS. The use of virtual reality, 3D games, and educational simulators is a trend and also helps in the motivating and engaging of students. With these technologies, we enrich the learning experience, provide a constructivist approach to learning, whereby students have free interaction with virtual objects, enabling them to explore, experiment, receive feedback and also allow greater interaction comparing to traditional teaching tools. Students can experiment and test their knowledge in the adaptive learning system based on computer game technology, this is, can learn by doing. Business world sees this technique as an opportunity to improve professionals' skills at low cost.

Learning to pilot an aircraft is well-studied task supported by carefully formulated regulations and rich computer and simulation technology. It is chosen as a well-defined learning task, suitable to evaluate the concepts proposed in the paper. Educational games have been developed for a long time and also applied in teaching at all levels of education [1]. Simulation games that can be used in teaching and training are particularly interesting, such as, for example, flight simulators with a long tradition and application [2,3].

This paper will present the testing of adaptive learning system based on a flight simulation game to measure the usability of the system. One of the main of purposes of testing and validation of this system is to solve the problematic how to make easier learning in VLE (Virtual Learning Environments) and reduce the need for instructor assistance, without decreasing effectiveness of studies (course completion), and also to see the true state of the benefits of such a system.

2. CESSNA 172 ADAPTIVE LEARNING SYSTEM BASED ON COMPUTER GAME TECHNOLOGY

Before testing begins, some basic concepts must be explained first, in order to understand the principle of testing.

The adaptive learning system based on a flight simulation game Cessna 172 is made from the model of an airplane used for training on the Vršac airport and contains all the needed instruments required for pilot training. Cessna 172 sky hawk is a 4seat airplane with 1 motor and fixed wings, the model was developed by Cessna Aircraft Company. First flight occurred in the year 1955. This model is one of the most produced airplanes in the world, counting 43.000 planes by the year 2015.

What sets Cessna plane apart is a wide spectre of modifications, powerful motors (from 134KW to 157KW), and constant speed propellers even using car fuel. Besides that, it is possible to increase the reservoir capacity and luggage space.

A beginner, aiming to gain a pilot license issued by aviation authority for a chosen type of aircraft, should pass flight training which is typically conducted in flight school under accredited syllabus. An example of training course syllabus for a private pilot license is outlined in [4].

Airport markings & signage

Airport pavement markings and signs provide information that is useful to a pilot during takeoff, landing, and taxiing.

Basic runways have centreline markings and a runway number. As in real-life aviation, Second Life runway numbers range between 01 and 36, and are determined by its direction (in degrees) related to magnetic north. For example, a runway numbered '09' points east (90°), runway '18' is south (180°), runway '27' points west (270°) and runway '36' points to the north (360° rather than 0°). A runway can normally be used in both directions, and is named for each direction separately: e.g., "runway 33" in one direction is "runway 15" when used in the other. The two numbers always differ by 18 (= 180°).
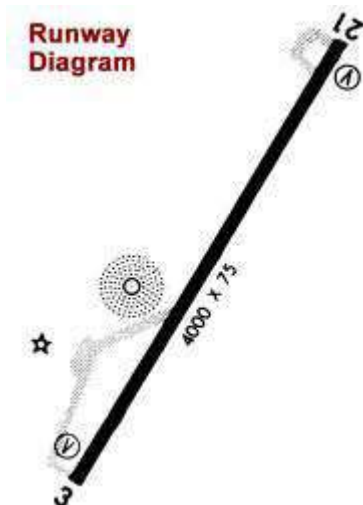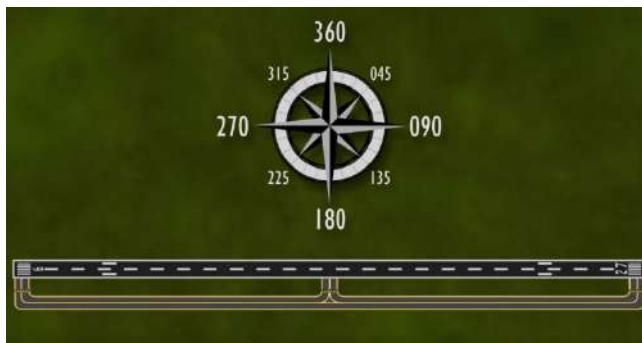
Fig 1-2: Reciprocal Runway Diagram

If there is more than one runway pointing in the same direction (parallel runways), each runway is identified by appending Left (L), Center (C) and Right (R) to the number to identify its position (when facing its direction) — for example, Runways One Five Left (15L), One Five Center (15C), and One Five Right (15R). Runway Zero Three Left (03L) becomes Runway Two One Right (21R) when used in the opposite direction (derived from adding 18 to the original number for the 180 degrees when approaching from the opposite direction).

Also Displaced Thresholds are designed to allow obstacle clearance.

Blast pads, also known as overrun areas or stop ways, are often constructed just before the start and end of runways as emergency space to slowly stop planes that overrun the

runway on a landing gone wrong, or to slowly stop a plane on a rejected takeoff or a takeoff gone wrong. This section of the runway is marked with yellow chevrons.

Signages are separated in 6 categories:

- Mandatory Instructions (white on red)
- Location signs (yellow on black)
- Direction signs (black on yellow)
- Destination signs (black on yellow)
- Information (black on yellow)
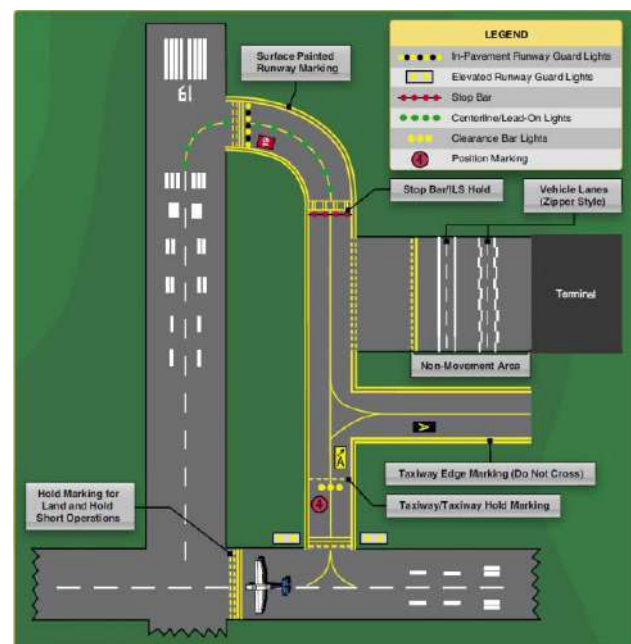
Fig 3: Overview of typical airport markings

Fig 4: Airport in adaptive learning system -

Learning task and syllabus

For the study described in the paper, a shortened version of syllabus is created for virtual flight school for those who want to learn basics of piloting an aircraft.
Namely, to prove concept of eLearning system reducing instructor assistance, it is sufficient to cover most

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

The following learning objectives (based on AC141are adopted:
 - Aviation regulations and requirements
 - Airport familiarization,
 - Airplane familiarization,
 - VFR navigation & flight planning
 - -Aviation weather
 - Flight mechanics
 - Basic manoeuvres of flight
 - Fundamental flight training manoeuvres
        - Straight and level flight
        - Constant altitude turns
        - Climbs
        - Descents
 - Systems and instruments

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

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

Adaptive learning system design
The primary goal of the adaptive learning system design is successful course completion with minimal instructor assistance. The goal will be achieved using game technology based design, considering course participant as game player.
The base of VLE is simulator of Cessna 172 and airport used in Pilot Academy at Vršac.
Considering learning as a game, the following correspondence may be established
a) player rank = learner skill = { beginner, intermediate, good }
b) game level = Lesson = { task_1, task_2, ..., task_n }
c) game level difficulty (= task difficulty) = { FM easy, FM intermediate, FM realistic }
Levels are to be ordered "in logical way" i.e. all the facts and concepts used as known at present lever should already have been learned at preceding levels.
    Like in games, student may pass to the next level (task) only after successful completion of the actual level.
By default, task difficulty is set to realistic if player is ranked as good. If, after several attempts student does not

successfully complete task, task difficulty is reverted to an easier level. On the other hand, if student successfully completed several successive tasks (levels), his rank is increased in order to speed up progression through the lessons.

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

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

Fig 5-6: Real life Cessna 172 VS Cessna 172 ALS based on computer game technology

4. TESTING AND VALIDATION THE ADAPTIVE LEARNING SYSTEM BASED ON VIDEO GAME TECHNOLOGY

For the usability test, we took CS367 Game Development 1 subject. In this subject, students learn about programming applications in Unity 3D, including the study of aircraft (also include aircraft physics, which is necessary to understand making the flight simulator). We found 10

students who offered themselves as volunteers to test adaptive e-learning system based on video game technology.

Initially, the students analyzed with the subject professor video materials detailing the operation of Cessna 172 aircraft (Flying lesson videos) to learn the basics of Cessna 172 flying and controlling. [5-11]

The lesions are made using the general guide for the preparation of a TCO for which FAA approval AC-141-1A. [4]

After that subject's teacher gave guidance and analysis of important aspects which are explained in the video material for that lesson. This was followed by a discussion. After the discussion, the professor presented the work of an adaptive learning based system and also explained how the system presented works and managed. After a more detailed analysis of the system, students themselves had the opportunity to become more familiar with the system and test its performance.

After the fourth lesion, the students are tested to figure out the level of understanding of the teaching and the application of learned lessons.

Testing lesion
FLIGHT LESSON (1 HOUR DUAL)
A. Objective. This lesson will consist of a review of selected maneuvers and procedures. In addition, the student will continue takeoff and landing practice.
CONTENT:
(1) Preflight discussion.
(2) Review
     (a) Startup
     (b) Straight and level flight (VR and IR).
     (c) Medium bank turns (VR and IR).
     (d) Takeoff and pattern departure.
     (e) Pattern entry and normal and/or crosswind landings.
(3) Postflight critique
B. Completion Standards. The student will display skill and understanding in the execution of selected maneuvers and procedures and show solo competence while executing takeoffs and landings. [4]

Video materials which is used to explain the lesion and problematic are:
- Cessna 152 Flight Training (startup, takeoff, landing, traffic pattern) [5]
- First Flying Lesson, takeoff, turns, climbs, descents. Part 1[6]
- First Flying Lesson, takeoff, turns, climbs, descents. Part 2[7]
- Straight and Level Flight: Pilot Mastery [8]
- Flying in the Traffic Pattern | C172 | POV Flying [9]
- Learn To Fly part 3 ~ Straight and Level Flight [10]
- Cessna 172 Steep Turns [11]

Explanation

Straight flight means - no turn. Straight flight is maintained by keeping the wings level with ailerons and applying the necessary pressures on the rudder pedal to prevent yaw. If you allow the aircraft to bank, it will begin to turn in direction of the lower wing.

An increase in power, which increases the rotation force of propeller slipstream, will cause aircraft with clockwise rotating propeller to yaw to the left. A decrease in power will cause the aircraft to yaw to the right. Any tendency of the aircraft to yaw with power change, should be anticipated and prevented by appropriate use of rudder.
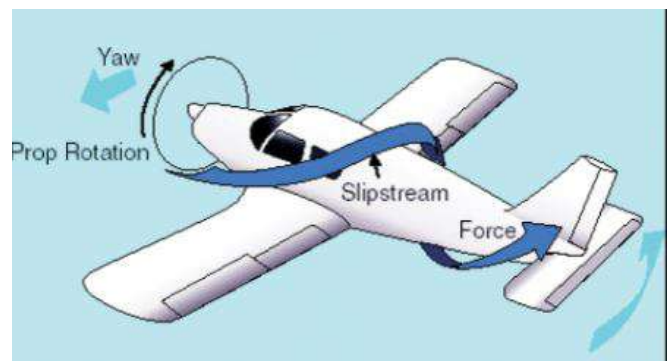
Fig 7: Straight flight control of Yaw [12]

Level flight means flying at constant altitude, not going up and down. As power is increased or decreased, pitch attitude is kept constant with appropriate elevator control pressure. When the aircraft is at desired airspeed, trim is used to relieve the control pressure, required to maintain straight-and-level flight.

A **medium turn** is defined as a turn using up to 30 degrees angle of bank.

Fig 8-9: Medium turn on left side in real life Cessna 172 VS Cessna 172 ALS

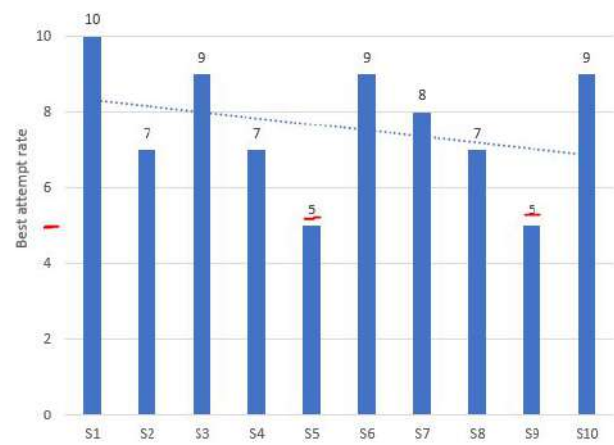**Fig 10:** Student rating chart

5. TESTING RESULTS

We conducted a retrospective analysis of 10 students (n=10), 80% are male (8) and 2% are female (2). According to recent data the 80% of students are the students of first year of study (8) and 20% are at second year of study. Each student pre-attended all lectures related to the use of the system for 4 weeks, 60 minutes = 240 minutes. During the test, each student had the right to try the system, and three attempts to solve the problem, the best result of problem solving was used. The rating given is in the range of 5-10.

Table 1: The results of testing 10 students

	Attempt 1	Attempt 2	Attempt 3	Best	Average
S1	6	8	10	10	8.25
S2	6	7	7	7	
S3	8	7	9	9	
S4	7	6	7	7	
S5	5	5	5	5	
S6	7	6	9	9	
S7	7	8	8	8	
S8	7	6	7	7	
S9	5	5	5	5	
S10	8	6	9	9	

Four-fifths of students are passed the test, with an average grade 8. 25.. In most cases, the first attempt had the worst result, which is normal given that adjustments to the system and tasks are required, despite the prior system testing.

5. CONCLUSION

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

With this, we can conclude that the introduction of new technology has helped the most of students to learn the specific problem-solving tasks especially can be usefully in reinforcement learning. Most students were able to complete the task, but the real motivation for further work may also be an attempt to identify problems encountered by students who have not completed the task and an attempt to correct it.

Acknowledgment

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[5] Cessna 152 Flight Training (startup, takeoff, landing, traffic   pattern)

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y772q2I7axSiM8dEgudAcFT-u5Hw

[6] First Flying Lesson, Part 1, https://www.youtube.com/watch?v=ZBEipeiKxh0

[7] First Flying Lesson, takeoff, turns, climbs, descents. Part 2, https://www.youtube.com/watch?v=r1i47qe7Sg8

[8] Straight and Level Flight: Pilot Mastery https://www.youtube.com/watch?v=x6tvNWuqX2A

[9] Flying in the Traffic Pattern | C172 | POV Flying, https://www.youtube.com/watch?v=xyPN2SdjfY8&fbclid
=IwAR2ccax1JAAbwcOlPSLQ1u8vY35XzUhvTn4op2F
qMFz8Ndk-6h8ipJ9xYm4

[10] Learn To Fly part 3 ~ Straight and Level Flight https://www.youtube.com/watch?v=IWs0EQYdQFc

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STEPS TOWARDS FUTURE – BREAK THROUGH CONSERVATIVE LECTURERS THINKING

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Abstract: The e-Learning environment are increasingly becoming as a modern way of teaching and learning, however few staff have experience of them and there is still something of a culture change necessary to integrate e-Learning in the traditional education. Lecturers will be forced to fundamentally change their approach to teaching to accommodate the shift in student learning styles. The development of methods and a system for encouraging the use of e-Learning system is a topical issue. In this paper are proposed staff development initiatives which will introduce the e-Learning systems to the lecturers and increase their awareness of what is possible.

