



BELGRADE
METROPOLITAN
UNIVERSITY

eLearning

7th Conference on e-Learning **2016**

29-30 September 2016

www.econference.metropolitan.ac.rs

PROCEEDINGS

The Seventh International Conference on e-Learning



Belgrade Metropolitan University

Belgrade, 29-30 September 2016.

www.metropolitan.ac.rs

Publisher

Belgrade Metropolitan University
Tadeuša Košćuška 63, Belgrade, Serbia
<http://www.metropolitan.ac.rs>

Printing

Kruševac: Sigraf

For Publisher

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Language

The official language of the eLearning-2016 Conference is English. English will be used for all printed materials, presentations and discussion.

E-ASSESSMENT WITH OPEN BADGES

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Abstract: This paper focuses on using Open Badges in e-assessment. Open Badges have evolved as a novel means of assessing, recognizing, and credentialing skills, competences, knowledge, and achievements in various learning settings (formal or informal, online or traditional classroom). Viewed as e-assessment systems, Open Badges systems can be used to support assessment and recognition of a variety of skills, including both hard and soft skills. A case study presented in this paper illustrates all the necessary strategies, design decisions, and practical steps in assessing hard and soft skills with Open Badges.

Keywords: E-Assessment, Open Badges, learning recognition

1. INTRODUCTION

In e-assessment, information technology and different software applications are used to support assessment processes. These processes include testing, test generation, assessment of cognitive and practical abilities, assessment of practical abilities, achievements, accomplishments, etc. [1].

If an e-assessment software application is designed as an e-testing system, it typically has two components: an assessment engine, and a database of assessment items/questions themselves that the engine uses generate a test.

If, on the other hand, an e-assessment system is designed to support more sophisticated forms of assessment, it typically supports some sort of interactive activity, enables students to reason and solve problems around that activity, and includes means of estimating students' understanding of the particular domain.

When used as e-assessment systems, Open Badges systems belong to the latter of the two kinds of e-assessment. Open Badges, <http://openbadges.org/>, are a widely used form of digital badges. A *digital badge* is a validated indicator of accomplishment, skill, quality or interest that can be earned in various learning environments [2]. In other words, it is an online representation of one's skill, knowledge, or achievement, such as those shown in Fig.1.

Open Badges (OBs), take that concept one step further, and allow learners to verify their skills, interests and achievements through credible organizations. "An OB attaches that information to the badge image file, hard-coding the metadata for future access and review. Because the system is based on an open standard, earners can combine multiple badges from different issuers to tell the complete story of their achievements — both online and off. Badges can be displayed wherever earners want them on the Web, and share them for employment, education or lifelong learning" [3].



Figure 1: Digital badges awarded to learners for their accomplishments in learning by means of various digital assets available at the Smithsonian's museum (figure taken from: <http://naskun.dvrlists.com/smithsonian-insider-smithsonian-insider.html>)

OBs greatly contribute to the general trend of open education by enforcing an open approach to recognition of learning achievements, by providing open evidence of learning accomplishments, by open criteria for credentialing learning no matter where, when, and how it happens, by being based on an open technical standard and free software, as well as by enabling open displaying and sharing of one's achievements [4]. The practical meaning of these open features is that OBs are "clickable at several points", Fig.2. One can click the badge issuer link to find out more about the authority who has issued the badge, or can find out more about the criteria used to issue the badge to the earner. Most importantly, one can also click the evidence link to see a digital evidence of the achievement.

2. THE GRASS PROJECT

OBs have entered The University of Belgrade as a means of supporting e-assessment through the GRASS project (<http://grass.fon.bg.ac.rs>). GRASS stands for GRAding

Soft Skills. It is a 3-year European project, coordinated by The University of Belgrade, being developed with the support of the Lifelong Learning Programme (LLP) of the European Commission. Eight educational institutions from four different European countries focus on how OBs can be used as means of grading learners' achievements in developing and demonstrating their soft skills (such as effective communication, collaboration, leadership, problem solving, and the like). The partner institutions come from different educational levels (secondary, upper secondary, and higher education) and their students' age spans from 12 to 26.

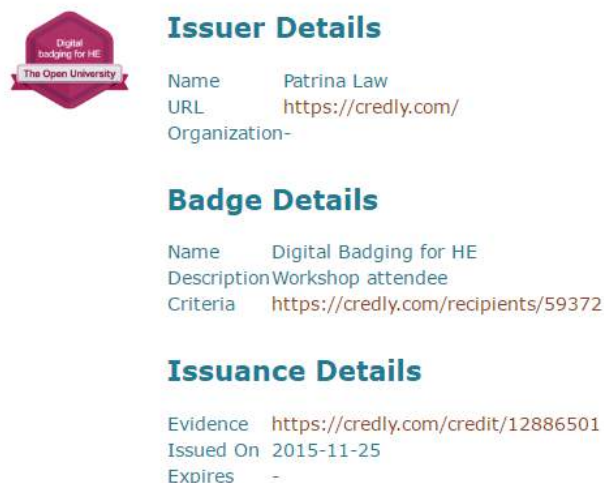


Figure 2: An Open Badge

Most researchers and teachers from these institutions do not explicitly teach soft skills to their students as specific courses. They typically explain the importance of soft skills and incite students to develop some of these skills as a side effect of regular courses. A set of a few dozens of soft skills (problem solving, emotional awareness, visual communication, summation, self-regulation, assertive behavior, creativity, critical thinking, communication, collaboration, etc.) is covered in the project activities, each partner institution typically focusing on a subset of 5-6 soft skills in the courses they teach. In about a dozen of application cases (ACs), the project partners award their students OBs for development and demonstration of different soft skills.

All project results are reported at the project Website (<https://sites.google.com/site/llpgrassproject/results>) and are already available for use by any interested institution or individual. They include:

- the GRASS pedagogical rubrics (links and interdependence between the critical elements that could influence learning activities and ultimately the development of soft skills), https://docs.google.com/spreadsheets/d/14Nk9OEw1UCg0s_RCctVQIXrTfPW7w-IFQGvdwVqeOm8/edit#gid=809795435
- various didactic materials
- a number of video tutorials for teachers, available through the project YouTube channel
- detailed descriptions of all project applications (ACs)
- detailed presentations and Websites of the Open Badge awarding platforms used by the partner institutions in different ACs

All of these products/results are already disseminated in more than a dozen of publications in international academic journals and conferences, the most comprehensive one to date being [5]; for other most important publications, see <https://sites.google.com/site/llpgrassproject/publications>). The project also maintains intensive contacts and exchanges experiences with other relevant European projects, networks and communities (see <https://sites.google.com/site/llpgrassproject/links>).

3. E-ASSESSMENT WITH OPEN BADGES – A CASE STUDY FROM THE GRASS PROJECT

The importance of soft skills in all educational and work settings is growing rapidly. However, such skills are easy to notice, but hard to measure. Defining metrics for soft skills, collecting measurements, and setting up the reference frameworks and measurement environments is extremely challenging – how can one, for instance, objectively measure and score a student's critical thinking?

In practice, metrics do exist (e.g., [6], [7]), but vary from one case to another, and are often rather implicit and vague. Contrary to that, the GRASS project use precisely specified, measurable factors, criteria, or functions to assess each soft skill. Although these GRASS metrics are not as general as those proposed in [6] and [7], they still have the advantages of being based on carefully developed GRASS pedagogical rubrics, being tested in the GRASS ACs, and being easy to reuse in practice with slight modification. In addition, GRASS has developed:

- a related new model and ICT framework for measuring, assessing, benchmarking, and evaluating learners' soft skills used in their activities, and generating appropriate feedback
- related sets of OBs (one per AC) for acknowledging, grading, awarding and recognizing learners' achievements in developing their soft skills, clearly reflecting their different education levels

SAGRADA model

The GRASS project team has developed the SAGRADA model that identifies a cyclic nature of development, measurement/assessment, displaying and recognizing students' soft skills by OBs, Fig.3. SAGRADA stands for SAMpling, GRAding, Displaying and Acknowledging. Using OB platforms and other ICT tools and services, students can submit digital artefacts representing their individual and/or work (sampling). These artefacts very often include traces of students' soft skills, and the teachers (as well as peer learners) can recommend awarding appropriate OBs for these skills (grading). Badge earners can then display the OBs they have earned on their Webpages or social network profiles (displaying),

and employers and other stakeholders can click them and check the evidence of the accomplishments that led to the award of badges (acknowledging).

GRASS metrics

In GRASS, the development of soft skills is measured differently in each specific AC (i.e., in a specific course in a partner institution). To this end, the project has developed rich, AC-specific, structured sets of soft skill metrics to serve as dynamic indicators of the learners' ability to apply, develop and improve their soft skills in

different ACs. These sets are all available online from the project results page for each specific AC (<https://sites.google.com/site/llpgrassproject/results>). They are based on well-known pedagogical approaches, such as constructivist alignment [8] and the cyclical model of experiential learning [9]. Starting from these approaches, each partner institution has elaborated a set of metrics to suit their specific learning settings. These sets of metrics look like the one shown in Table 1.

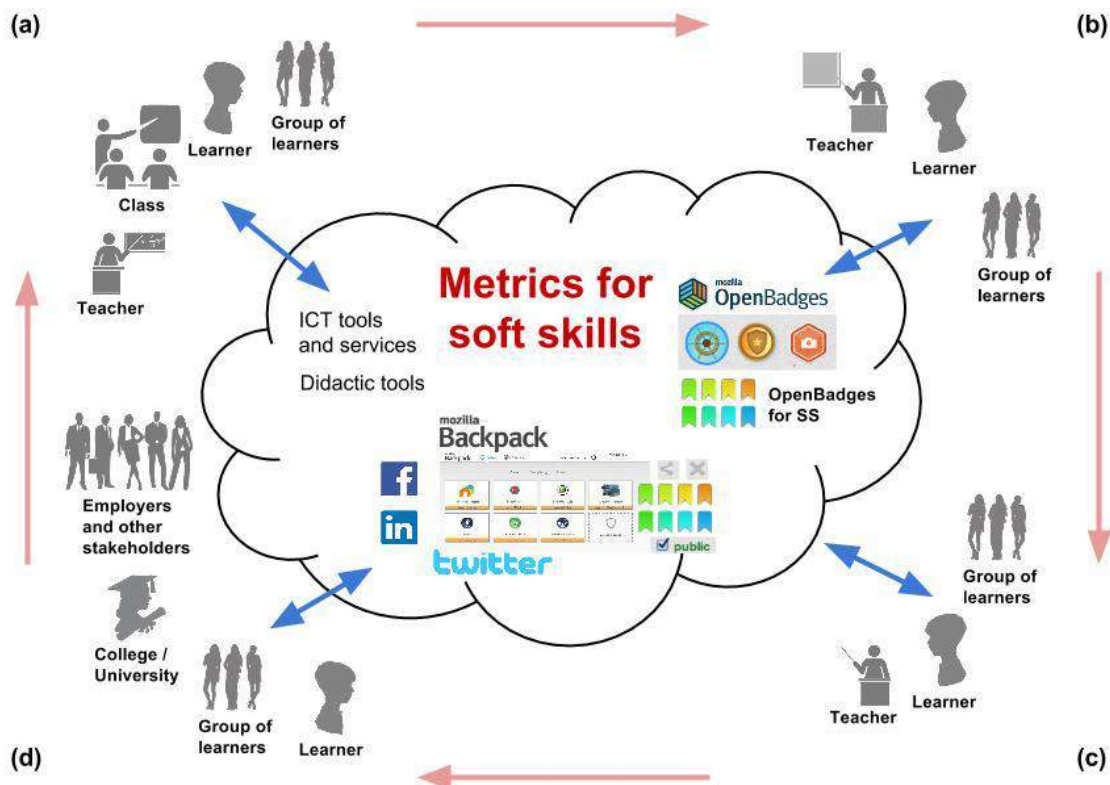


Figure 3: SAGRAD model (a) Sampling (observing, measuring) soft skills (b) Grading (assessing, awarding) soft skills (c) Displaying (sharing) soft skills (d) Acknowledging (recognizing, credentialing) soft skills

Table 1: Examples of soft skill metrics used in the UB application case. Soft skill: collaboration. See <https://sites.google.com/site/llpgrassproject/results> for all metrics.

Soft skill	Soft skill Quality/Criteria	Key indicator	Performance measure	Performance standard
Collaboration	Collaboration effort - behavior during 1.5-hour labs	Student displays collaborative behavior during labs	Live observation by tutor/peer (team member) during the labs	Tutor/peers notice that student engages in collaborative activities (Likert scale: No collaboration - Low Collaboration - Average Collaboration - High Collaboration Threshold ¹ : Average Collaboration)
Collaboration	Collaboration effort - code (evidence) being produced	Student produces significant code improvements ²	Code review - number of non-empty lines of code (per team member)	Student produces a significant number of non-empty lines of code (Scale: Less than 20 lines - 20-25 lines - 26-30 lines - more than 30 lines Threshold ¹ : 26 lines)

¹ With that metric value (or higher), the student is a candidate for a badge in the corresponding achievement category.

For example, The University of Belgrade (UB) as a partner in GRASS has developed its AC for badging development of soft skills of entry-to-mid level Java programmers (BSc and MSc students learning Java in different courses taught at UB). Experienced teachers have identified a set of soft skills important for such programmers (collaboration, skilled communication, real-world problem solving, innovation, enthusiasm, initiative, critical thinking). For each soft skill in the set, the teachers have specified: a corresponding importance statement (e.g., for collaboration: "Most programming and software engineering nowadays is conducted in small teams..."); the pedagogical approach to incite, monitor and measure the skill development (for collaboration: the programming problem(s) that students work on in small teams, the role of the tutor, the roles of the peers, the level of contribution, and so on); and the context of the skill development (lab, assignment, presentation, etc.). Based on this, the teachers have defined several specific metrics for each soft skill. Descriptions of the metrics currently used in the UB application case are available online from the project results page, and an excerpt of these descriptions is shown in Table 1. The first row of the table exemplifies a metric that is derived from the tutor's online journal of students' collaborative activities, while the second row illustrates a metric that is based on the data collected from logfiles and students' submissions when working with specific ICT tools (e.g., programming code commits to code repositories).