Keywords: Enhance, gain knowledge, work plan, advanced lecturer, e-Learning skills

1. INTRODUCTION

In recent years, various formats for learning have become available besides traditional classroom learning. These include e-Learning, distance learning, blended learning, digital learning, and virtual learning. Such online learning has attracted a greater number of educators. Teachers implementing online learning agree that online education meets the needs of modern students whose daily life and learning style have been changing rapidly. Online education can provide student-centered and technology-enhanced instruction. Nevertheless, conservative and skeptical ideas still dominate online learning discussions.

Regardless the strong desire and urgent need for development and implementation of modern eLearning strategy and platform, a modern thinking group of people have struggle in a serious obstacle. The main problem in innovating the educational programmes to the next logical step – eLearning, is not the development and implementation of the eLearning platform itself, but instead in the lack of support and engagement of a big part of the lecturers at the university. The traditional type of educators believes that receiving instruction in classroom setting is the best way to learn to learn. The persistent argument is that online teaching is not as effective as face-to-face instructions.

This issues leads us to resolving first of all the problem with the conservative academics and how to introduce to them the benefits and the positives of the new technologies. This chapters analyzes the steps to introduce the benefits of eLearning to the educators. An initial plan of implementation is proposed, which is based on the personal and professional needs of the teaching staff at the university.

2. OVERALL LOOK

Education has become a commodity in which people seek to invest for their own personal gain, to ensure equality of opportunity and as a route to a better life [1]. As a result, providers of Higher Education (HE) are finding themselves competing more than ever for students and recognition within the wider society. The rapid growth in eLearning has overcome many of the barriers to HE, providing traditional universities with an opportunity to meet the changing worldwide demand for education. Society requires higher levels of skills and qualifications to fill the "worthwhile" jobs, and individuals see education as a status provider [2].

Realization of the permanent education of university teachers will contribute to the improvement of their competences, increase in productivity and allow for a more efficient transfer of their knowledge to their students. A dedicated pedagogical training of teaching staff for the introduction of modern teaching methods which, by their structure, allow increase of efficiency of teaching process, as well as independence and self-efficacy of students in the process of sustainable and permanent self-education in this area.

The pedagogical preparation of the students presupposed and requires immediate interaction between lecturers and students. Precisely because of these reasons professional preparation is realized in attendance (and group) learning. Direct contact lecturer-student is irreplaceable in view of the professional pedagogical preparation. In parallel with this, theoretical preparation in the disciplines has opportunities to use the advantages of e-Learning.

3. WHY WE NEED A CHANGE

Undoubtedly the development of technology has led to changes in the traditional learning environment. The governments are increasingly investing in the information and communication technologies through last years. "E-learning meet new educational needs arising from the transition from industrial to information society and is associated with changes in all aspects of the educational process", as it is said in [3]. In a world with fast evolving technologies, every HE institutions must try to follow the leading world institutions and to follow their steps in the future education and technologies.

International studies, however, find that digital technologies are not yet fully integrated into teaching and learning. One of the reasons for this is that universities and education systems as a whole are still not ready to realize the full potential of technologies. Until now in our institution is working hard to implement a eLearning platform for student education and with the imposed pace of work and the strong motivation of the staff involved in this is expected in the very near future the work on the system to be completed and to start a pilot year. This leads to the problem we are dealing with in this report and the subsequent strategy and measures to address it, the name objective is the inadequate lecturers training on how to use technology in teaching and some gaps in the digital skills of some of them.

In the implementation of eLearning programmes, HE institutions are demanding a change in the role of university lecturers. Traditional teaching and learning skills need to change in order to get maximum benefits from virtual learning [4], hence lecturers are posed with the task of developing a new model of effective teaching. Lecturers must be provided with sufficient time, resources and training to ensure that the courses are suitably developed and implemented to meet the needs of students. Alongside this, the transition into new teaching styles must be managed effectively to ensure that lecturers are supported through and beyond the evolutionary period. Therefore if the provision of eLearning is to become a key element of our university education, employers will need to provide a major programme of staff development and training [5]. Training and support is required to ensure that technology can be integrated into daily routines and that its use will be efficient and effective, as it is pointed in [6]. Due to the lack of experience of some of the long-time working lecturers, who keep on teaching in old ways, and due to the continual need for retaining as other lecturers struggle to keep up to date with technological progress, the importance of training cannot be overstressed.

4. PLAN FOR ACTION

The target is to establish a working model for gaining knowledge from all the lecturers who wish to move forward to the new technologies in the education. The main objective is the design of a comprehensive and beneficial programme for initial training for the academic estate. The program will be framed within 6 pillars. The activities should follow the main dimension and aim, namely the introduction and implementation of reforms in education and training systems for the continuous modernization of staff skills for further training our future highly qualified staff. It is essential for each lecturer to have the skills to capably combine different types and methods of training to motivate their students to engage in diverse activities and thus develop their potential and capability for the future. For achieving this goal, first and foremost, the lecturer himself should be aware of new systems and technologies and be able to work with them.

4.1 Action 1: Creating a system for upgrading the qualification and competencies of lecturers

Developing the overall strategy and drawing up a work plan is the first step included in this action. Through this it will be determined the direction of the training, which group of trainers it will be targeted at, and so on. As a result a clear and accurate strategy will be developed for the implementation of the academic staff training system to present the benefits and workings of eLearning training systems and a program to work on following the main idea.

This process—the first important cornerstone of the project—demands considerable efforts in order to lay the foundations for ultimate project success. The requirements analysis forms an integral part of the project plan. The requirements analysis is not only important for the course itself but also for the development of the institutional capacities of teacher training.

4.2 Action 2: Tools to improve the quality of preparation

The aim of this action is to establish in the lecturers the attitude to constantly update their own competencies to provide eLearning training that corresponds to the contemporary public expectations. Among the lecturers is set a model of work and thinking, according to which the lecturers themselves wish to improve and develop.

In order to ensure good assimilation and learning integration, it is advisable that the course unfolds along the different stages corresponding to the building up of e-learner competence in an e-Learning course, as described in the Salmon five-stage model [7]:

Stage 1. Gaining access and handling technology;

Stage 2. Becoming familiar with online learning and its specific socialisation mode;

Stage 3. Exchanging information;

Stage 4. Knowledge construction and collaborative learning;

Stage 5. Individual development and competence building.

4.3 Action 3: Planning and organizing the training

Main goal is the preparation of trainers' training courses - types of trainings, schedules and programs and teaching materials.

It includes:

- Instruction and training - introducing modern teaching methods through ICT - acquiring skills for planning and preparation of the content in e-learning and e-environment and conducting specialized seminars - related to the contemporary educational strategies and technologies;

- Preparation of programs, tailored to the qualification and individual needs of the lecturers;

- Development of learning materials (e-books) to support learning and to complement it. After completion of the training they will remain as a source for inquiries and information;

- Creating a timetable for training and seminars. Important step where the best time and place for training are elect, schedules are also planned and specified.

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In the specific case of this courses, each module will be connected to specific learning outcomes representing essential theoretical and practical skills needed to manage the different aspects of an e-Learning project. These modules are listed in Table 1.

Table 1: Learning modules

Module 1	- know how to effectively use Moodle communication tools; - know what a blog, a wiki and a virtual whiteboard are and how to use them in an educational environment;

Module 2	-know e-Learning basics such as definition, history, learning models and trends; -know what added value e-Learning can bring in a VET context;
Module 3	-know what a requirements analysis is and why it is important in the e-Learning content production process; -know how to define a target group profile and the corresponding knowledge, skills and personal characteristics; -know how to process collected data to plan an e-Learning action;
Module 4	-know what blended learning is; -know the most common didactic theories of e-Learning; -know the methods for designing and structuring a course; -know how to create the structure of a course (course syllabus) on the basis of well-defined learning objectives;
Module 5	-know what a learning object is and what it is useful for; -know what instructional design is and what an instructional designer does; -know how to read a storyboard template and how to write a storyboard based on a template;
Module 6	-know how to adapt existing teaching materials to an online course; -know how to find e-Learning resources using web repositories; -know how to integrate e-Learning components in one's own course; -know how to create interactive activities for self-learning; -know how to create collaborative activities for web-based learning;
Module 7	-know how to use a set of conceptual criteria and operational tools to make the right choices in delivering an e-Learning course;
Module 8	-know how to facilitate an online discussion and how to write a summary or a weaving message to wrap up an online discussion; - know how to create e-activities for an online course;
Module 9	-know how to design an evaluation grid based on appropriate methodology guidelines for evaluation and assessment
Module 10	-know the importance of strategic planning as a key success factor for implementing e-Learning in an organization; - understand the costs and benefits of e-Learning courses/ programmes;

4.4 Action 4: Dissemination of information

Advertising is a very important element for every activity, so much attention will be paid to information activities. There will be provided various ways of offering the information to the attention of the academic staff - brochures, posters, internet, e-mail notification, etc. Which in turn leads to a greater desire for the lecturers to be part of this project and to improve their qualification.

4.5 Action 5: Application and selection

Determining the type of application form and creating a criterion that will determine which of the candidate lecturers are appropriate for the training will be included in this step. The application form will contain several sections that each tutor needs to fill in: information about the person's personal data, what training he/she wishes to visit, what is his/her motivation to participate in the training, and, if available, the foreign language skills and competences . The main criteria for selecting the candidates will be the experience and motivation of the lecturers for the practical application of the acquired skills. The application form gives an insight into the needs and desires of lecturers related to their wish for career development. Also, the stated personal desire to participate is directly related to the internal motivation of the academics, which in turn increases their activity and their satisfaction with the training.

If the target group is composed of absolute beginners in the e-Learning field, the course designer should choose carefully the type of the learning materials to be used in the course. To avoid confusion and frustration in learners, new kinds of learning should be introduced gradually over the course (possibly not at the very beginning of the course) and should be accompanied by more traditional activities (web pages, web quests, etc). After the learner has become confident with new kinds of learning activities, the number per learning unit can grow and the LO-to-other resources ratio may sensibly change.

4.6 Action 6: Conduction of training

The main goal is the improvement of the qualification of lecturers, who take part in the training in different fields, to work with e-learning systems - the methodology of the training, the work with ICT and others. At this point, the idea is to conduct a specialized course on the application of ICT in the teaching process and an initials course for working with eLearning systems – working with the Moodle platform, creating lessons, conducting examination, etc.

The overall objective is to enable learners to acquire the competences to deploy e-Learning in the institution and understand the different phases of an e-Learning course, its design, management, delivery and evaluation

processes. In particular, participants should learn or understand the following: E-Learning deployment, course syllabus creation (understanding differences with traditional teaching), online teaching and learning material design (presenting knowledge online and creating specific activities and tasks), the content production process, E-Learning course tutoring, main managerial aspects of e-Learning, organisation of evaluation processes. At the end of the course, learners should be able to implement an e-Learning course customised to the needs of their country, training institution and student profiles.

The planned scope for the courses will be 3 courses with 10 lectures involved in each of them. This step includes and organizing of specialized seminars related to the topics of modern educational strategies and methodology for work with electronic and distance learning systems.

Performance evaluation is multidimensional and should take into account the perspectives of participants, coordinating and tutoring staff, learning, methodology and design and the administrative field. With regard to participants, performance evaluation refers to:

- Satisfaction with the learning methodology, content and dynamics with the coordinating and tutoring staff during the course and in the short term.

- Self-assessment of the learning path with respect to the content proposed and of the skills presented during the course and in the short-term.

- Self-assessment of skills' and competences' transferability, referring to the skills and competences acquired during the learning process in the short and longer terms.

5. CONCLUSION

The urgent need for development and qualification of academic staff is clearly emphasized in the National Strategy for Lifelong Learning, where as a main goal is pointed out the need to ensure and maintain the quality of training and academic staff. Lifelong learning policies, emphasize the need to create opportunities for learning key competences aimed at personal and professional development.

ELearning has a fundamental impact on the modern education policies of HE. For lecturers, eLearning programmes represent a change in teaching style. The precise nature of the change is difficult to quantify, however allocation of sufficient time and resources, combined with managerial support, will help staff through the period of transition. The effective implementation of the strategy and the above proposed action, will lead to increasing the value of eLearning platform. Nevertheless no matter how good will be the eLearning platform as software and hardware, it will be

at no use if the lecturers don't understand the positive aspects of it and its use regarding modern education. ELearning offers HE institutions all the benefits of a global consumer base. In order to reap these benefits, the university first of all should carefully prepare its lecturers, because they are the main gear in every high educational institution.

Teachers should be trained first in using e-learning technologies since they are the ones who pass on this knowledge to students. As the ultimate goal of the system for improving the work of lecturers with e - learning systems, the conducted trainings, seminars and courses will contribute to the improvement of the qualifications and skills of the academic staff involved. Their knowledge of working with modern ICT and teaching methods will be developed. This development of their qualification will also lead to a change and improvement of their teaching methodology, which will also affect the students' training in a positive direction.

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INTELLIGENT TUTORING SYSTEMS: A SYSTEMATIC REVIEW

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Abstract: Incorporation artificial Intelligence (AI) techniques into learning can be used to produce educationally useful and personalized computer systems known as Intelligent Tutoring Systems (ITSs). ITSs are complex, integrated software systems that use different learning strategies to increase or correction of learner's knowledge. They are intended to support and improve the teaching and learning process in the chosen field of knowledge while respecting the individuality of the learner. AI techniques enable ITSs to deliver guidance and instruction or evaluate learners by customizing the learning experience based on factors such as pre-existing knowledge, learner's preferences, learning style, motivation, and the learner's progress through the learning content. This systematic review reports key information about existing systems and the different features across different educational fields. An overview of used AI techniques used in analyzed systems is given.

Keywords: eLearning, artificial intelligence, intelligent tutoring system

1. INTRODUCTION

The emergence of Intelligent Tutoring Systems (ITSs) has significantly changed the content and practice of teaching and learning in today's learning environments [1]. ITSs represents systems designed to replicate the effectiveness and efficiency of traditional tutoring within computer-based, digital tools and environments [2].

Incorporation Artificial Intelligence (AI) techniques into ITSs aims to provide learning in a meaningful and effective manner with the goal to interact with learners with one-on-one, personalized tutoring approach, similar to a human tutor, automatically enabled by using a variety of computer technologies [3][4]. Unlike other computer-based learning environments, ITS systems analyze each learner's actions and characteristics and, based on their background and the learning progress, provides personalized instructions such as additional learning content and explanations, hints, examples, demonstrations, etc. [5]. In recent years, ITSs have clearly shown that learners can make rapid progress and improve their motivation, knowledge, performances and skills in specific areas [1].