The assessment process

In the AC implemented at The University of Belgrade, students work on simple programming problems and are guided by the teachers/tutors. They also get programming assignments to complete out of the regular classes. Parts of the assignments always include incentives to demonstrate one or more soft skills. If, for example, the point is to develop collaboration as an important soft skill, they get group assignments – a group of 3-4 students is assigned a collaborative project. When they are ready, they can submit their project through a dedicated BadgeOS badging platform called JGRASS, <http://jgrass.fon.bg.ac.rs/>. BadgeOS (<http://badgeos.org/>) is a WordPress-based software that enables users to design, develop, and organize badging process on their WordPress-powered Website (such as JGRASS).

Fig.4 shows a page from the JGRASS Website. It includes 2 badges (out of a dozen) that students can earn in this AC for their Java programming skills. For example, if they demonstrate a good command of the Git software versioning system, they can earn the *GIT Apprentice* badge. Similarly, if they demonstrate that they have mastered JUnit testing, they can earn the *JUnit Tester* badge. To apply for a badge, a student has to log in to JGRASS, complete the related programming assignment created by the teacher/tutor, and submit the program to the GitHub repository (<https://github.com/>) for review, Fig.5.

Advanced Java Programming Tools and Techniques

Optional Course

HOME

TOPICS

BADGES

MY PORTFOLIO

CONTACT

Badges

This is the list of badges that are available for earning:



GIT Apprentice

GIT Apprentice is capable of using basic Git commands when working on a programming task. They are capable of collaboratively working with other developers on the same project that is kept on a dedicated online server (e.g. [Github](#)).



JUnit Tester

JUnit is a unit testing framework for the Java programming language. A unit test is a piece of code written by a developer that executes a specific functionality in the code to be tested. A unit test targets a small unit of code, e.g., a method or a class, and they ensure that code works as intended. JUnit has been important in the development of test-driven style of programming.

This is a website for The Advanced Course of the Principles of Programming for students at the Faculty of Organizational Sciences, University of Belgrade. The purpose of this course is to teach second year students advanced topics of programming in Java. All necessary materials and tasks can be found on this website. By completing tasks, students can achieve an appropriate badge for the specific topic.

Login here

Username:

Password:

☐ Remember me

Login

[Lost your password?](#)

Figure 4: Some of the badges that students can earn from the JGRASS Website

GIT Apprentice

By Nikola Milić | March 16, 2015 0 Comment

GIT Apprentice is capable of using basic Git commands when working on a programming task. They are capable of collaboratively working with other developers on the same project that is kept on a dedicated online server (e.g. [Github](#)).

Create a New Submission

Submit

Category: Edit

JUnit Tester →

This is a website for The Advanced Course of the Principles of Programming for students at the Faculty of Organizational Sciences, University of Belgrade. The purpose of this course is to teach second year students advanced topics of programming in Java. All necessary materials and tasks can be found on this website. By completing tasks, students can achieve an appropriate badge for the specific topic.

Recent Posts

Collections task closed June 15, 2015

JSON task closed May 31, 2016

Collections task is open May 29, 2016

My Achievements

Three-tier Designer

Figure 4: Applying for a badge on the JGRASS Website

More specifically, through the Create a New Submission box (see the lower part of Fig.5), the student submits a link to their project (Java program) stored in the GitHub software repository. The teacher(s)/tutor(s) responsible for assessing their project and the level of mastery of the related Java skill reviews the project and can award the related badge to the student.

If a student is awarded a badge, he/she gets an email notification of the achievement and can accept or discard the badge awarded. If the student accepts it, the badge is automatically stored on the Credly badge displayer platform (<https://credly.com/>), from which he/she can easily share it on his/her LinkedIn profile, on Facebook, on Twitter, or on another relevant Web page, Fig.5. This is typically very important – when seen, e.g., on LinkedIn, the badge can be clicked for evidence (the View evidence link in Fig.5), which takes the viewer to the digital evidence of the achievement (in this case, the Java program developed to demonstrate the mastery of Git). This can be essential for recruiting job candidates. As with all OBs, the digital evidence is an unambiguous testimony of one's demonstrated skill, knowledge and effort. If, in addition, the badge is awarded by a trusted issuer (the upper left corner in Fig.5), it can be a great advantage for the job candidate.

If during the work on an assignment the students have demonstrated not only their hard programming skills, but also some soft skills, they can be awarded some of the GRASS badges for soft skills. For example, working on a group assignment and demonstrating good collaboration, they can earn one of the GRASS collaboration badges – the *Collaborator BRONZE*, *Collaborator GOLD*, and *Communicator SILVER* and *Communicator GOLD* badges. There are also *Problem Solver BRONZE*, *Problem Solver SILVER*, and *Problem Solver GOLD* (for skilful problem solving abilities), and *Enthusiast SILVER* and *Enthusiast GOLD* awarded for recognizing enthusiasm of student programmers.

Obviously, GRASS soft skills badges acknowledge different "levels" in demonstrating soft skills. For example:

- *Collaborator BRONZE* badge (shared responsibility) is awarded if code commits come from all team members and contain significant code improvements (empty commits or commits that fix typos don't count)
- *Collaborator SILVER* badge is awarded if code commits clearly identify that certain tasks were done by certain people (evidence of decisions made regarding roles/responsibilities for each team member) and that roles/responsibilities were divided among the team members
- *Collaborator GOLD* badge is awarded if code commits clearly identify that all team members' work is interdependent and that it is equally divided

The teachers/tutors evaluate the students' soft skills in two ways. For example, when it comes to collaboration when working on the project, the teachers/tutors observe their activities when they work in the lab, but also use data and figures collected automatically by the GitInspector tool (<https://github.com/ejwa/gitinspector>), Fig.6. Both the live observations and the GitInspector data are used when judging how intensive their collaboration was. The indicators from the GitInspector tool visualize when, how often, and to what extent each team member has contributed to the Java program developed (how many times they have committed (uploaded) new program code to the repository, how often they have done so, how many times they have made changes to the existing program code, when they have done it, etc.). Thus the reviewers have a pretty good picture of how much has each team member really contributed to the project.

With all these indicators and observations, the reviewers consult the reference metrics table developed and evolved over time for this AC, and can decide to award (or not) a collaboration-related OB to the team members. There are three such badges in this AC:



Ana
received Credit!

Share on [f](#) [t](#) [in](#)

[Report abuse](#)

Here's what GRASS Project said:



Congratulations! You have earned the GIT Apprentice badge!

Badge Details

Title

GIT Apprentice

Description

GIT Apprentice is capable of using basic Git commands when working on a programming task. They are capable of collaboratively working with other developers on the same project that is kept on a dedicated online server (e.g. Github).

Issue Date

05/08/16

Evidence

[View evidence](#)

Issuer Details

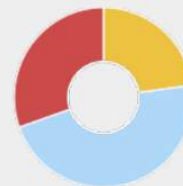
Issuer

GRASS Project

Figure 5: A student (Ana) has been awarded the *GIT Apprentice* badge

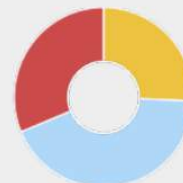
The following historical commit information, by author, was found in the repository.