The fact that ITSs field has a long history of productive research and continues to grow, it is evident that this field warrants important consideration regarding the major differences in research goals, terminologies, theoretical frameworks, and emphases among ITS researchers. Research on ITSs aims to: (i) provide computer-based, intelligent sophisticated tutors that know what they teach, whom they teach, and how to teach, and (ii) to develop and test models about the cognitive processes involved in the process of teaching/learning [6]. Consequently, ITS researchers are required to have a good understanding of computer science, cognitive psychology, and educational research, resulting in competing demands [5].

The intelligence of ITS represents applying artificial intelligence techniques and methods in different aspect of the learning process, principally in four main components of typically ITS architecture [7]-[9]:

1) The Domain model

2) The Learner model

3) The Tutor model

4) The User interface model

The domain model (also known as the cognitive model/expert knowledge model) represents the knowledge of the particular domain to be taught and the knowledge that the student wants to learn (domain knowledge) [10]. It consists of the concepts, facts, rules, and problem-solving strategies of the domain in context to be taught [11]. The second component is the student or learner model consisted from different learner's characteristics gathered and updated from ITS's environment during the process of learning, such as the level of knowledge, skills, preferences, actions, responses, behaviors, learning styles, student's knowledge deficiency, etc.[12][13]. The tutor model (also called teaching strategy or pedagogic module) use the learner model, detects the knowledge deficiency in students and based on its own tutoring goals, to devise the pedagogic strategies and methods of teaching [14]. Core components of the tutor model represent: adaptive feedback, hints, recommendations for additional learning content, navigation of the learning path, and presenting adaptive educational content to each individual learner [15]. The last module is the user interface model which represents front-end of the ITSs and provides communication part

for controlling the interaction between user and system [16]. How the main factors for user-acceptance of the system are user-friendliness and presentation, this module integrates all types of information needed to interact with learner, through graphics, text, multimedia, etc.

In order to better understand the challenges that ITSs face, in the relevant literature have been some reviews of ITSs with the focus of the examination of the: (i) applying AI techniques in eLearning systems in order to improve the personalization of learning process [17][18], (ii) inspecting the effectiveness and usability of ITSs [1][19], and (iii) ITSs for specific knowledge area or game-based ITSs [20]-[22]. An analysis of the available review papers has revealed that some questions remain unanswered. Therefore, this paper aims to provide a comprehensive view of ITSs developed across all educational fields, consider different information and their characteristics, applications with particular emphasis on considering applied AI methods.

This paper is organized as follows: Section 2 describes the research questions. Section 3 represents the used methodology for data collection and analysis. Section 4 discusses the found results. Finally, Section 5 concludes this paper.

2. RESEARCH QUESTIONS

A systematic review focuses on research questions that try to identify, appraise, select and synthesize all high-quality research evidence about ITSs.

The following research questions were formulated:
RQ1: Which AI techniques have been used in ITSs?
RQ2: What adaptive features/purposes of the ITSs have been used?
RQ3: In which educational fields ITSs have been used/evaluated?
RQ4: What types of user-interface have been used in ITSs?

3. METHODOLOGY

In order to address the research problem, papers related ITSs and applying AI techniques in eLearning systems were considered during the systematic review as shown in Figure 1. Preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines were used [23].

Papers were searched within the period from 2009 to 2019 from the Web of Science, Google Scholar, Research Gate, Academia databases and by using backward referencing from papers cited within the literature that met the inclusion criteria. Some of the papers are taken from similar review papers about ITS filed with their reached conclusions.
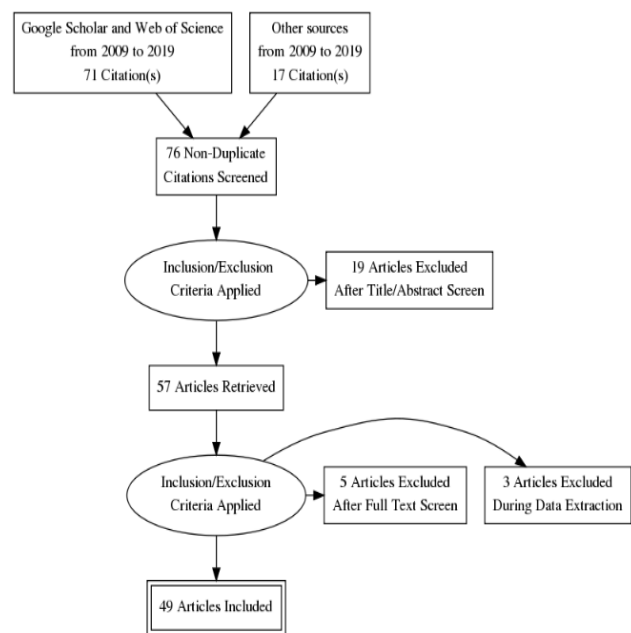
Figure 1: The process of PRISMA for data collection and analysis[1]

3.1. Search string

Within the research field there are multiple terms that relate intelligent tutors. The PICO criteria were used to define the search string [24]:

- Population (P): intelligent, adaptive, personalized learning systems OR environments OR tools,

- Intervention (I): student OR teacher OR instructor learning OR education OR tutoring

- Comparison (C): other (medical staff, pilots, etc.) training

- Outcome (O): effective learning

Used search string was: (intelligent OR adaptive OR personalized learning systems OR environments OR tools *for*) AND (student OR teacher OR instructor learning OR education OR tutoring) OR (medical staff OR pilots training *in order to achieve*) AND (effective learning).

3.2. Inclusion and Exclusion Criteria

Collected papers were evaluated based on the following inclusion and exclusion criteria:

1. Only journal and conference papers were included. Reviews, abstracts, news, editorials, and web resources were excluded.

2. The papers closely related to ITSs were included. The game-based ITSs, non-intelligent adaptive or personalized education systems, partially prototyped ITSs without evaluation and studies that used commercial adaptive eLearning platforms without improving were excluded.

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[1] Retrieved by PRISMA Flow Diagram Generator
http://prisma.thetacollaborative.ca/

3. Only papers published from 2009 to 2019 were included.
4. Only papers reported in English were considered.

3.3. Data Extraction

Once articles were identified as meeting the criteria for inclusion the full-text of papers was read once again in order to extract the following variables: (i) the name of the proposed system, (ii) AI techniques that were used, (iii) field of education, (iv) adaptive features from proposed ITSs, (v) purposes of extracted adaptive features and (vi) details about user interface.

4. RESULTS AND DISCUSSION

RQ1: Which AI techniques have been used in ITSs?

The most commonly used AI techniques in ITSs with the intention to support and improve the teaching and learning process while respecting the individuality of the learner are listed in Table 1. It can be seen that Condition-action rule based reasoning and Bayesian based techniques are most common. On the other hand Case-based reasoning is researched in the least amount of papers.

Table 1: Frequencies of used AI techniques in the ITSs.

AI Techniques	References	%
Condition-action rule based reasoning	[26], [27], [31], [33], [35], [37], [40], [41], [42], [55], [57], [60], [61], [62], [64], [66], [67], [68]	36.73%
Bayesian based techniques	[26], [28], [29], [44], [45], [46], [48], [49], [51], [63] , [64], [65], [69]	26.53%
Data mining techniques	[27], [31], [36], [41], [56], [61], [64], [65], [67]	18.37%
Fuzzy based techniques	[34], [38], [39], [43], [53], [54], [71]	14.29%
Other techniques	[52], [58], [59], [70], [72]	10.20%
ANN based techniques	[47], [50], [52], [56], [71]	10.20%
Intelligent agents	[25], [67], [69], [71], [73]	10.20%
NLP based techniques	[32], [35], [50], [69]	8.16%
Case-based reasoning	[30]	2.04%

RQ2: What adaptive features/purposes of the ITSs have been used?

As mentioned before, AI techniques enable ITSs to deliver guidance and instruction or evaluate learners by customizing the learning experience based on factors such as pre-existing knowledge, learner's preferences, learning style, motivation, and the learner's progress through the learning content. Adaptive features and purposes of applied AI techniques in ITSs are summarized in Table 2.

Table 2: The adaptive features and purposes of applying AI techniques in ITSs.

Adaptive features/ purposes of ITSs	References	%
Personalized feedback, hint or recommendation	[25], [27], [28], [33], [35], [36], [38], [41], [42], [45], [46], [50], [57], [58], [59], [60], [61], [64], [66], [67], [68], [69], [70], [71], [73]	51.02%
Classification, clusterization and updating learner's characteristics (learning style, needs, skills, etc.)	[27], [28], [29], [32], [34], [36], [38], [39], [41], [43], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [61], [64], [65], [68]	48.98%
Learner's knowledge, performance or skills evaluation	[25], [26], [30], [31], [32], [33], [35], [36], [41], [44], [56], [58], [59], [60], [62], [63], [65], [66], [67], [69], [70], [71], [72], [73]	48.98%
Presenting adaptive personalized learning material or content	[26], [27], [37], [40], [42], [43], [45], [52], [53], [54], [55], [57], [60], [62], [66], [67], [69], [71], [73]	38.78%
Adaptive or personalized learning path navigation	[32], [37], [42], [46], [57], [60], [62], [66], [67], [68], [69], [71], [72], [73]	28.57%
Presenting adaptive test and exercises	[31], [54]	4.08%

RQ3: In which educational fields ITSs have been used/evaluated?

The frequency of educational fields in ITSs are given in Table 3. It is evident that the ITSs are mainly used in computer science education.

Table 3: Frequency of educational fields in ITSs.

Educational fields	References	%
Computer Science	[27], [29], [30], [34], [38], [39], [42], [46], [52], [53], [54], [57], [58], [59], [61], [63], [65], [67], [68], [69], [73]	42.86%
Health/Medical	[25], [26], [32], [48], [49], [51], [70]	14.29%
Mathematics	[28], [55], [60], [62], [64], [66]	12.24%
Language	[36],[37], [40], [50], [71]	10.20%
Physics	[35], [45], [56]	6.12%
N/A	[41], [44], [72]	6.12%
Others	[43], [47]	4.08%
Artificial Intelligence	[31], [33]	4.08%

RQ4: What types of user-interface have been used in ITSs?

Important part of ITSs represents user interface infrastructure. The results show that the web-based user interface is the most frequent (97.96%) for the development of ITSs, while only 2.04% of ITSs user interfaces are mobile-based.

5. CONCLUSION

This paper analyzed intelligent tutoring systems across different educational fields and artificial intelligence techniques used in order to deal with different challenges, such as providing computer-based, intelligent sophisticated tutors that know what they teach, whom they teach, and how to teach, and developing cognitive models involved in the process of teaching/learning This work included 49 reviewed papers. It was concluded that the most used AI technique in e-learning is Condition-action rule based reasoning, while the most frequent educational field was Computer science.

Although, research on ITS provided many interesting theoretical insights, there are relatively few ITSs which are really used in schools. Therefore, future work will analyze a larger number of papers with greater emphasis on practical usage of proposed ITSs in educational environments.

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FLIPPED LEARNING

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Abstract: *Flipped learning is one of the pedagogical approaches that is very flexible and useful on many levels and in many courses of education. With the development of flipped learning, the education system has adapted to the new younger generations, who were born in the modern technological age, dependent on ICT devices, which prefer to use devices rather than direct contact (Z-generation) for their communication. The emphasis is on the presentation of integrating videos into education and mostly on the advantages of flipped learning in comparison with classical education. It also focuses on how flipped learning can improve the process of education for the students and teachers. Students are introduced to the learning material before class. According to research in Amerika, combined education is a very successful form of gaining new knowledge from the mix of e-learning elements: accessibility of content anywhere and anytime, and learning with a higher education teacher and his immediate explanations.*

Keywords: *E-learning, flipped learning, online*

1. FLIPPED LEARNING AS THE PEDAGOGICAL APPROACH

The concept of flipped learning goes back to the 1990s, when Harvard Professor Eric Mazur developed a model of 'peer instruction'. He provided material for students to prepare and reflect on before class and then used class time to encourage deeper cognitive thinking via peer interaction and instructor challenge. He called this "just in time teaching"[1]. The phrase 'flipped learning' came into general use in the early mid-2000s when it was popularised by chemistry teachers Jon Bergman and Aaron Sams in Colorado, USA [1]. This model was later expanded to include technological elements, which developed the 'flip' concept and emphasized the role of learning management systems in delivering materials to students before class.

Flipped learning is a pedagogical approach in which the conventional notion of classroom-based learning is inverted. The concept of flipped learning is very appealing to education teachers and students, as it incorporates elements of the traditional way of learning that they are already used to and the best feature of technology-based learning, which is that content is accessible online no matter the time or place [3]. In a very simple way, the flipped learning model can be interpreted as: what used to be done in school classes is now implemented at home, and what used to be done at home (homework) is now implemented in the classroom.

Flipped learning is a coexistence between technologically supported education and classical education that allows students to get familiar with the subject's content before the classes even begin. It encourages independent learning with the help of technology, so students can come to the lessons prepared and during the class only deepen their knowledge or solve different problems.

There is no specific model of flipped learning, and anyone who chooses to introduce such learning has the opportunity to design their system to the greatest benefit of the students.

In the broadest sense, flipped learning involves three phases:
- work independently at home,
- test,
- active work in the classroom.

The role of the teacher was articulated as facilitator and coach or 'guide on the side'. Subsequent research focused on the notion of 'inverting the classroom' as a means of providing an inclusive learning environment in which personalized coaching and mentoring was the norm. This is also one of the benefits of such a model for both the teacher and the higher education program.

Each teacher chooses a different way. Some teachers choose to make videos, some written resources, and others computer presentations, which are then uploaded to the site. However, there is only one rule for all models of flipped learning, which is to move the learning center from teacher to student; transforms passive ones into active ones [1].

Flipped learning is a coexistence between technologically supported education and the traditional mode of education. If we take one of them as an alternative to the other, this model loses meaning and has no desired effect Fast growth of online content creation, collaboration and distribution tools provide lecturers with an accessible toolkit for delivering flipped learning [4]. Video creation (e.g. Screener and Webinar) and distribution tools (e.g. YouTube and Vimeo) provide the opportunity to create flipped content with ease.

There is a wealth of pre-existing media available for reuse (e.g. iTunes). Technology is not a prerequisite for using flipped learning. Flipped text based content is just as valuable as video content. The intersection of web 2.0 technology and learning theory has enabled flipped learning to become a valuable addition to the spectrum of blended learning.

Integrating videos into education is the advantage of flipped learning in comparison with classical education, because flipped learning can improve the process of education for the students and teachers.

Flipped learning network is based on 4 pillars:

- flexible environment (space, time),
- a culture of learning based on student-cantered pedagogy,
- differentiated content (based on what the teacher explains and what students can explore on their own),
- professional teachers who formally monitor their students and reflect on their practice.

2. FLIP

Flip learning, or the word flip itself, is of great importance in understanding the model of flipped learning. These letters are based on the whole concept of the model [1].

F – flexible environment.
The form of the learning environment depends on the teacher. The idea of short recorded lectures has evolved into a flipped classroom format, where independent learning by viewing short recordings takes place outside of school space and time. The student has the opportunity to stop videos, turn them back, look several times and take notes, questions in the meantime.