Author v	Commits	Insertions	Deletions	% of changes
Student 4	10	1240	248	46.79
Student 5	6	814	152	30.38
Student 6	11	701	25	22.83



Below are the number of rows from each author that have survived and are still intact in the current revision.

Author v	Rows	% in comments
Student 4	990	23.64
Student 5	719	26.70
Student 6	589	4.07



The following history timeline has been gathered from the repository.

Author	2015W15	2015W19	2015W20
Student 6	<div></div>	<div></div>	<div></div>
Student 4	<div></div>	<div></div>	<div></div>
Student 5	<div></div>	<div></div>	<div></div>
Modified Rows:	108	888	2184

Figure 6: Indicators of collaboration generated by the GitInspector tool

4. EVALUATION AND LESSONS LEARNED

The course on Java programming implemented in this course was organized in the summer semesters of two consecutive academic years: 2014/2015 and 2015/2016.

The course is an extracurricular one (not for credits), but attracts good students with high GPAs. In the first year (2014/2015), 56 second-year BSc students attended the course; in the second year (2015/2016), 64 second-year BSc students attended.

In the final week of the course, in class, the attending students were asked to fill out a questionnaire and state

their opinion about OBs as a motivational mechanism, about soft skills, and about the course in general.

A subsequent analysis of the students' responses has revealed the following:

- Students generally like the idea of e-assessment with OBs and like getting OBs for their achievements. It indicates that OBs in e-assessment can be an interesting alternative to traditional test scoring. Still, creative work on real-world problems is a prerequisite for using OBs in e-assessment successfully.
- However, students do not perceive OBs as a crucial motivational mechanism for completing their assignments. This is in line with [4], where it has been discussed that OBs in assessment do not work as badges in gaming.
- Not all students understand the value of displaying the OBs earned in public; although most of them have displayed their OBs on Credly, not all of those have shared them on LinkedIn. This calls for a more thorough explanation of the benefits of OBs in the beginning of each course.

There are many more details related to this analysis. They are all publicly available in [10] and [11].

5. STEPS IN ORGANIZING E-ASSESSMENT WITH OPEN BADGES

In summary, if a teacher wants to organize e-assessment using OBs, she/he should make some strategic decisions first. These decisions have been made in GRASS starting from adaptations of the steps proposed in [12]:

- step 1: inform stakeholders about the importance of OBs
- step 2: explain all students the achievement standards and expectations
- step 3: identify partners to support e-assessment with OBs
- step 4: decide how students will participate in e-assessments with OBs (individually, collaboratively, as peer assessors, and the like)
- step 5: when possible, integrate performance observations with automatically collected data
- step 6: use a variety of e-assessment approaches; for instance, OBs can accumulate in formative assessment in a variety of ways and help decide on the final grade
- step 7: score the OBs earned, report results, and use the data for course improvement
- step 8: evaluate the e-assessment with OBs

In addition to these steps, one should be aware of different perspectives of using OBs for assessment: learners, teachers, schools, employers and other stakeholders all have different interests in e-assessment with OBs and perceive that process differently. The details

of these different perspectives are beyond the scope of this paper, but are discussed thoroughly in [5].

6. CONCLUSION

Open Badges are an effective mechanism that can be used to support e-assessment. The emphasis here is on *support* – there is very little (if any) automatic assessment test scoring with OBs. They are rather a mechanism that can be used to capture the results of students' activities, the overall learning accomplishments, the levels of learning achievements, a variety of knowledge, skills and competences, and, most importantly, the evidence of these accomplishments, skills, competences, etc. As the experience from the GRASS project shows, OBs are somewhere midway between quantitative and qualitative assessment support. If used in a sophisticated way, scoring with OBs is also possible (guided by human judgement and with careful design of the underlying OB system), augmented with a strong digital evidence of the learning achievement (hard-coded in the badge itself).

ACKNOWLEDGEMENT

This publication was partially supported by the European Commission under the Lifelong Learning Program (LLP), the GRASS project (no.543029-LLP-1-2013-1-RS-KA3-KA3MP). The publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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LEARNING ANALYTICS: WHAT DO COMPANIES KNOW ABOUT OUR KIDS (AND WE DON'T)?

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Abstract: *The article provides an introduction to the increasingly important field of Learning Analytics (LA), new opportunities as well as threats from not that unlikely places. As we gather students' learning-related data, we should be more able to help them by providing them with means of understanding their progress as well as offering them "early warning system" for potential failure. If such systems offer other useful features such as problem reporting tools or achievement history, they bring additional new value to education in terms of better communication and motivation.*

However, beside students and teachers, many other people usually have access to some aspects of that data and their analytical representation. Some people should have an access but lack knowledge of interpretation and/or are not aware of crucial ethical and privacy issues. On the other hand, some who do, clearly shouldn't.

The article focuses on companies which provide IT systems for different purposes related to education. Should we entrust them with our kids' grades, homeworks, records of daily activities, communication with teachers and peers, especially if such services are cloud-based? Can this be used for "silent" future job profiling proposes? Can our kids be blackmailed some day? The article covers potential future(s), from benevolent ones to some extremely Orwellian.

Keywords: *Learning analytics, educational information systems, privacy, ethics*

1. INTRODUCTION

Learning Analytics has become increasingly important field of educational research in the last decade. There is no single definition for the term, however one of the most frequently used is the one by professor Erik Duval from the KU Leuven in Belgium defining learning analytics as "collecting traces that learners leave behind and using those traces to improve learning" [1].

Other definitions include Horizon 2016 Report [2] which describes learning analytics as "an educational application of web analytics aimed at learner profiling, a process of gathering and analysing details of individual student interactions in online learning activities."

In many scientific publications learning analytics is perceived as a key technology for the improvement of education. It is also referred to as "big data" applied to education. Beginnings of this scientific field come partly from the commercial sector that has used analyses of consumer activities to identify key consumer trends.

Educational data mining (EDM) uses similar techniques of consumer data mining, only in the context of education on all levels.

Typical phases of educational data mining projects consist of preparation of data through the process known as ETL (extract, transform, load), followed by mathematical

analyses, visualisations (often including interactive dashboards) and actions triggered by the results.

Advanced application of learning analytics include mathematical modelling that can be grouped in 4 types of analyses: descriptive, diagnostic, predictive and prescriptive.

Descriptive analysis aims to explain what is happening, diagnostic helps in understanding why certain things happened, predictive helps in prediction what will happen in the future, while prescriptive suggests the best course of action to take to optimise business outcomes. (3)

In job profiling there are elements of all four types of analysis, however with focus on the first two, especially with the goal of classification of candidates.

2. CORPORATE VIEWPOINT

What would be the incentive for the companies providing information systems with educational data to analyse them and by doing so as well analysing their clients – the students? Would they do it for purposes other than sole interests of their clients?

In typical corporations, set of values and resulting business ethics are a bit different than in education. "If a company's purpose is to maximise shareholder returns, then sacrificing profits to other concerns is a violation of its fiduciary responsibility"[4]. This in many aspects extreme viewpoint is confronted with more moderate and modern "corporate social responsibility" set of values,

emphasizing more holistic view which includes protecting interests of customers, other citizens, local communities, employees of companies in their supply chain, nature preservation, etc.