L – learning culture.
A classroom time is intended for more complex content or for helping individuals to understand the substance. The learning centre is moved from the teacher to the student. For better concentration, it is important to exclude disruptive factors (phones, tablets, noise) during flipped learning.

I – intentional content.
The teacher develops a teaching material to meet the needs of active student-cantered learning theory. In order to produce a suitable video through which the teacher communicates the substance, it is essential, that the teacher must already be very familiar with the substance.
Students must have plenty of time to watch the videos. All materials must be available on the Web site at the beginning of the academic year. First students represent their own notes about videos without questions asked, so that the teacher can assess whether everyone has watched the videos. After reviewing the students' notes, the class may continue with questions and possible problems. The teacher can spend he rest of the lesson for consolidation of knowledge and exercises. There can be much more time in the classroom to practise and do various examples and use the gained knowledge in flipped learning.

P – professional educator.
Although the learning centre is placed on the student in flipped learning, teachers may have an even larger, more challenging role than in the traditional way of learning. The role of the teacher in flipped learning has changed from a substance trainer to a mentor, a facilitator and to a designer of the learning process. The main task of the teacher has become to help students.

3. CRITICAL EVALUATION OF FLIPPED LEARNING
The effectiveness of flipped learning in the educational environment has been steadily increasing in recent years.

The teacher's perspective.
The teacher is placed in the role of the tutor and coach. The lessons are intended for research, collaborative work, project work, problem solving and discussion. It is very important at the beginning of the academic year to make an introduction to learning by the flipped learning model and to explain to students how to approach watching videos properly. Such work requires a high level of knowledge, professional competence and applied orientation from the teacher. He or she can take any form for the greatest benefit of the student.

The teacher should write a script beforehand, so that the speech is clear and flowing. The teacher is not to be seen in the video and the student must have enough time to go through the contents. The videos must be short and easy to understand. With the introduction of flipped learning, the teacher begins gradually, first with only a selected topic within the unit, and later the whole design of the learning unit is considered.

Before the teachers make a video, they must create a scenario, how everything should proceed: from the text to the recording. The final product should be fluid as possible and in one piece, without visual or auditory change and recorded in a quiet place and without a teacher on screen, because this is reportedly distracting and takes away more important things. Videos must be short, but not too short. The best time is from15 to 20 minutes, presenting only lighter material and presenting more challenges of the content in the classroom. The teacher should use the interactive whiteboard [1].

Flipped learning can be used by all teachers involved in the educational process, from primary, secondary, and high schools and universities. The method can be used for teaching in the fields of technical, natural sciences, social and other sciences. It requires a great deal of resourcefulness, professionalism and work engagement from the teacher. The initial work input of a teacher is far greater than that of the traditional method of learning. Later, reusable videos make it easier for the teacher to work. This reduces the psycho-physical strain of the teacher. The teacher must ensure that the video content is updated regularly. Basic knowledge usually remains the same for many years.

Student perspective.
Flipped learning is a pedagogical approach in which direct learning moves from the classroom to the individual's learning space. Flipped learning can be taken quite literally as it represents the perfect turn. The contents that would otherwise be discussed in the classroom are processed by students at home. The modern model of education places much more emphasis on independent learning. Flipped learning is a combined active learning, which improves the academic view on the process of learning, where the students have an active role.

Due to the degree of independent processing of certain materials outside the classroom, the flipped learning approach makes the classroom work more dynamic,

interactive and productive. Flipped learning does not necessarily translate into better results when it comes to knowledge testing than traditional forms of learning and teaching.

Using this approach contributes to:
- longer information retention,
- developing critical thinking, autonomy and responsibility,
- effective problem-solving and effective learning strategies,
- higher levels of motivation and learning commitment,
- developing teamwork, collaboration and communication skills,
- acquiring ICT competences and strengthening relations between students and practitioners.

Students are generally positive about modern teaching practices, but it is not reasonable to expect that new pedagogical approaches will have the same effect on all students. Due to individual characteristics (e.g. personality traits, abilities) and environmental characteristics (e.g. teacher behaviour), students may react differently to the introduction of modern teaching methods. The student has the opportunity to learn by himself and at the most appropriate pace.

The technical aspect.
This kind of learning and teaching is possible today because there is a possibility of using information communication technology. Flipped learning is a coexistence between technologically supported education and the traditional mode of education. If we take one of them as an alternative to the other, this model loses meaning and has no desired effect. Educational institutions co-finance the construction of wireless networks and the purchase of ICT equipment, and the development of e-services and e-content.
All available flipped learning content requires a computer with internet access or a powerful mobile device. Despite the proper layout of the content, the size of the screens and related technology can cause problems in monitoring video content with mobile phones or tablets. Headsets or speakers are also required, and the correct setting of the audio playback device with appropriate outputs to allow playback is necessary. A web browser must also be installed. With the same web connection, browsing across different browsers can be slower or faster. That could make it impossible to download animations due to timeouts and bottlenecks. Students need to be available to help an IT team troubleshoot or install additional software on their computer to ensure video content is played.

Legal aspect.
The legislation in the field of education is not yet adapted to modern forms of teaching. The autonomy of the teacher is left to the choice of how to impart knowledge to the students. The curricula set out the competencies that the teacher must follow in delivering the lessons. A stricter legal regime is laid down in the assessment of knowledge. Flipped learning does not require a change in legislation, because the acquired knowledge can be tested in the traditional way. Changing the law requires a broader area

of e-learning because of a different way of archiving documents, security, protection of personal data, intrusions into the computer system, exam fraud and the like.

5. CONCLUSION

Education is constantly moving towards more flexible, effective and active learning and teaching strategies. New learning strategies seek to go beyond traditional pedagogical approaches that put the teacher at the forefront. Effective learning strategies are student-centred pedagogical approaches that take into account student needs and differences in learning and teaching styles.

Modern learning practices, such as flip, problem, project or blended learning, aim to develop and take responsibility for independent learning. The model of flipped learning is still a new and not very examined way of learning. Final knowledge and students' satisfaction show more advantages than disadvantages of it, so it is smart to include it into teaching and substitute the classical way of teaching with it.

As an advantage, students in flipped learning could cite:
- the ability to watch, repeat and pause videos,
- independently write notes and questions to develop critical thinking,
- videos are short and concise,
- the lectures end sooner, as students come ready to progress after a preliminary review of the content,
- the teacher and the student also bonded better through the game, communication was relaxed and two-way,
- adaptability and the ability to learn according to their pace, which greatly facilitated their deeper and broader understanding of the substance,
- the ability to view your own work through videos and learning from mistakes,
- better students' health and less nervousness and anxiety,
- the ability to communicate with the teacher allows for immediate clarification of problems,
- possibility to study for students who are further away from the educational centres or who live in remote places or do not have enough money to study,
- they talk to each other, discuss, debate, practically demonstrate and teach each other.

Research was conducted between 2012 and 2016 about the comparability of flipped and traditional methods of learning performance in the United States, Australia and Canada. Given the differences between these and European socio-economic systems, the results need not be the same. The essential advantage of flipped learning over other forms of e-learning is that in this form students do not lose communication skills, do not become asocial and over-embedded in the virtual world.

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DEVELOPMENT OF COMPUTATIONAL THINKING SKILLS IN PRIMARY SCHOOL THROUGH DIGITAL STORYTELLING WITH SCRATCH

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Abstract: *Digital storytelling is a process of telling multimedia stories that can be interactive and contain game elements like labyrinths, sorting games, or puzzles. By combining the steps of the traditional storytelling process, creating multimedia, and defining game elements, teachers can encourage their students to acquire many fundamental skills including computational thinking. As a tool for both digital storytelling and computational thinking development, teachers may use a visual programming language Scratch. This paper presents a model for educating primary junior grade school teachers to use digital storytelling with Scratch for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of their students. The model is included in the blended learning course developed within the Erasmus+ project GLAT (Games for Learning Algorithmic Thinking). The paper brings experiences about educating the teachers enrolled in the GLAT course and engaged in designing interactive Scratch stories.*

Keywords: Digital storytelling, Scratch, educational games, GLAT project

1. INTRODUCTION

Digital storytelling has been recognized as effective way for achieving learning outcomes of different school subjects [1]. It is a process of telling stories by integrating multimedia elements (images, sound, text, animation) using digital tools [2]. By engaging in the process of designing and creating digital stories, students can develop computational thinking skills as well as many other skills such as research, organization, digital literacy, and problem solving skills [3].

The process of computational thinking involves formulating a problem and expressing its solution in a way that a human or a machine can effectively perform [4]. Among fundamental skills needed for that process are [5]: decomposition, abstraction, algorithms, debugging, iteration and generalization. These skills are used to break the problem into smaller parts, logically organize and analyse data, identify and apply existing solutions in order to design efficient solution of the problem, etc. [2]. Computational thinking skills are related to programming skills since some programming techniques are used in the problem solving process. In addition, computational thinking skills are needed to implement the developed solution of the problem using a computer [6]. Computational thinking skills should be encouraged from primary school [7] because these skills are useful for a career in many sectors (e.g. education, healthcare, tourism, business and financial markets) [5].

To motivate students to engage in learning activities that support the development of computational thinking skills, teacher can combine digital storytelling activities with Game Based Learning [1], [7]. Since most of today's students are fond of digital games, they find activities that include playing or designing games very interesting. These activities can also support the learning of basic programming concepts and motivate students to start using programming languages appropriate to their age (i.e. visual programming languages like Scratch) [2].

One of the project that tends to promote development of computational and algorithmic thinking using games is Erasmus+ project GLAT (Games for Learning Algorithmic Thinking) [8], [9]. This paper present a model for educating primary junior grade school teachers to use digital storytelling with Scratch for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of their students. The model is included in the blended learning course developed within the GLAT project. The paper also brings experiences about educating the teachers enrolled in the GLAT course and engaged in designing interactive Scratch stories and gives overview of the outstanding digital stories created during the project.

2. DIGITAL STORYTELLING

By combining the steps of the traditional storytelling process with gathering and creating digital media, teachers can encourage their students to become creative narrators, enable them to acquire many generic skills, as well as to achieve specific learning outcomes of different school subjects [1], [3]. For example, students can illustrate events from their lives or a plot of a favourite fairy tale [2].

Key elements of the digital story are [3]:

- setting of the story,
- characters,
- scenes,
- sequence of events,
- narrative perspective (point of view).

To make stories interactive, students can add game elements or challenges like mazes, brain teasers, sorting games and puzzles that should be solved by the player [10]. Mentioned games enable the player to develop computational thinking skills [11]. For example, after researching about cultural sights of their region, students can present them using a story and design games in which the player should demonstrate the knowledge of these sights. Students can also illustrate a real life mathematical problem and design logical games combined with mathematical tasks in which the player needs to apply knowledge to achieve the goal of the game.

As shown in Image 1, the teacher can start the digital storytelling process by selecting a topic and, with the help of students, formulate the initial ideas about the story and define its purpose and target audience. The teacher then guides students in exploring the topic and gathering necessary information. In this step students construct knowledge and organize ideas [3].

Students should decide regarding appearance, personality traits, and motivations of characters, describe the setting of the story (time and place), formulate the problem faced by the characters, how it is approached, and about its outcome. They should also design game elements - challenges that should be solved by the player (the playing character) [10]. Besides the player, stories can have narrator, a non-playing character who guides the player through the game and gives instructions and feedback, as well as other non-playing characters [3].

In the next step a script should be defined. An initial ideas need to be further developed and text that will be shown or told by characters prepared. Teacher should help the students to write interesting but focused and concise story that it is easy to understand. Before actual work on creating the digital story using the chosen tool, the storyboard is usually created. It is a written or graphical representation of all the elements that will be a part of the story including media files (images, text, narration, music) [3].

Interactive digital stories with game element can be created using visual programming languages like Scratch which offers a library with numerous sprites (characters), backgrounds, and sounds [2]. While designing and creating

Image 1: Digital storytelling process [3]

interactive stories with game elements, students have the chance to develop their computational thinking skills since they [2]:

- formulate a problem – students determine which elements should be used,
- logically organize and analyse data – students create characters, scenes and sequencing by building blocks of code,
- represent the data – students tell the story by defining movement of characters and dialogs among them, define variables for collecting points and timers,
- identify, analyse, and implement solutions – students ensure that the program works as intended, in the ordered steps.

After combining all elements together and sharing the created story with others, the final step of the process is gathering feedback and reflection [3].

3. PROMOTING DIGITAL STORYTELLING WITHIN THE GLAT PROJECT

During the GLAT project [8], a professional development training was organized for primary junior grade teachers to encourage the integration of activities for development of computational thinking skills into the daily teaching of different subjects (from the first to fourth grade of primary school).

GLAT training for primary junior grade teachers

The participants of the training were Croatian primary junior grade teachers. They attended a blended e-learning [12] training course where three face-to-face workshops were combined with online mentoring in a learning management system. During the training, teachers were introduced to innovative teaching strategies including Game Based Learning (GBL), Problem Based Learning (PBL), and Inquiry Based Learning (IBL) [11]. Besides theoretical topics, examples of games and digital tools that can be used for development of computational thinking were presented and analysed.

The following three two-day workshops were organized:

1. GBL and unplugged activities,
2. PBL, online quizzes and logical tasks,
3. IBL, games and tools for learning programming.

After each workshop, teachers applied acquired knowledge and skills and, with the help of experts from the project team, developed learning scenarios (i.e. preparations for classes in digital form [13]) for different school subjects. Learning scenarios developed by teachers included educational activities for development of algorithmic and computational thinking in line with workshop topic and presented teaching method. Teachers implemented all developed learning scenarios in classes with their students.

Introduction of digital storytelling

Digital storytelling was introduced during the third GLAT workshop so teachers planned activities related to digital storytelling in their learning scenarios. Image 2 shows the sequence of activities performed by the teachers, their students, and university students after the third GLAT workshop. The teachers first developed learning scenarios for the chosen school subject and topic. They included the activity of designing the digital story with game elements as well as IBL activities. Then, teachers developed initial ideas for digital stories related to the chosen topic. In the next phase, the teachers implemented the designed scenarios in the classroom with their students. After a set of activities designed in line with IBL (and other strategies), all the teachers planned the following activities: designing interactive story with game elements, viewing/playing the designed story with game elements, and reflection.

The teachers guided students through the process of designing the story with game elements. They described the setting of the story and decided on names and appearances of characters (playing characters and characters who guide the player through the game and give instructions and feedback). After exploring the topic and gathering necessary information, students also designed game elements that enable the player to develop algorithmic thinking skills (e.g. challenges like labyrinths, brainteasers, sorting games, and puzzles). The students were also included in defining scenes, the sequence of events, and logical conditions for directing the flow of the game.

In the process of designing digital stories with game elements, the students could learn basic programming concepts [2], [14]:

- sequence – students arrange the elements in the chronological order in which they will appear in the story
- data – students define which data need to be stored (e.g. player's name, collected points, remaining time, etc.)
- condition – students direct the story flow, define how the player will collect points, define the end of the game, etc.
- loop – students define challenges for the player, decide how many attempts the player will have to finish the game, etc.

Visual programming language Scratch [15] has been chosen for creating designed digital stories. The participants of the GLAT workshops were junior grade teachers and non-informatics teachers who did not have enough knowledge and skills to independently code in Scratch. Therefore, in the preparation of the stories with game elements university students - future teachers of informatics, helped the teachers. They programmed the stories according to the instructions provided by the teachers and their students. The Table 1 shows outstanding digital stories that were created during this very successful collaboration.