Analysis of the existing and perspective clients is a key business activity for any company, aimed at providing business goals such as:

- understanding clients' needs;
- classification of clients based on historical data;
- predicting clients' future decisions;
- maximizing sales and client retention opportunities;
- minimizing lost sales opportunities.

In cases when the clients are educational institutions and their students, it is generally less known to the public how the companies providing educational information system make use of potentially very interesting future job profiling value of this data. Companies that possess such data could potentially use them for their own recruitment needs or could create a business model to offer services to another legal entities.

3. EDUCATIONAL INFORMATION SYSTEMS, DATA AND POTENTIAL ANALYTICAL OUTCOMES

Today, there are numerous information systems used in all levels of education, from primary to higher. In this article only information systems containing educational data about students are presented. Those information can be used to analyse student's success, performance, behavioural patterns, interests, social connections, etc.

The following is the list of types of commonly used educational information system, types of data they contain potentially relevant to job profiling and potential outcomes of analyses.

Information system: Student information system (SIS)

Relevant data: courses, teaching staff, students, enrolments, mid-term and final grades, timetable, attendance, financial data (tuition, loans), socio-economic data (address, previous education).

Potential analytical outcomes: success, progress, recoveries from failures, learning outcomes/competencies, motivation, interests, health, financial status, socio-economic status.

Information system: Learning management system (LMS)

Relevant data: courses, teaching staff, students, enrolments, learning content (read/viewed, created, edited), lesson progress, tasks/assignments, communication (initiated, replied), testing and self-testing results, polls.

Potential analytical outcomes: success, progress, communication skills, social skills, promptness, punctuality, interests, opinions on selected topics.

Information system: Productivity (office)

Relevant data: learning content (read/viewed, created, edited), social interactions (comments), tasks/assignments
Potential analytical outcomes: success, progress, punctuality, interests, opinions on selected topics.

Information system: Team / project management system

Relevant data: tasks/assignments, milestones, social connections, communication (initiated, replied).

Potential analytical outcomes: success, progress, communication skills, promptness, project management skills, leadership skills, punctuality, interests, opinions on selected topics.

Information system: Learning object repository (LOR)

Relevant data: learning content (read/viewed, created, edited), social connections, communication (initiated, replied), social interactions (likes, comments recommendations, shares).

Potential analytical outcomes: interests, opinions on selected topics, communication skills.

Information system: Social networks

Relevant data: social connections, communication (initiated, replied), social interactions (likes, comments recommendations, shares).

Potential analytical outcomes: social skills, communication skills, interests, opinions on selected topics.

Information system: E-mail system

Relevant data: social connections, communication (initiated, replied).

Potential analytical outcomes: social skills, communication skills, promptness, interests, opinions on selected topics.

Information system: Video on Demand (VoD)

Relevant data: learning content (read/viewed, created, edited), social interactions (likes, comments recommendations, shares).

Potential analytical outcomes: interests, opinions on selected topics.

Information system: Learning record store (LRS)

Relevant data: learning content (read/viewed, created, edited), communication (initiated, replied), social interactions (likes, comments recommendations, shares), communication (initiated, replied), testing and self-testing results, polls.

Potential analytical outcomes: success, progress, interests, communication skills, promptness, opinions on selected topics.

Information system: Classroom management system with Mobile Device Management (MDM)

Relevant data: courses, teaching staff, students, enrolments, learning content (read/viewed), screens (teaching staff and students), communication, whiteboards, testing and self-testing results, polls, time management log, device control log (lock / unlock, application launch), device's physical location log.

Potential analytical outcomes: success, progress, interests, communication skills, promptness, opinions on selected topics, social interactions in physical space.

Information system: **Educational mobile/web applications**

Relevant data: learning content (read/viewed, created, edited), communication (initiated, replied), testing and self-testing results, polls.

Potential analytical outcomes: success, progress, interests, communication skills, opinions on selected topics.

Information system: **Interactive whiteboards**

Relevant data: whiteboard content.

Potential analytical outcomes: interests.

Information system: **Access control / management**

Relevant data: students' access log for lecture rooms and other physical and virtual learning spaces.

Potential analytical outcomes: interests, motivation, punctuality, health.

Information system: **Assessment software**

Relevant data: testing and self-testing results.

Potential analytical outcomes: success, progress, interests.

As this overview of most commonly used educational information systems shows, many systems contain sensitive, personal data: grades and other elements of success, abilities to recover from failure and ability rarely/never to enter critical situations needing recovery, amount, quality and promptness of communication and contributions, motivation at certain points of schooling, interests and potential health issues visible in longer periods of absence.

4. AUTHENTICATION TYPES AND PRIVACY ISSUES

All potential privacy issues arising from availability of such data to commercial companies "multiply" with how closely this data can be tied to a certain person and how easily it is to gather and integrate such data.

National and international authentication ID schemes, with initial authentication of the user from a trusted, official source are the worst in that regard. On the other hand, such schemes are the best for introducing intelligent government and other services to its citizens.

Many global (cloud) service providers offer their authentication schemes. Examples of such companies are Google, Microsoft, Apple and Yahoo. They usually rely on user's e-mail address used in login creation process. This e-mail is generally unreliable and may not reveal genuine name or other credible elements of identity. Governmental ID services offer reliable identification of the user and usually tie the username with national or international citizen ID number. If this information is passed on to the commercial provider at any stage, privacy is threatened and needs to be managed and monitored with maximum care.

There are several levels of confidence when pairing a certain person to a user of an educational online service.

- **Anonymous access**

In this case there are little privacy issues, since users are anonymous. Such services are nowadays very rare. One possibility of such service to remember the returning user is by means of browser cookies. Using another browser would make service forgetting the entire history for the returning user, making the service unintelligent and in many cases practically useless.

- **Username not tied to the real, verified name**

This authentication in which user chooses his/hers own username and password, without reference to an existing e-mail account or other trusted authentication scheme is a candidate for the best option concerning privacy. It is rare, since service provider companies wish to have a reference to a more concrete user identity in case of issues concerning illegal content or activity, rather than just a timestamp and the IP address, that can be hidden behind multiple VPN's or anonymity networks such as Tor [5].

- **Real, verified name, connected to school-level ID scheme**

In this authentication scheme students are given username/passwords pairs by the schools authority and part of this information is sent to the commercial provider as part of the SSO (single sign-on) procedure, usually with unchanged user ID. Full name and e-mail address are usually sent along with user ID to enable correct addressing and e-mail communication with users. Such approach is far from ideal from the privacy point of view, but in a global scenario would require collecting user data from many individual schools by the global providers to create a relevant database for a global commercial use. With educational services markets already segmented, making a global database is practically impossible without radical corporate acquisitions and mergers.

- **Real, verified name, integrated with a permanent regional / national / international ID scheme**

This authentication scheme presents potentially the most dangerous combination, concerning the privacy. For a global provider, this would enable creating global database of users and a basis for all kinds of analytics, potentially usable for job profiling purposes.