Reflection on the development and implementation of learning scenarios

Most of the learning scenarios developed by teachers were for the Science course and the other scenarios were for Mathematics and Croatian language. After the implementation of learning scenarios in the classroom, a reflection was performed.

During reflection, teachers expressed their comments regarding implementation, how the students accepted the designed activities (especially the parts about designing the game and playing the game), whether all the learning outcomes stated in the learning scenario were realized and the possible changes in the scenario before the next implementation.
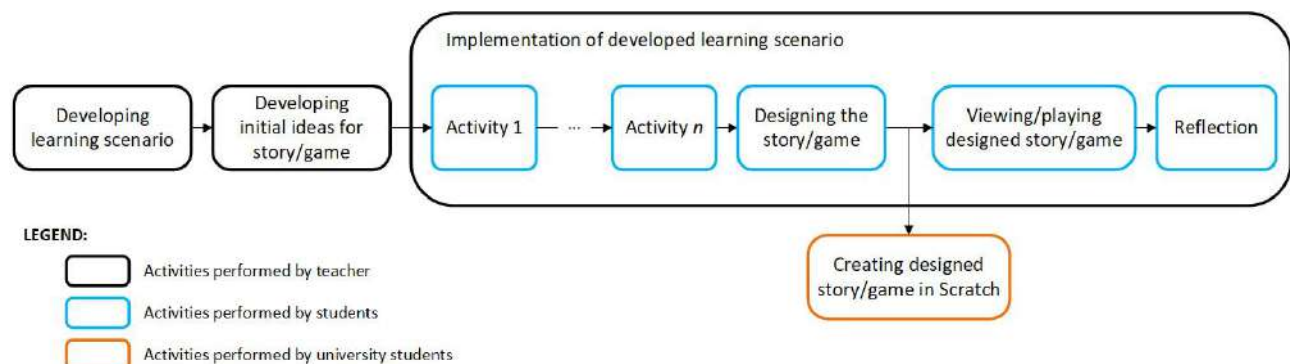
Image 2: Development and implementation of learning scenarios that include digital storytelling

Table 1: Outstanding digital stories with game elements created during the GLAT project

Name	Subject and grade	Story	Game elements	Preview
Seasons [16]	Science 1st grade	A girl named Mia moved from Africa to Croatia and wants to learn about the seasons.	Choose appropriate clothes, seasonal food, and write the names of the seasons.	
Let's eat healthy! [17]	Science 2nd grade	A girl named Tašana goes to the market to buy healthy food for a meal.	Collect healthy food, write the names of the main meals, and put the cutlery next to the plate.	
Cultural heritage [18]	Science 4th grade	A boy named Joseph was abducted by aliens who want to learn about the Croatian cultural heritage.	Mark the Croatian counties where UNESCO sights are located, collect pictures of the intangible cultural heritage.	
Calculation castle [19]	Mathematics 1st grade	To win the princess' hand, young prince must find the golden key and free the princess from the castle.	Collect a number of items (according to given numerical expression), solve word problems.	
Hlapić plays with words [20]	Croatian language	To find his lost friends in a castle, a boy named Hlapić needs to recognize different word classes (nouns, verbs, adjectives).	Sort words, to find a certain word class in a sentence, collect words of a given class.	

Teachers expressed great satisfaction with the prepared scenarios and implementation in the classroom as well as with high motivation of students for creating and playing their own game:

"The introduction of digital games into teaching greatly enhanced my teaching experience and contributed to the fun of the lesson and the project day."

"Learning outcome: Searching, finding, and separating relevant information from the irrelevant has been the most difficult, because this is the first grade. However, I believe that this way of working contributes to developing the ability to search, retrieve and extract relevant from irrelevant information, and that each time further, we will be better at achieving this outcome."

"The developed computer game will serve many other generations, and the motivation for further creation in students and teachers is very high."

"The working atmosphere was wonderful. Students were active and eagerly participated in all the steps of creating the game. When they first played the game, they kept repeating that this is exactly how they envisioned their game."

"Most of my students are involved in the program of early learning informatics, so they were very interested in how the game was developed and expressed their desire to learn how to do it, too."

"Designing this learning scenario was the most challenging for me, but the joy and enjoyment that the students showed while working was worth the effort."

Most of the teachers also pointed out that their students played the game multiple times at school and that link to the game was sent to their parents so they can play at home, too. After playing the game, the students were also interviewed about their experiences.

The favourite part for students during the implementation of learning scenarios was the part when they had chance to play the game they had designed together (Image 3).

The students perceived the game as a fun experience through which they could learn. Many of them indicated that their game is better than the existing examples of Scratch games, precisely because they participated in designing it. It is clear from the following students' responses that the experience of designing and playing the game is positive and that students have accepted this approach to teaching and learning very well:

"I liked when we were choosing the characters. We had to draw characters on board. We easily agreed, we voted for ideas. In the game, I liked the maze the most. I learned about the crew of the ship. There was no difficulty, I found it interesting, I felt good. Our game is better because we did it. I would change that game have more levels and tasks because it was too short for me."

"I felt good, a little angry at the first task because I couldn't get through it. There was no difficulty while playing the game. Our game is better because it's more fun and has a lot more colors. I would change the maze to be more difficult and add three more levels."

4. CONCLUSIONS AND FUTURE PLANS

Using digital storytelling, teachers can encourage their students to become creative narrators, but at the same time enable them to acquire many skills, including computational thinking. Digital storytelling activities can be planned for various school subjects. Students eagerly participate in these activities and they enable them to achieve learning outcomes in a fun way.

This paper presents a model for educating primary junior grade school teachers developed during the GLAT project. Digital storytelling with Scratch is used for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of students. Teachers' and students' engaged in designing interactive Scratch stories expressed positive experiences.

The GLAT project will end in October 2019. However, activities for promoting development of computational thinking skills will continue at University of Rijeka within the project "Digital educational games". During the project "Digital educational games", possibilities of using GBL in the context of learning, teaching, and promoting inclusive education will be further explored. Efforts on building pedagogical-technological frameworks based on GBL to educate the teachers will be made.

Image 3: Students playing the game they designed

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ANALYSIS AND IMPROVEMENTS OF EXISTING E-LEARNING SYSTEMS FOR C PROGRAMMING LANGUAGE

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Abstract: The purpose of this paper is to analyse new approaches to the e-learning systems for C programming language . Recent years have seen a rise of numerous e-learning systems for learning programming languages based upon a direct program code entry into a web browser and evaluation and display of corresponding output. Firstly, this paper gives an overview and a short description of the existing systems and their characteristics. Based upon the previous analysis we will recommend a system adequate for the C programming course, which is currently in process of developing at the Belgrade Metropolitan University, and which offers some advantages compared to existing systems. Also, this e-learning system can easily be adapted for operation with severalother programming languages. This system is based on automatic check of problem solutions produced by students.

Keywords: E-Learning, C programming language, C programming language, Codecademy, Codingbat, HackerRank

1. INTRODUCTION

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] [2].

Programming language C is a general-purpose, procedural, imperative computer programming language developed in 1972 by Dennis M. Ritchie at the Bell Telephone Laboratories to develop the UNIX operating system. C is the most widely used computer language. It keeps fluctuating at number one scale of popularity along with Java programming language, which is also equally popular and most widely used among modern software programmers.

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

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

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

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

CodingBat e-learning system [3], 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.

Another solution analysed here, the e-learning system Codecademy [4], enables learning of the basic elements of programming languages.

These two systems were analyses in details in [5], and we concluded that an important disadvantage of these group of e-lrarning systems is that they do not offer support for e-learning of C programming language.

The third solution is the HackerRank e-learning system, discussed in more details in [6], includes support for C programming language, however it is not a conventional e-learning system, and it is more adequate for students who are already familiar with programming fundamentals.

3. DESCRIPTION OF CODE ONLINE EDITOR (COE), AN E-LEARNING SYSTEM FOR C 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 programing fundamentals for C programming language.

This system represents an advancement of the system JOE, describe in [4], where for every solving problem there is a group of tests, and these tests give a basis for the solution evaluation. The system enables learning of the programming fundamentals in programming language C, starting from scratch, including a theoretical part, and also including the input of the entire code into an integrated editor, as well as modifying/extending the already existing code and correcting the mistakes in the existing code.

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

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

So, the developed COE system combines good characteristics of the existing systems, and offers more flexibility and more learning comprehension compared with the analysed systems.

Image 1 illustrates the architecture of the proposed system
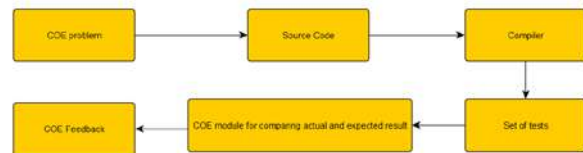
Image 1: Architecture of COE

Image 2 illustrates the GUI of the proposed system with sections of problems that are consistent with course C programming course at the Metropolitan University. By adding new sections and problems, we can enable this system to the course Algorithms and data structures at Metropolitan University.
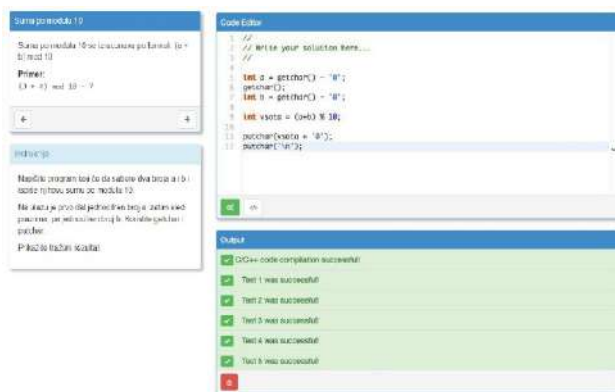

Image 2: Sections in COE

Image 3 illustrates the GUI of the proposed system with problems for the specific section (in this case – Introductory Problems)
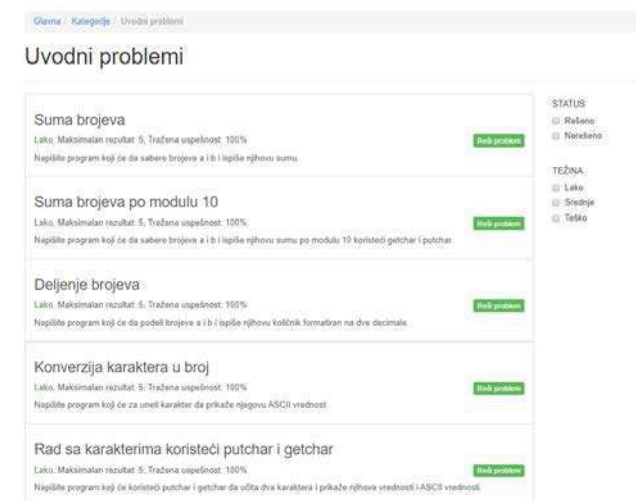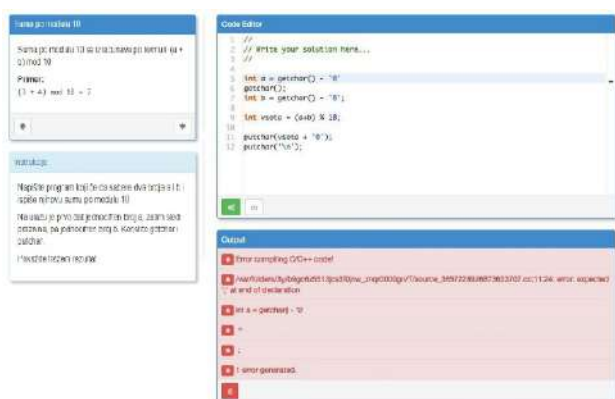

Image 3: Problems in one section in COE

Image 4 illustrates the GUI of the proposed system for successfully solved problem (5 of 5 tests passed), image 5 illustrates the GUI for unsuccessfully solved problem (compile time error).

Image 4: Problems in one section COE

Image 5: Problems in one section COE

4. CONCLUSION

So, the developed COE system represents an advancement of the JOE system, which supports work with C programming language, where for every solving problem there is a group of tests, enabling the evaluation of problem solutions.

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

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COLLABORATIVE LEARNING WITH REAL-TIME LEARNING INTERVENTIONS

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Abstract: This paper describes the process of collaborative learning and project design work using various collaborative tools. Teachers use "doKumaran", within the LAMS * Learning Activity Management System, to manage collaboration within different groups of students in the learning process. Outside the learning process, collaborative tools available in the market ("JIRA" and "Slack") can also be used that also offer the ability to be used to create project tasks in a group. The paper demonstrates the use of "doKumaran" LAMS collaborative activities within the learning process and the application of "JIRA" and "Slack" collaborative tools used in the software development industry. Outside the learning process, collaborative tools available in the market ("JIRA" and "Slack") can also be used, and they also offer the ability to be used to create project tasks in a group. The paper demonstrates the use of "doKumaran" LAMS collaborative activities within the learning process and the application of "JIRA" and "Slack" collaborative tools used in the software development industry.

Keywords: Colaborative learning, Colaborative tools, E-Learning, Distance learning, LAMS, JIRA, Slack

1. INTRODUCTION

Collaborative learning enables communication, exchange of knowledge, ideas, and the students' joint work to accomplish a particular task. It is often the case that the group is made up of students with different levels of knowledge, learning style, different grades and the degree of motivation. The difference between students in a group may also be geographical distance or type of study (the traditional way of studying or studying online).

The initial goal of the group must be set by the author of the teaching material (the teacher), who forms the learning process and the tasks that need to be solved. The next step is for a group of students to set their goals and how they will solve the task while solving the problem.

The goal of collaborative learning is to enable unobstructed and real-time work in the chosen environment, regardless of the possible differences between the students of the group members [3]. Teacher involvement is desirable in order to provide guidance and instruction for solving a particular task. This paper will introduce some of the possible environments for supporting collaborative learning and the development of different types of assignments (project assignments, writing documents, programming a specific part of the application) of students in a group at Belgrade Metropolitan University (BMU). Some of the collaborative tools that will be described are popular in the software development industry and are used for different types of projects.

2. CURRENT BMU LMS

Belgrade Metropolitan University uses LAMS (Learning Activity Management System) [5] to display teaching materials. The teaching materials are created in the form of learning objects using the mDita editor tool [4] developed at Belgrade Metropolitan University. LAMS enables the creation of an interactive learning process and the addition of additional activities to the process itself.

Studying at Belgrade Metropolitan University is possible in the traditional way (fifteen weeks of classroom lectures during the semester) and online (using the LAMS learning management system). In addition to classroom teaching, traditional students have access to the LAMS system as well as internet students. Teachers create learning processes (Fig.1) that are visible on LAMS for both types of students. Accordingly, students are given access to teaching materials [1] anywhere, anytime, while before using collaboration tools students can also use:

- Audio and video materials within the learning process: making it easier to understand the teaching topic being covered
- Self-test tests: which help the student to test his / her knowledge in several different places in the learning process. The student may run the test several times (within which he/she will receive a

different set of questions each time) and test his / her knowledge until he/she is satisfied with the results obtained on the test. The test shows several questions that were randomly selected from the test bank of that test.

- Additional resources: additional materials provided by teachers in the form of case studies, scientific papers, documents that allow students to gain a real-life example of what is being processed in the learning process
- Mind maps: by means of which they can freely move through the learning process and read the contents of learning objects [2]
- Forums: where students can exchange views with other students on a teaching topic
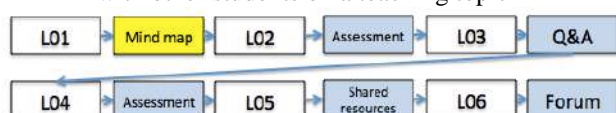
Figure 1: An example of a learning process with LAMS activities and a mind map

3. LAMS TOOL FOR COLABORATIVE LEARNING

LAMS since version 3.2 allows the implementation of collaborative activities between students. The "doKumaran" activity is an integrated tool with the LAMS system that allows teachers to easily create a collaborative learning process within which they can track student activities in real-time [6].

The tool allows students to collaborate on writing one or more different documents in real time according to the learning outcome set by the teacher for that part of the learning process.

The benefits of the "doKumaran" tool are:

- Possibility of real-time collaboration between students with the supervision of teacher involvement in work
- Archiving students' discussions and decisions during collaborative work
- Increasing the level of engagement of each student regardless of the level of knowledge
- Improving students' critical thinking according to the learning process

Following these activities, which are part of one learning process, students can do the tasks using a collaboration tool. It is up to the author of the instructional material to assign a task (whether students will do an example exercise, homework or project assignment) through a collaboration tool. Also, the author of the teaching materials creates groups of students who will work together on a defined assignment. Groups of students can communicate with each other, exchange task solutions, and work together to solve problems when needed.

Fig.2 shows the lesson of the subject "Software Design and Architecture". After going through the learning process, students are tasked (in colaborative tool) with

defining functional and non-functional requirements for the system within a common project assignment. Students are divided into groups of three students (it is possible to place more students in a group).
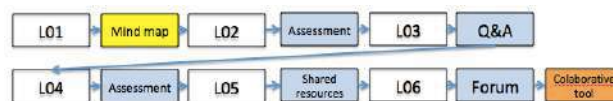
**Figure 2:** Adding collaborative activities to a previously created learning process

Fig.3 shows the lesson of the subject "Software Design and Architecture". After going through the learning process, students are tasked ("doKumaran" activity) with defining functional and non-functional requirements for the system within a common project assignment. Students are divided into groups of three students (it is possible to place more students in a group).
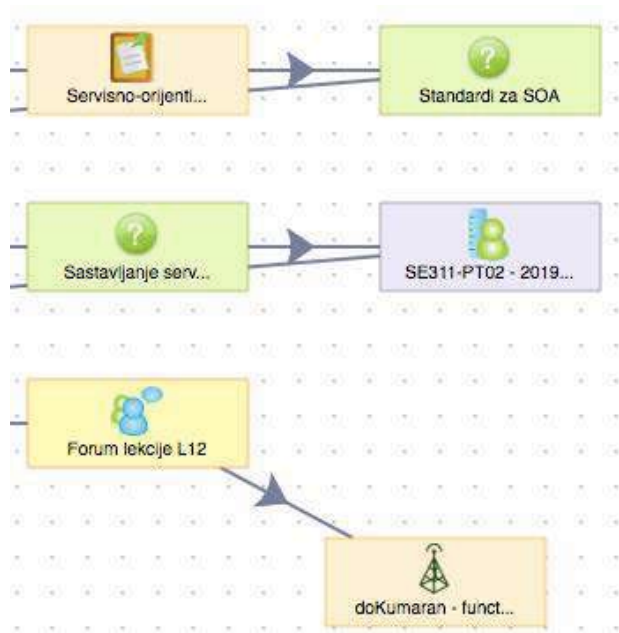
Figure 3: Part of learning process for "Software Design and Architecture" subject with doKumaran activity

Students must go through the complete learning process in Fig.3 and all activities in order to arrive at collaborative activity. At the beginning of the learning process, there is a mind map that students can access or any learning object in the learning process while they are on a project assignment if they need it. The student approaches a collaborative tool as part of the learning process and enters the first sentence: "List of functional requirements:" (Fig.4). The rest of the students in the group enter the text of the first student shown in green (Fig.5).
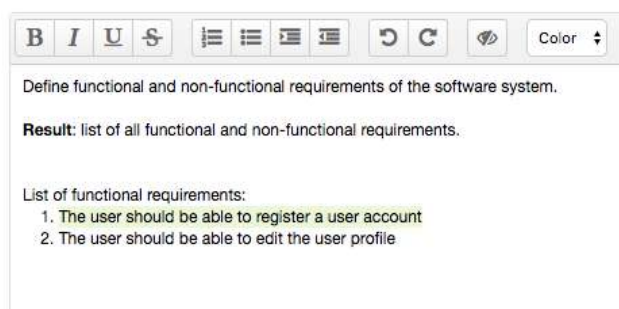
Figure 4: User interface for student 1

The second student who has accessed the collaborative tool enters a section of text under serial number 1 which is now displayed to the first student in green (Fig.4).
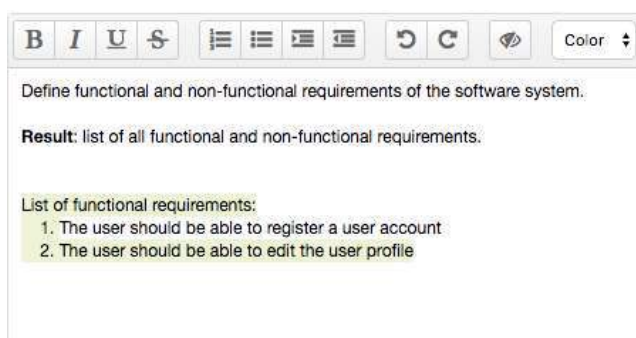
Figure 5: User interface for student 2

Text input by a third student within the group is indicated by a purple color. Students can change the previously entered part of the text, which after the change will be marked by their color for other students. (Fig.6).
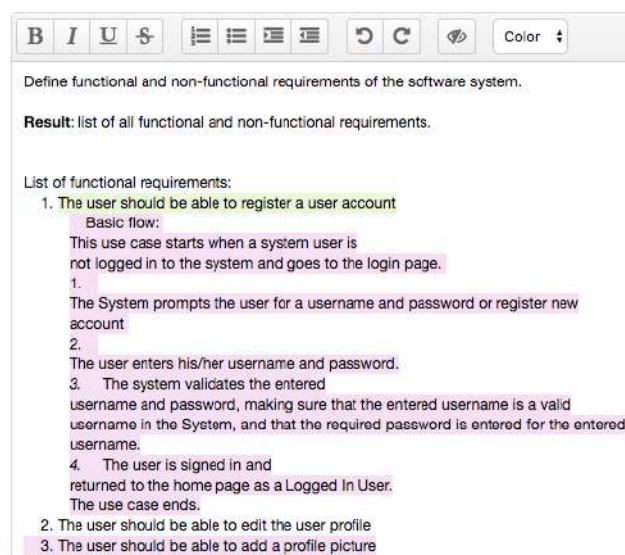
Figure 6: Example of text entry by a third student in a group

The author of the teaching material can at any time monitor students' activities in real-time in a collaborative tool, engage in a chat option in discussions between students, or directly correct part of the text that students have previously written. The written text can be saved as HTML or text file which can later be opened and modified in another word processor.

4. JIRA AND SLACK COLLABORATION TOOLS

JIRA [7] is a collaboration tool that incorporates various toolset according to project needs. It is widespread and is used in combination with other available tools. It is possible to create different fields, types of problems, data flows, notifications and generate different reports and diagrams to view the activities of project participants. Also, the tool is used as an issue tracking system and for workflow modeling.

For the purpose of working together students on a specific assignment, it is possible to define a task list for each student. The advantage of this tool is that the teacher can define assignments for each student and also the students themselves can select assignments from the to-do list and thus choose what suits them best. Students in the group can follow the progress of the project and the activities of other group members and, if necessary, get directly involved in its design.

An example is the creation of a part of a project assignment from the subject "Software Design and Architecture" within which a group of students has certain tasks that they need to distribute among themselves and complete within a certain time interval. The teacher created a to-do list, distributed them to students, and defined the estimated time each task was required to complete (Fig.7). Students, if they see a need for it, can create new tasks, split existing ones, and assign them within a group to other members to successfully complete the task.

Figure 7: List of student activities on the project

Fig.8 shows the list of assignments, the students to whom the assignments were assigned, and the current status of the assignments. Students, when they complete a particular task (which is in progress), can move the task into the "done" section, after which they must enter the time they need to complete the task.
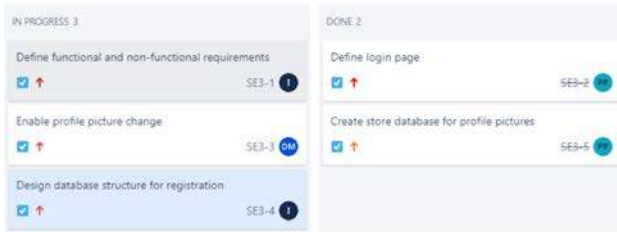
Figure 8: List of active and completed tasks

Jira is used in this case to create and assign tasks to a specific student. Slack [8] is used to communicate and inform students in a group while working on assignments. Slack works on the principle of different channels for communication and the main channel is connected to the Jira application in which the tasks are predefined. Any changes to the Jira Task are automatically displayed on the Slack General Channel. It is possible to use Bitbucket [10] or GitHub [11] to store code in combination with these tools.

When students update the program code, a notification is automatically created on Slack and all group members can comment on that notification or the program code entered by the student. Students within a group can be members of several different channels and the main channel contains all members of the group. It is also possible to create channels for each of the defined tasks and it is also possible to use a direct message for private communication.

Communication with the teacher through channels or direct messages is also possible at any time. Fig.9 shows Slack communication between students and teachers about predefined assignments through the JIRA tool. Students can comment on assignments, refer to them during the discussion, or assign a question to a particular group member. Also, the teacher can control communication and, if necessary, answer students' questions.
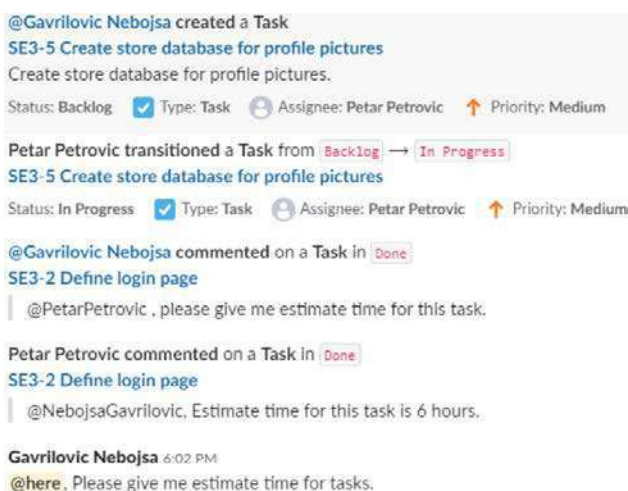
Figure 9: Slack Student Communication on Defined Assignments

The teacher as project manager can control the complete project work and generate different types of reports in which he can see all the activities of the students, the time

it took them to complete a specific task and assign the following tasks accordingly. Fig.10 shows the status of project assignments and the time it takes students to complete a particular task.
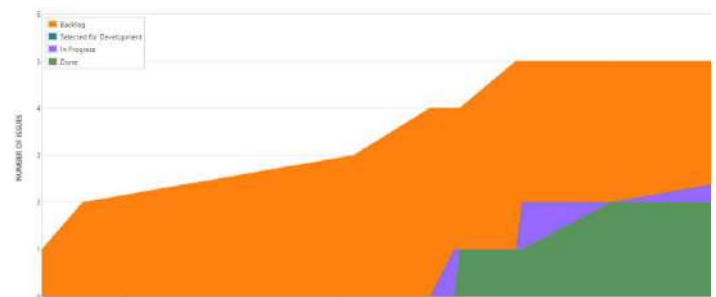
Figure 10: Diagram of the status of tasks within the JIRA project

5. RESULTS OF COMPARISON OF APPLIED COLLABORATION TOOLS

The collaboration tools described providing students with the ability to solve project assignments in a defined group in different ways. The LAMS tool (doKumaran) allows you to write project documentation and documents that are important during software design with the direct supervision and participation of group members and teachers.

JIRA as a tool allows you to define tasks and assign tasks to a specific group member. Also, JIRA has the ability to include a Confluence tool [9] that allows group members to participate together in writing a specific document. The advantage of the doKumaran tool is that it is directly integrated into the learning process and the student has the ability to read instructional materials and see case studies without using another tool or a new user account. Slack allows you to directly associate a specific JIRA tool task with a chat discussion.

The LAMS Collaboration Tool does not have this capability in chat, it is already necessary to emphasize what task is being discussed.

Based on the analysis of the collaboration tool, it is recommended that the "doKumaran" tool be used as part of the learning process and that students communicate with each other via teacher chat about the assignments given by the teacher. The JIRA and Slack tools in combination with a "Bitbucket" or "GitHub" account must be used for tasks involving programming.

6. CONCLUSION

This paper analyzes collaboration tools that can be used by a teacher to track student activity on a collaborative project. The teacher can:

- Controls student work in real-time
- Corrects program code or document in real-time
- Advise students through chat through student assignments

- Has insight into the time it takes students to complete a particular assignment
- Evaluates the performance of a particular student
- Monitor communication and collaboration within the group

The integration of collaboration tools within the learning process enables the student to have insight at any time into the teaching materials he / she has previously read and, if necessary, to go through the same and recall certain parts. Collaboration tools used in the software industry often require multiple different user accounts that need to be linked and verified before getting started.

The result of the analysis of this paper concludes that future research in the field of collaborative learning can be based on the integration of LMS systems and collaborative tools so that both students and teachers within one system have all the opportunities that available collaborative tools on the market offer (program code storage, updated program code, discussion of updated program code, etc.).

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https://slack.com

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https://www.atlassian.com/software/confluence

[10] Bitbucket, code management tool.

https://bitbucket.org

[11] GitHub, code management tool,

https://github.com/

DIGITAL TEXTBOOKS IN THE CLASSROOM

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Abstract: Digital textbooks are innovative tools and a comprehensive technological solution for improving the teaching process. They contain videos, movies, animations, 3D models, scenes, tools, tests, quizzes etc. on the most up-to-date educational platforms. Moreover, they can be enriched and fulfilled with some new contents. Digital textbooks bring greater adaptation to the needs of students, multimedia resources and special purpose tools (zoom, writing, drawing, colouring, hiding, links, additions). They take up a little space, are available continuously, not expensive, have a variety of task types. Appropriate software platforms are used to store educational materials. LMS is an integral solution for the complete teaching process. Digital teaching materials can be set on a variety of devices (computer, mobile phone). In intention to make learning and teaching more productive, digital teaching platforms are powerful IT resource. In this way, the teaching orientated towards achieving the pre-set learning outcomes will be with better quality.

Keywords: digital textbooks, teaching, LMS, software platforms.

1. INTRODUCTION

Traditional printed textbooks have been long in schools. They are generally massive, heavier to carry, more expensive, and lately little used. Students are gaining knowledge from a variety of sources, with an increasing number of online resources and other support materials. They also do this with the help of smart phones and tablets, with easy and fast access to new textbook versions.