5. ETHICAL STANDARDS AND CORPORATE PRACTICES

All this has a lesser negative impact on privacy if ethical standards are applied by all parties, including commercial companies.

One of the relatively new ethical recommendation comes in the form of 8-step guideline known as “DELICATE” [6]:

1. *Determination: Decide on the purpose of learning analytics for your institution;*
2. *Explain: Define the scope of data collection and usage;*
3. *Legitimate: Explain how you operate within the legal frameworks, refer to the essential legislation;*
4. *Involve: Talk to stakeholders and give assurances about the data distribution and use;*
5. *Consent: Seek consent through clear consent questions;*
6. *Anonymise: De-identify individuals as much as possible;*
7. *Technical aspects: Monitor who has access to data, especially in areas with high staff turn-over;*
8. *External partners: Make sure externals provide highest data security standards.*

Another important issue are legal obligations and commitments arising from the contracts, “terms of use” documents and end-user licenses. Nowadays, most commercial providers dedicate themselves in protecting user data from the “third parties”, while explicitly stating intention of using data themselves for the purpose of making their software and services better and more useful for their users. How exactly this goal will be achieved is often not explicitly stated. This almost always include possibility of automated data gathering and analytics, since knowing clients is a key to success and is integrated in the business practice.

Microsoft claims to use clients’ data “*only to provide customer the online services including purposes compatible with providing those services. For example, (Microsoft) may use customer data to provide a personalised experience, improve service reliability, combat spam or other malware, or improve features and functionality of the Online Services. Microsoft will not use customer data or derive information from it for any advertising or similar commercial purposes.*” [7]

Some companies such as Samsung inform and ask the users of their “Samsung Smart School” platform to accept the extensive monitoring of the use of their services[8]: “*In addition to the data you provide, we may collect information about your use of our services via software on your device and other means. For example, we may collect:*

- *Information about the product - hardware model, IMEI number and other unique device identifiers, MAC address, IP address, operating system version and device settings that you use to access the services.*
- *Information on the application - such as the time and duration of your use of our service, the search terms you enter through our services and any information stored in cookies we set up on your device.*
- *The location data - such as the GPS signal of your device or data about WiFi access points nearby and*

repeaters that we would be able to transfer when using certain our service.

- *Voice details - such as recordings of your voice that we record (and possibly store it on our servers) when you use voice commands to manage our service. (Please note that we work with the third party provider who provides speech-to-text on our behalf. This service can receive and store certain voice commands.)*
- *Other information about your use of our services, such as applications you use, websites you visit and how you interact with content that is offered by us.”*

The nature and type of data collected data strongly suggest systematic use of analytics, including third-party companies. In the chapter on how Samsung uses collected data the focus is on making products and services better as well as marketing purposes, without mentioning user job profiling. As proposed in “Conclusions and recommendations”, standardisations of contract articles regarding privacy and data analyses, EULA’s and terms of use should guarantee a global acceptance of privacy policies and standards.

The goal of global market domination for an educational provider means that it should aim to sign as many contracts with schools or counties/states as possible. As job market becomes increasingly global, the pressure to use data for job profiling rises. To increase the market share, companies try to acquire or merge with other companies.

In such processes several scenarios are possible, including:

- Global ID and services provider acquiring educational information system provider(s) (and vice versa less likely);
- Global career/job site acquiring educational information systems provider(s) (and vice versa less likely);
- Global ID and services provider acquiring a global career/job site (and vice versa less likely).

In June 2016 Microsoft, as a global ID and services as well as educational information systems provider [9] acquired world’s leading career/job site LinkedIn for 26.2 billion USD[10]. This potentially enables Microsoft to provide its new clients – job recruiting companies using LinkedIn – with services based upon data collected from current school / university students, giving the company an important advantage for its own recruitment process as well.

In the past there have been unsuccessful learning analytics projects, with InBloom case [11] perhaps being the most famous for its failure in communicating project goals with key stakeholders such as parents, failure in proving collected data is secure and lack of opt out possibility.

Good examples of innovative business models involving some aspects of learning analytics could be found in the case of Stanford’s massive open online course “CS221:

Introduction to Artificial Intelligence”[12] held in 2011. After 160.000 interested students enrolled and 20.000 successfully completed the course, some of the leading tech companies got interested to hire the most successful students. Course authors from Stanford University Sebastian Thrun and Peter Norvig quickly built the business model charging the companies for that information, but first sending an e-mail to the best 1.000 candidates asking for permission to pass on their contact information to the companies such as Google, interested in their employment. Majority of candidates answered positively, as such business model was both ethical and beneficial for all interested sides.

Later, Udacity[13](co-founded by Thrun) built on that experience a new, revolutionary model of online education called “Nanodegree Plus” [14], promising to return tuition to students of their niche specialisation online courses if they don’t get a job in 6 months following the successfully completed course.

6. CONCLUSIONS AND RECOMMENDATIONS

“Digitalization” of education and related administrative processes has led to appearance of vast quantities of educational data. Learning analytics can help in making such data useful primarily for students, but also for teachers, school and university administration bodies as well as governmental bodies responsible for education on different levels.

Companies that offer educational information systems and educational services collect all sorts of educational data based on their users’ educational activities. Such data can be used to create useful educational tools such as personal analytical early warning systems for potential difficulties and upcoming failures, but can also be used for job profiling purposes in the future, making learning environment extremely hostile and unsafe. Market logic is that companies which would employ such practice would be rewarded and gain competitive advantage. Therefore, regulation, monitoring and acceptance of ethical standards are absolutely necessary.

To holistically approach such challenges several initiatives should be undertaken, some of which may include:

1. Widespread application of ethical standards and the best practices of protecting privacy and related data lifecycle (including destruction) in the contracts, terms of use documents and EULAs (end user license agreements) by all involved entities, especially commercial companies that provide educational information systems and related services as well as their employees.
2. Widespread adoption of opt out possibility for students not wanting to be represented in information systems with their real personal information, in situations where opt out of an information system is generally not possible.

3. Widespread adoption of learning analytics in helping students, teaching staff and schools’ / universities’ management to help them in education and administration. Data driven decision making processes should be implemented at all levels where possible, in an ethical way.

Failure to make use of learning analytics is a failure of management of educational institutions and a good predictor for an educational institution to become obsolete in the globalised educational market for a simple reason for not helping its clients, the students, the best it can.