While there are advantages and disadvantages to all, digital education systems provide more opportunities for students and teachers, for those who seek alternatives to existing learning models for their environment and with the technological innovations and devices available.

Key facts of the revolution in education is the emphasis on interactive, exploratory and collaborative learning activities. There is an increasing amount of digital materials that are applicable in education. The main functions of digital textbooks include the basic features of printed textbooks and the supplementary features of IT and digital media. For certain teaching subjects, digital content must be tailored to their specificities.

2. KEY FEATURES OF DIGITAL TEXTBOOKS

A textbook which uses the digital format as a recording method is called digital. A digital textbook is an electronic version of the textbook and is intended for contemporary teaching, both for students and teachers. It is an interactive version of an existing textbook, usually containing the following multimedia accessories: photo galleries, videos and audios, 3D animations, tests and the like. [1-2]

In addition, the textbook contains tools by which the student can mark the text of the lesson himself, round off certain parts and add content to the lessons in the form of pictures, texts, audio and video materials, internet links. They have general tools, or groups of special tools for individual subjects. Flexible, optimized, personalized and portable, digital textbooks have evolved very quickly and become popular with today's students. They are unavoidable elements in the digital classrooms (Image 1). [3]

The essential features of digital textbooks are as follows.

- Both cheaper and lighter than print textbooks.
- More flexible and new apps and downloadable content is constantly being developed.
- Available for use on computers (tablets) and smartphones, their use is more attuned to modern pedagogic practices of blended learning and 21st century learning skills.
- Interactive content, images, 3D views, diagrams, sounds and videos to keep students engaged and make learning fun and easy, they also make it possible for teachers to customize student learning and pick and choose the best content for each subject matter.
- Students have the freedom to highlight, promptly search for major chapter terms or titles, adjust font size, copy and paste important facts, and hear/see audio/video transmitted from lessons.
- Provide an opportunity to solve a quiz, or answer questions based on given chapters, this allows students to take responsibility for learning, without external instruction from the teacher, and even for self-assessment. [4, 5]

Digital textbooks provide an opportunity to solve a quiz, or answer questions based after chapters. This allows students to take responsibility for learning, without

external instruction from the teacher, and even for self-assessment. [5]

Teachers and designers need to incorporate flexibility in their materials and assignments so that students can choose among a variety of tools or strategies in order to customize learning for their specific disciplinary context and student goals within this co-evolving educational landscape. [6]

Digital textbooks are most effective and engaging when they are customized to the technology, course and students; interactive in exploiting the hypertextual, multimodal and communicative affordances of the platform; and usability tested with the students and teachers, revising as needed. [6]

Image 1: Digital Classroom

Many free videos are available online at specific sites, so incorporating videos does not have to be difficult and expensive. Probably the most famous YouTube site is a database of millions of educational videos that can be accessed, browsed and shared for free. Animations and video clips are also useful for studying the text itself and illustrating the essence. [7]

Infographics allow students to easily interpret adequate graphical representations, decomposing seemingly complex statistics and facts into acceptable elements, and those parts to remember. Interactive infographics, maps, and maps engage students directly in content, helping them stay interested while still retaining and remembering more information at the same time. [7]

Active learning is certainly more effective than passive and certainly recommended as much as possible. Quizzes can further reinforce knowledge with correct answers and build confidence in students, highlighting problem areas that require more examination. Evaluations can also mimic real-life scenarios, encouraging students to actively solve problems and demonstrate mastery of the subject matter. [7]

The implementation of the play elements in a teaching is known in pedagogical practice. There are options to encourage different tools to motivate, which is made easier by the use of IT today.

One of the easiest ways to add interactivity to a digital textbook is to insert links. Today's students are used to searching for and viewing information online. There is a wealth of valuable information readily available on the web, by sharing relevant and current links within learning materials. [7]

Digital textbooks can also make up for the lack of some teaching tool (such as maps, lab work equipment). At home, the digital tutorial allows students to self-emphasize, tag, and enrich lessons with additional content, images, videos, audios and links. This encourages a significant creativity and exploratory spirit in students. They learn from digital textbooks with interactive 3D animations, educational videos, and through defined tasks (tests, tests). Most often, registration, registration and then activation of code for certain textbooks are required (access is time-limited). [3]

Through interactive tests and tutorials in the textbook, students can check how well they have mastered certain material (teaching topics/units), and by reviewing the relevant statistics, the teacher immediately gains insight into the extent to which each student has acquired certain content. [3]

Today there are quite a number of quality textbooks from different publishers. An example of a digital textbook view is presented in the image 2.

Image 2: Digital Textbook

Additional options for digital textbooks are: virtual transport students to the place under study, simplify complex subjects, bring alive concepts benefit from blended learning, stimulate curiosity, master subjects through storytelling, making homework more interesting

3. DIGITAL TEACHING PLATFORMS

Learning Management System (LMS) is the core of a successful digital learning environment. It can be compared to a content management system but is targeted toward digital education. [8]

The main objective of the LMS is typically to host and track online learning. Providing a virtual place where learners can access training resources, an LMS aims to make training accessible for remote learners and provide a central location for training. Additionally, they make learning more streamlined, organized, and cost-effective.

A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting, and delivery of educational courses, training programs, or learning and development programs. An LMS allows to manage content, record and measure learning, store learner data, and communicate with users. [8]

The LMS may be used to create professional structured course content. The teacher can add, text, images, tables, links and text formatting, interactive tests, slideshows etc. It can be created different types of users, such as teachers, students, parents, visitors and editors. It helps control which content a student can access, track studying progress and engage student with contact tools. Teachers can manage courses and modules, enrol students or set up self-enrolment, see reports on students and import students to their online classes. [8]

There are six major advantages of LMS: interoperability, accessibility, reusability, durability, maintenance ability and adaptability.

Classical LMS systems consist mainly of the following elements:

- course content
- administrative information, including timetables
- detailed course monitoring requirements, assessment methods and instructions
- supplementary parts with important information
- modules for registration and tracking of students with possible payment option
- basic educational material and sometimes complete material (in the case of distant learning contexts or complete distance education), which can be presented in various forms (text, audio/video material, etc.)
- additional resources, including appropriately materials and links to external contents. [9]

LMS is a suite of standardized learning components, designed to connect learning and existing information system within an organization or through a learning web portal (image 3).

Image 3: LMS

The software that forms the basis of the LMS manages the essential elements of teaching and records all the parameters needed to monitor the process. Based on these parameters, it is possible to monitor the progress of an individual student or group at any time, and to measure and analyse the individual's performance at the end of the education process. There are a growing number of LMS

solutions in the world that differ greatly in quality, capabilities and some specific characteristics. [9]

Textbooks on learning platforms are comprised of resources that are the base of a printed textbook and upgrades in the form of layers with specific digital content. Images and snippets of texts can be separated and used, layers of multimedia and interactive content can be used, independently created and shared. The textbook thus becomes the curriculum foundation on which we use appropriate content and tools. Teaching materials are usually available through the activation code in printed textbooks and will be disposed for purchase as separate digital editions upon completion of the experimental program (see image 4). [3]

Digital textbooks should include: questions and responses, monitoring students based on learning data, assessment, experimental learning and learning by doing, some functionalities of learning management system (LMS). [10]
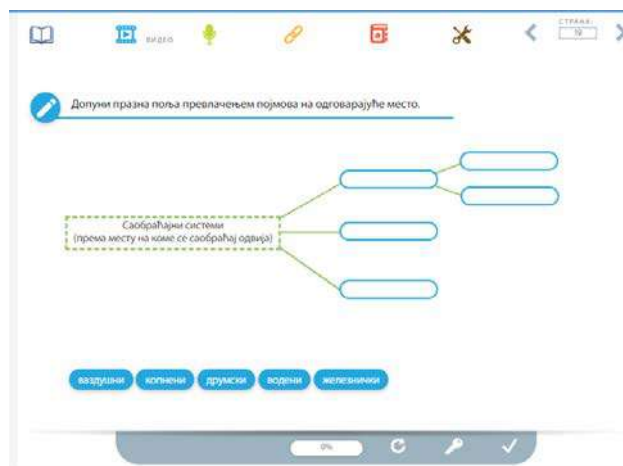
Image 4: Digital teaching platform

Currently there are several special, adaptable and developmental platforms for the use of digital textbooks in the teaching process. As the introduction of these textbooks is ongoing, improvements to existing software platforms, or the development of new ones, are expected soon. The cost for the complete process of implementing digital online textbook platforms in schools is not high and is strategically justified (expedient), as time goes by. There are certain similarities between these platforms, but most often each of them has its own specificities (manufacturer). [3]

Collaborative digital textbooks – comprehensive materials covering entire curriculums. They are developing from being books in pdf format to becoming collaborative digital environments, where teachers and students can communicate, engage in feedback and discussions, share and manipulate materials, test knowledge, and monitor results. [11]

Although not much time has passed, flexible, personalized and portable digital textbooks are evolving rapidly and are becoming used by today's students. Textbooks on learning platforms are comprised of resources that are the base of a printed textbook and upgrades in the form of layers with specific digital content. Images and snippets of texts can be separated and used, and layers of multimedia and interactive content can

be used, independently created and shared. The textbook thus becomes the curriculum foundation on which we use appropriate content and tools. Teaching materials are usually available through the activation code available in printed textbooks and will be available for purchase as separate digital editions upon completion of the experimental program. [3]

4. CONCLUSION

Digital textbooks are teaching tools for a modern education. They have only recently been used in a teaching (schools). The first researches have shown that digital textbooks are a significant resource for the progress and future of modern teaching.

The introduction of software learning platforms is a process that requires significant funds, but in the long run they are more than dedicated and justified.

Digital textbooks have features that set them apart and put them at a higher educational level than the classic ones. They are affordable, easy to use, portable and not expensive. Then they have rich and functional content, such as: interactive 3D animations, recorded tours, virtual walks, photo galleries, videos, audios. All this greatly facilitates the work of teachers, who now have the opportunity to cover teaching topics using these modern digital technologies. They develop different skills in students, stimulate immeasurably important creativity, curiosity and a research spirit for further education and later work.

Digital software platforms are innovative solutions in the field of IT and represent repositories (bases) for display and analysis of created functional teaching materials. There are currently several such systems, usually purchased or rented by publishers, and are now available to use and display relevant educational topics.

Learning Management Systems (LMS) are comprehensive and helpful tools for the provision and distribution of different electronic materials to students and usually contain numerous other features, such as test, analytics and controlling.

With digital textbooks, assessment is facilitated by the simple application of evaluation resources, that is, control exercises, tests and tasks tailored to each student. Through the created and accessible statistical analysis, it is easy to track the work of individual student, as well as the entire department/class.

Digital textbooks, as integral teaching tool, will provide students with more advanced study options, more thorough insight, and a deeper connection to the course material. This ensures that the defined goals and objectives of the teaching are more effectively achieved. The essence of using this IT resource for learning is to optimally meet educational standards and satisfied learning outcomes.

By using digital textbooks in classrooms, teachers can leverage digital technology to make learning more obviously, fun, interesting and more aligned to modern education psychology and practices. Those textbooks also promote self-paced learning, allowing learners to explore various digital interactive tools to satisfy their curiosity for acquisition more knowledge.

These digital teaching tools also allow students to learn by doing and thus prepare them for the changeable circumstances in education and workplace, which are constantly in evolving phases. Digital textbooks are constantly being upgraded with certain new functionalities and in the future, they will be an increasingly, powerful teaching tools.

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FACEBOOK AS A FREE AND MODERN TEACHING TOOL

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Abstract: *This work describes the use of the social networking site, Facebook, as a free and modern teaching tool that can be accessible and visible to everyone. In addition to being ideal for sending tasks, lessons and other educational material, Facebook allows you to post and promote the work of an educational institution. All relevant information is presented on Facebook and not only to students, but also to parents and the general community. Marketing is imperative to lead a modern life nowadays, and Facebook , with more than 1.5 billion users, is an exceptional tool for its realization.*

Keywords: E-Learning, Distance learning, online

1. INTRODUCTION

As we all know, Facebook is a free and modern online platform used mostly as a social networking site. But, it can also be a teaching tool that can be accessible and visible to everyone. In addition to being ideal for sending tasks, lessons and other educational material to students, it can also be used to generate visibility and popularity on certain school-related issues, events, and successes.

2. THE USE OF FACEBOOK IN TEACHING MATHEMATICS

During the school year 2017/2018 and 2018/2019, a Math teacher, Mrs. Marija Milovanovic, used a social networking site – Facebook as a helping tool for teaching Mathematics. This new form of work included 26 elementary school students. A special group was formed on Facebook to practice Mathematics. Mrs. Milovanovic, the administrator of the FB teaching group, has devoted much of her free time to the working of the group.
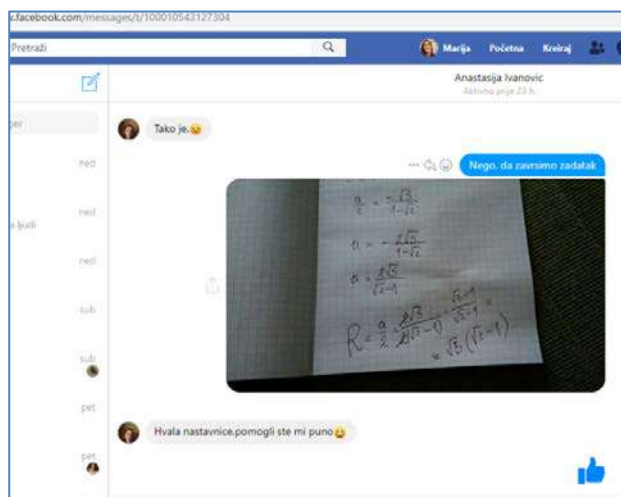
Image 1: Math task

She was active in the afternoons, evenings, during holidays and school breaks. Within the group, students were trying to solve tasks for preparation of written assignments, tests and the Final Exam (a high school entrance exam, divided into 3 parts, one of them is just Maths).
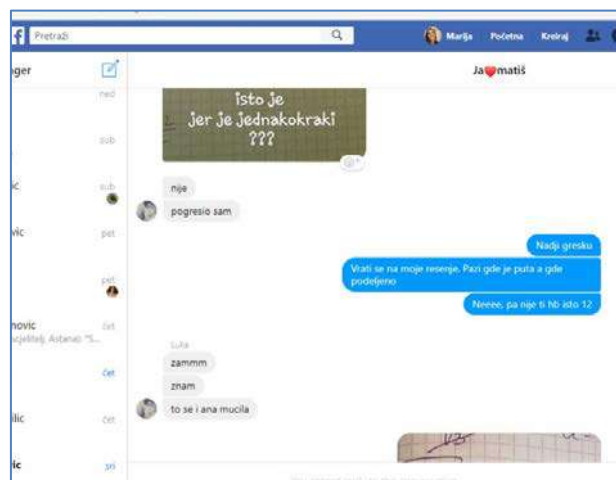
Image 2: Discussion

Questions were being asked, some doubts were resolved, and some discussions were conducted on mathematical problems. Over time, the Facebook Math project has yielded better and better results. It was more interesting to do assignments online, within the group, so the students practiced Mathematics more regularly, and, of course, the Math grades were getting better.

At the end of 2018/2019 school year. students took the final math exam and achieved good results.
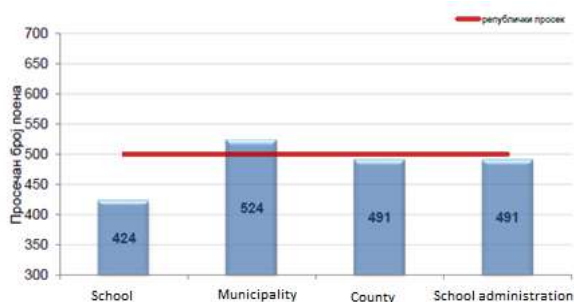
Image 3: The results of Math Final Exam 2017/2018
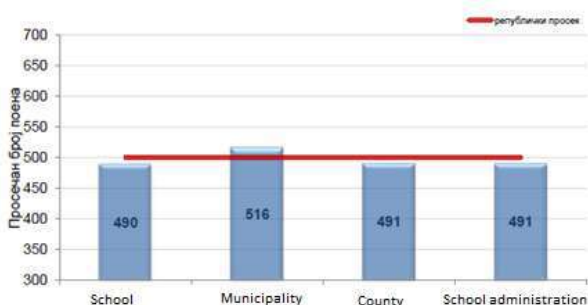
Image 4: The results of Math Final Exam 2018/2019, 15% higher than the year before

3. THE USE OF FACEBOOK IN TEACHING TECHNIQUE AND TECHNOLOGY, AND INFORMATICS AND COMPUTER SCIENCE

A Facebook account was made for teaching Technique and technology, and Informatics and computer science in January 2013, and since then, it has been actively used for following purposes:

3.1.Educational

a) homework assignments, flipped classroom

b) test preparations and mock tests

c) competition training

d) Final Exam and High School Enrollment

3.2.Informative

3.1.EDUCATIONAL PURPOSES

The original idea was to bring the teaching content closer to the students and facilitate the acquisition of new concepts in the field of Technique and technology. It started with the realization that students spend a lot of time in front of their computers and on their Facebook accounts, i.e. online, and that this place is an actual place where they need to be joined and supported in their learning.

a) Homework was given, material was presented to be watched at home and come back to school with new knowledge ready for discussion, practice or practical work. It was done on the principle of "flipped classroom".
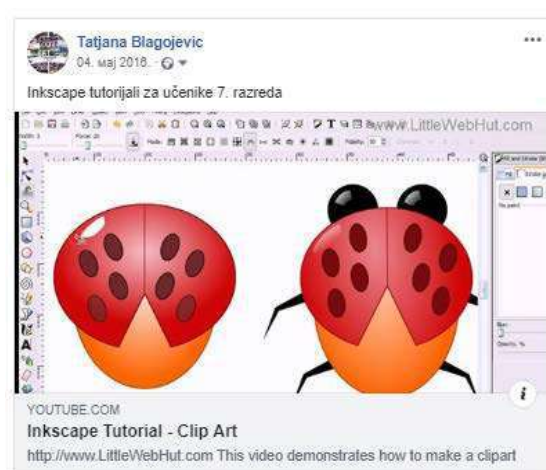
Image 5: Homework

b) Then the story was expanded onto test preparations and mock tests. In the absence of a textbook, question pool (questions database) was uploaded on the Facebook account, and as such, it was used to prepare for the upcoming tests. Not all students have all the textbooks, but, they all have Facebook accounts.
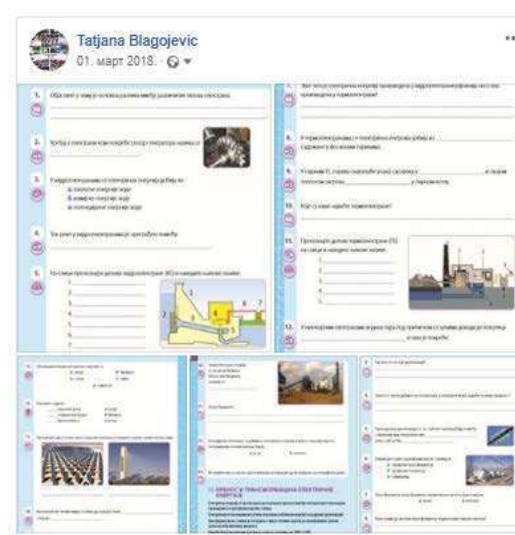

Image 6: Questions database

c) Competition trainings are done from the beginning of the school year, but, just before the competitions start, there is a school winter break. Immediately at the beginning of the second semester, upon arrival at school, competitions begin and students are left without final preparations due to their absence. To overcome this, a Facebook group was formed in order to train students for competitions in Informatics and computer science. In school year 2016/2017, three students of our school were placed on the national level of the International Competition in Information and Computer Literacy "Beaver" ("Dabar"). Preparations for the competition continued during the winter break by sending assignments and communicating through the group. The result was good again. All three students achieved excellent results and won bronze medals.

Then, in 2017/2018, during the school break, the team for the Battle for knowledge ("Bitka za znanje") competition was trained. Two students, Milica Jankovic and Jovana Jovanovic, devoted their free time to programming robots and robotics. Yet again, the result was not missing. First, they were placed in the national competition and then won the maximum number of points at the national level. Continuous work with the help of Facebook has yielded excellent results.
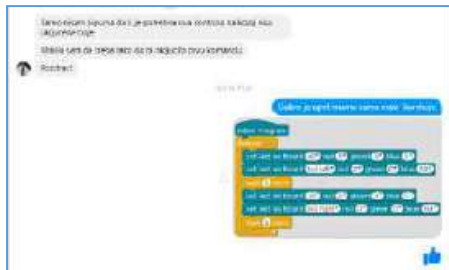
Image 7: An assignment example

d) One of the most important and stressful periods in the life of every elementary student and their parents is the Final Exam and High School Enrolment. In addition to the extraordinary commitment of the class teachers, the Facebook account also played a significant role. All information, notices and instructions were available in a timely manner and were available 24/7 online. To support when it matters the most – that was and still is the goal.
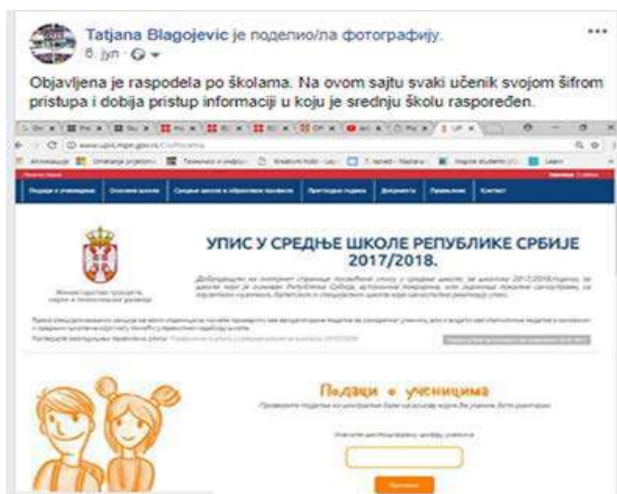
Image 8: An announcement on High School Enrolment

3.2.INFORMATIVE PURPOSES

At a time when everyone is on Facebook, not only the students but also the parents and the local community, it is very important to reflect on school happenings and work results. Any information on student success should be shared.

Image 9: Battle for knowledge

Image 10: Robot plays Waltz

In addition, enhancing the environmental awareness of students and parents through the contributions that have been shared and published online – also proved to be helpful.

Image 11: Environmental awareness

5. CONCLUSION

The ultimate conclusion is that the Facebook account created for educational purposes has achieved much more than was expected, and contributed to various teaching curricular and extracurricular activities.

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A CYCLE OF COMPUTATIONAL THINKING AND ITS RELEVANCE: AN EMPIRICAL STUDY

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Abstract: To solve problems with technology, apart from disciplinary reasoning, learners need to apply computational thinking (CT). In this contribution we will first describe a learning cycle whose stages capture core CT activities. Then we will examine the relevance of this cycle to different subject areas and distinctive learning tasks commonly given in these subject areas. To this end, we refer to an empirical study undertaken and summarize its main outcomes. This study evidenced that the CT cycle is not only relevant to the subject area of computer science-informatics and its commonly given task of programming. Suggestions for research and practice are included.

Keywords: Computational thinking, Empirical study, Learning cycle

1. INTRODUCTION

To solve problems with technology, apart from disciplinary reasoning, learners have to apply a distinctive way of computation-based reasoning called computational thinking (CT). This is viewed as a fundamental personal ability like reading, writing, and arithmetic [1], especially in the life and work context of the 21st century, which is highly influenced by technology use. This ability enables a person to recognize aspects of computations in various problem situations, and to deal with those aspects by applying tools and techniques from computer science [2]. CT has often been cultivated through programming (e.g., [3]), but CT is more than programming [4]. Although a widely accepted definition of CT is lacking [5], there are still common CT components in various CT definitions, such as decomposition, abstraction, and algorithms [6]. In the rest of this contribution we will first describe a learning cycle whose stages capture core CT activities. Then we will examine the relevance of this cycle to different subject areas and distinctive learning tasks commonly given in these areas. In doing this, we refer to an emprical study undertaken and summarize its main outcomes. The contribution ends with suggestions for research and practice.

2. CT CYCLE

It has been assumed that CT uses four steps to solve problems, namely: (1) decomposition, (2) patterns, (3) abstraction, and (4) algorithms (for them, see https://studio.code.org/unplugged/unplug2.pdf). Bearing in mind that CT deals with solutions in representations that could be efficiently processed by information-processing agents [1], and that these agents are mostly computers nowadays, a CT cycle may comprise the following four stages: decomposition, abstraction, algorithmization, and automation. As presented in Figure 1, these stages may be advanced in a complex, nonlinear way, meaning that in practicing CT, learners may often go back and forth between (not only neighboring) stages. This cycle and its

application in simple spreadsheet modeling were presented at a previous *e-Learning* conference [7]. The relevance of this cycle may, for example, be supported by a CT model that assumes the following core CT facets: abstraction (data preparation and analysis, pattern recognition, modelling), decomposition, algorithms (algorithm design, parallelism, efficiency, automation), iteration, debugging, and generalization [6].
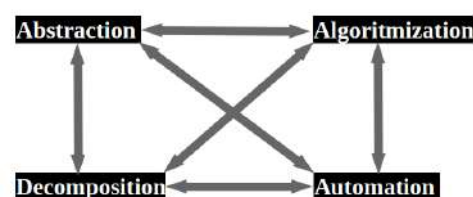

Figure 1. CT cycle

3. RELEVANCE OF CT CYCLE

To examine the relevance of the CT cycle presented in Figure 1, the author of this paper undertook an empirical study, whose subjects were participants at the *e-Learning* 2018 conference who had followed his presentation about this learning cycle. Data was collected by using a short questionnaire, which was administered at the end of the presentation. The questionnaire comprised questions regarding a few background variables (e.g., occupation, gender, working experience), the relevance of this cycle to different subject areas, and the relevance of the cycle to distinctive learning tasks commonly given in these subject areas. The content of this questionnaire is given in Figure 2.

Most attendants at the presentation completed the questionnaire, which resulted in a 24-subject sample. Ten subjects were teachers, four were both teachers and researchers, one was researcher, and nine indicated other occupations (e.g., e-learning developer). Most subjects were females. The subjects' work experience ranged from 3 to 45 years, whereas their experience in studying or practicing computational thinking was mostly less than 15 hours.

Before statistical analyses were applied, the subjects' responses to each question regarding the relevance of the CT cycle, which were initially represented by corresponding numbers 1–5, were transformed into Guttman's image form scores [8]. For each question, this transformation resulted in a more precise and interval measurement of each of its three indicators. Because the reliability (Cronbach's alpha) of each variable (taken as the mean of respective indicators) was greater than 0.90, and the correlation of it with each indicator was greater than 0.90, the reliability of each indicator was greater than 0.85 (the formula for correction for attenuation [9] was applied). The author has used this transformation in a number of his earlier studies (see [10, 11]).

Regarding the relevance of the CT cycle to three different subject areas, it was found that for each area, the average transformed score was greater than 4 (i.e. "cycle is found Relevant"), and that the cycle was the most relevant to the area of computer science-informatics (4.64 *vs*. 4.34 for mathematics and 4.11 for science). Regarding the relevance of the CT cycle to three distinctive learning tasks commonly given in these subject areas, it was found that for each learning task, the average transformed score was greater than 4 (i.e. "cycle is found Relevant"), and that the cycle was the most relevant to the task of programming (4.54 *vs*. 4.25 for data visualization and 4.12 for spreadsheet modeling). Except for 4.25 *vs*. 4.12, other differences were statistically significant.

Short Computational Thinking (CT) Survey

Occupation: A) Teacher   B) Researcher   C) Other _____

Gender: A) Female   B) Male

Working experience (in years): _____

Do you have any experience in studying or practicing computational thinking (CT)?   A) Yes (about _____ hours in total)   B) No

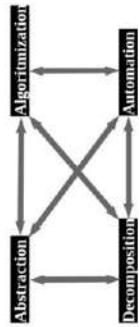1. Please indicate the relevance of CT to the learning of the following disciplines in upper secondary education

Relevance \ Discipline	Totally irrelevant	Not relevant	Neutral	Relevant	Very relevant
• Mathematics	1	2	3	4	5
• Computer science (Informatics)	1	2	3	4	5
• Science	1	2	3	4	5

2. Please indicate the relevance of the CT cycle below (left) to solving the following tasks in upper secondary education:

Relevance \ Task	Totally irrelevant	Not relevant	Neutral	Relevant	Very relevant
• Data visualization	1	2	3	4	5
• Spreadsheet modeling	1	2	3	4	5
• Programming	1	2	3	4	5

Algorithmization — Automation — Abstraction — Decomposition

Figure 2. Questionnaire administered

These outcomes were not surprising. CT has often been connected to computer science, especially programming. CT was introduced by Papert in 1980 to denote specific thinking children applied in learning mathematics through LOGO programming [12], but, since then, CT has mostly been taken over by computer science specialists, who have carried out many studies that link CT and computer science topics, frequently programming (e.g., [13]). Although coming from different disciplines, the subjects of this study had a common interest in e-learning, which is heavily dependent on the applications of tools and techniques from computer science, frequently involving programming whenever an e-learning system is under development or improvement.

4. CLOSING REMARKS

CT is not only a critical component of computer science or informatics education [14], but also a critical component of problem solving supported by technology in any discipline [6], highly relevant to compulsory education [15, 16]. To cultivate CT, we may practice it within a suitable CT cycle, such as one whose stages are decomposition, abstraction, algorithmization, and automation. An empirical study reported in this paper evidenced that despite supporting the highest relevance of this cycle to the subject area of computer science-informatics and its task of programming, this cycle is not only relevant to different subject areas, such as mathematics and science, but also relevant to distinctive learning tasks commonly given in these subject areas, such as data visualization and spreadsheet modeling. To make the CT cycle more specific, research may focus on the components of these stages and their relations under the influence of the subject area chosen and the learning task considered. The contribution of the automation used to these stages and components should also be taken into account. To support students in applying the CT cycle, educators need to support them in practicing its stages (e.g., abstraction, automation) and their components (e.g., identification of entities in abstraction; debugging in automation) and relating them [17].

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