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USE OF THE JAVA GRADER AND LAMS INTEGRATION FOR VALIDATION OF STUDENTS PROGRAMMING SKILLS IN PERSONALIZED E-LEARNING PROCESSES

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Abstract: *Personalized e-learning processes require validation of learning outcomes after each learning activity. In case of Java programming courses, validation activities require the use of a Java grader, a software component that checks the syntax and results of students programs developed in validation activities of an e-learning process. This paper demonstrates how a Java grader, developed as an integrated software component of LAMS (Learning Activity Management System) can be used in personalized e-learning processes. A course developer may now choose the Java Grader as a new LAMS activity used for validation of students programming skills, during design of a learning process with branching based on validation results. External Java graders have been used as external plug-in components of Learning Management Systems (LMSs), but in the presented implementation of Java graders, the developed Java Grader is the integrated software component of a LMS (known as LAMS).*

Keywords: *E-learning, personalized learning, Java grader, validation of learning outcomes*

1. INTRODUCTION¹

In parallel with the development of the Internet areas that are directly related to this type of information exchange have been developed as well. E-learning represents the presents and the future of learning. This type of learning provides opportunities that are not available with traditional lectures (in the classroom). Professor in the traditional way of teaching is a lecturer while in online e-learning he is an author who creates and posts teaching materials visible to users (pupils, students). Authors of teaching materials for distance learning have to attract users and to facilitate interactivity and collaboration between them. The advantage of e-learning is the interactivity that is possible within the system, availability of learning materials at any time, consultation and collaboration between users. [8]

Development of the system for distance learning has enabled the implementation of additional activities in teaching materials. In addition to standard materials, systems for distance learning provide lectures in electronic format (PDF, HTML format), an author has also additional activities that can encourage users to further deepen their knowledge. Author, using e-learning systems, can create lessons with additional content such as questions and answers, colloquium on the system, links to external additional materials. By posting the above content, author improves and enriches teaching material and brings it closer to the traditional way of teaching

where the lecturer shows additional examples, asks questions and makes suggestions to students.

The creation of teaching material for distance learning is a complex process as well as the selection of the system for posting it. There is a variety of open-source system for distance learning but this paper will focus on the LAMS system (Learning Activity Management System) [11] that is used within Metropolitan University and the creation of a learning process. This system has the ability to add a large number of activities that can enhance the learning process and improve the interactivity and flexibility of teaching materials.

2. MOTIVATING OF STUDENTS

The biggest identified problem of learning process is to motivate students to go through the learning process. Very often, students take a PDF version of teaching materials without opening the process of learning and passing through interactive content. The LAMS, as a system that supports the creation of a learning process, offers the possibility of creating a defined learning process. One of the proposed ways to improve and increase the number of students using the learning process is to set additional activities. A PDF version of teaching materials is more convenient for students, as they may go through the same many times without conditions as it is the case in LAMS learning process. Additional interaction with students in activities such as questions and answers, additional resources, advices and information on a topic on external sites may increase the desire of students to access and go through the learning process. [7] If the author of the course provides students with interactive

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

approach in lesson with the types of the final exam questions of the course, where students will check their knowledge in each lesson (the learning process) and have an outline information about their knowledge and possible exam questions, it is possible to increase the number of students using the learning processes. Also, by adding video material (YouTube video, or video from a computer) where students will have an insight into the teaching topic explained in other way with completed demonstration examples that will facilitate homework and preparation for the practical part of the exam it can be achieved greater collaboration with students in the learning processes. The authors of the course may be present in the activities of the learning process and provide additional guidance and advice to students through teaching material. [3]

In courses that deal with programming, the introduction of external graders for the Java programming language, which was developed at the University Metropolitan, and similar activities will present the learning process that does not differ greatly from traditional lectures and exercises where the student in a few seconds can get answer for completed task and continue the path through the learning process. One of the methods may be the LAMS branching activity where students will be able to choose by which learning process want to go through the teaching topic. Author of the course is the one who defines learning objects and activities for each of the available paths. Informing students that, if they have prior knowledge of the teaching topic, they can choose the path (a learning process), which has an advanced level and the increased number of tasks that is needed to students, it can enable a larger number of students who access to learning processes. The described methods may be implemented as a test in one or two subjects in the learning processes that possess the above activities with a constant message to students about the benefits of going through the process of learning (collecting only relevant information, demonstration examples and assignments).

3. PERSONALIZED LEARNING

Personalized way of learning is based on the good quality environment in which learning takes place. This includes LMS (Learning Management System) that supports this way of learning and offers various forms to create the path of the learning process. This type of learning allows students to obtain only that material needed according to their knowledge. Professor is the one who determines the materials that will be available to students depending on their knowledge.

The first thing that should be identified is the level of knowledge that the student possesses at the beginning of the learning process. The second item involves finding teaching materials and author who can provide the required level of knowledge. As already stated, the use of LAMS allows for the use of various activities to check students' knowledge on the basis of which the author of the course can have an insight into the level of knowledge possessed by students. Most often this is resolved by using questions and answers as well as tests after lessons. The results represent data that show the student's level of knowledge and therefore the level to which the teaching

material should be adapted. Author, if necessary, can also use other activities that are available in the system. In accordance with the results obtained through testing of students, two approaches to personalized way of learning can be developed. [6]

The first approach assumes that based on student's answers and activities, the author of the course finds the level where student gravitates through his/her learning. Whether it is about the answers to questions, work on assignments, time spent on specific topics in the learning process, the results are collected and represent the subject of future analysis of the student. Author of the course will have at disposal the relevant information about students on the basis of which it is possible to create adequate levels of a particular course or lecture. [1]

In this approach, a problem that can occur is the inability of the student to refer if he/she notices that the level of knowledge is not adapted to the knowledge previously shown (it may happen that the student shows knowledge in one area while showing the low level of knowledge in another area). If the student notices that it is necessary to increase the level of knowledge in a particular area he/she may contact the professor with the request.

Adaption of learning process to the specific needs and abilities of student in order to optimize student's learning path, requires information on the current state of student's knowledge in the field relevant to the lesson studied by the student, as well as other data relevant to the determination of the further path of student's learning. As the student, and his/her acceptance and mastering new knowledge are decisive influential factor for guidance of learning process during a lesson, it is necessary to create an appropriate **studentmodel** (i.e., user of e-learning system) who will direct the future course of his teaching by his/her behavior and reactions to different kinds of assessment tests during the learning process. The e-learning system adapts next activities of learning and teaching content (by area and level of shown knowledge) taking into account the behavior of the student model in the activities of knowledge verification after each learning activity during the verification of the learning process. In this way, the learning process becomes a **process of personalized learning**, as the next learning activities adapt to the results of the verification activities of the newly acquired knowledge after each learning activity.

The system, based on presented knowledge of student can determine the next learning activity in the learning process. Ideally, generation of new activity with ad-hoc determined optimal content of the next learning activity would be performed at the time of completion of the verification activity of newly acquired knowledge (Figure 1a). However, this way of adaptive personalized e-learning is a very challenging research and development task. It requires fast, ad-hoc configuration of teaching material of the next activity in the learning process, in accordance with ad-hoc determined next task of learning, compatible with the result of previously completed verification of student's knowledge.

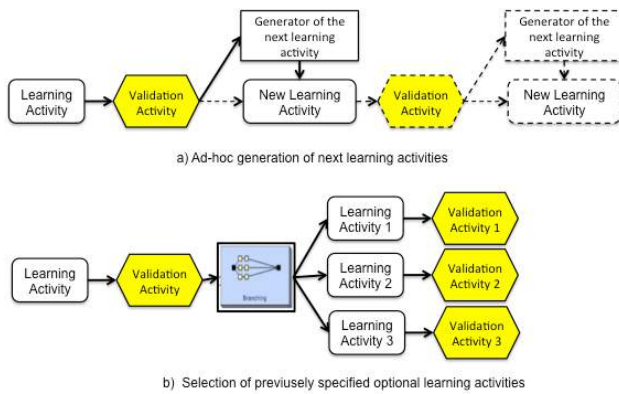


Figure 1. Two approaches to personalized e-learning

This is the direction of a long-term research conducted at the Belgrade Metropolitan University. However, at this point, our research is aimed at achieving more modest objective. We are currently aiming to achieve branching of learning processes after each verification activity of the student's knowledge. His/her learning process is directed towards several options of the next learning activities, which are pre-defined and entered into the system (Figure 1. b). This approach requires from the author of the course to prepare and provide in advance a variety of teaching materials for different, optional learning activities and learning paths, adjusted to pre-defined objectives of each of these activities.

In parallel with the determination of the level of student's knowledge during the learning process within a lesson, it is possible to find students with similar answers and demonstrated knowledge and thus create a **network of students** who can jointly work on specific educational topics and tasks. In this way, it creates a learning process and networks of students with similar levels of demonstrated knowledge. Of course, networks of students can be changed on the basis of lessons and teaching materials accessed by students and it is possible for a student to be in different networks at different educational topics and tasks. Previously described user modeling is performed once a week. If necessary, it is possible to reduce or increase the time limit according to the teaching materials that need to be reviewed. Each student gets a different model based on the previously demonstrated knowledge on teaching subject, while the same case is with the network of students. Also, based on user model, the author of the course can customize future teaching materials and activities to the needs and knowledge of students. [9].

More modest approach to the formation of networks of students is their (just) classification into several groups, formed according to their initial level of knowledge and their ability to acquire new knowledge. Each group has its own path of learning. They can be defined at the course level or at the lesson level [4]. This approach encourages collaboration among students, joint problem solving and emphasizes the development of relations between students acquiring knowledge through group work.

Beginning of introduction of personalized learning involves creating student models. Based on the research, student model is defined based on the behavior of the student during learning, through a review of the activities through which the student has passed (log files), the

number of clicks in a lesson, downloading additional material and time spent on specific topics. Creation of a student model often includes available algorithms that goes through the system and collect the necessary information and thus provides the author of the course with an insight into the knowledge of users. In addition to these activities, it is again necessary to mentioned answers to questions during the lesson (function offered by LAMS). The analysis of results of verification of an acquired knowledge enables the teacher or tutor to access and get the necessary information without the use of an algorithm for determination of the user model. For example, the activity of verification "Questions and Answers" offers the possibility to analyze students' answers (through user interface) and possible additional verification of knowledge. (Figure 2).

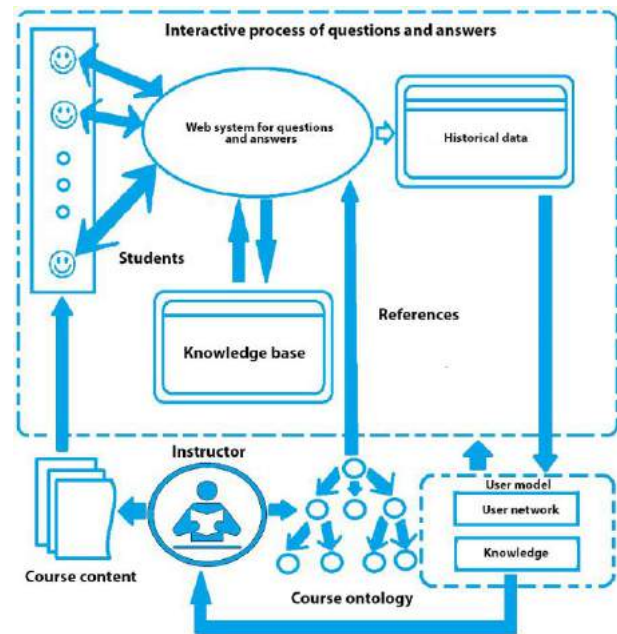


Figure 2. A typical process in a personalized way of learning

1. Structure of course and lessons: It represents the division of material into simple units and determination of the structure of the lesson. Author of the course determines the lessons of the course, as the highest level of grouping of learning activities within a course. Then, the author determines teaching material for certain units that make each lesson. On this basis, it is possible to perform division into levels of learning according to defined structure.

2. Interactive process: Starting from the predefined hierarchy of the course through the LMS system it is possible to create an interactive process in which students will participate. Interactive process enables the system to maintain student activities through the teaching process (answers to questions, most commonly used teaching materials, time spent on teaching materials) and consequently to determine the way of student's learning and his/her activity in the teaching process. If the student spends most of his/her time doing tasks on the system, the system will then provide additional tasks to the student, in order to reach the required level of efficiency in solving

them. Student model remembers, for each student, data on his/her learning process, and on the activities of the process accessed by the student. [4]

3. Student modeling: Student model is created, either for each student individually or for a group of students with similar demonstrated knowledge and capabilities. Student group model approximately represents the average model of students who are part of a group. Using a larger number of groups within a course (subject), group model is closer to the model of each student in the group.

As mentioned, groups of students can be formed at the beginning of the course, based on initial estimates of the level of their knowledge and learning capabilities, or groups are formed in an ad-hoc manner during the learning process of the course, based on demonstrated knowledge of the student during the verification activity of acquired knowledge. Ad-hoc groups of students can be formed on the basis of identification of students with similar answers and demonstrated knowledge and thus creating a network of students who can jointly work on specific educational topics and tasks. This is the way of creation of the learning process and establishment of network of students with similar levels of demonstrated knowledge. Of course, networks of students (i.e., ad-hoc student groups) can be changed on the basis of lessons and teaching materials accessed by students and it is possible for a student to be in different networks at different educational topics and tasks. Previously described user modeling is performed once a week. If necessary, it is possible to reduce or increase the time limit according to the teaching materials that need to be reviewed.

In the case of application of e-learning system with the predefined learning paths for different groups of students (Figure 1b), author of the course for each branch of the process and its activities must provide adequate teaching materials. The system of e-learning of the Metropolitan University, therefore, uses learning objects of small granularity, which can be easier and more often combined to create teaching materials in accordance with the goals of learning activities. This creates a multiple usability (reusability) of learning objects, which reduces the cost and time for preparation of teaching materials.

4. ENVIRONMENTS FOR PERSONALIZED E-LEARNING PROCESSES

The environment in which the student will go through the learning process must be set up so that the focus is on the following components:

- characteristics of the student
- goals to be achieved in teaching and learning
- activities associated with the process of learning
- tasks setting strategies that are used to obtain information about the student's knowledge and determination of path throughout the learning process.

Six basic components are:

1. Characteristics of the student
2. Support in the learning process
3. Skills of the student

4. Content of teaching material
5. Available additional resources
6. Tasks

Each of these basic components has additional subcomponents that represent additional items that make up the learning process. (Figure 3) Depending on the results of students, there are components that will make the learning process while relating to the environment in which learning takes place. Of course, the author should determine the other components in the process based on the components of characteristics and skills of the student. Each level uses the same components and different subcomponents that are available. An example might be an advanced level where it should be post to the student as many different subcomponents of the component „tasks“, while at the basic level it is needed to post more educational material to introduce students to the basics of teaching topic, as well as demonstrative examples. Author of the course creates a course by looking from the students' perspective, intelligibility of posted materials and activities included in the learning process. [2]

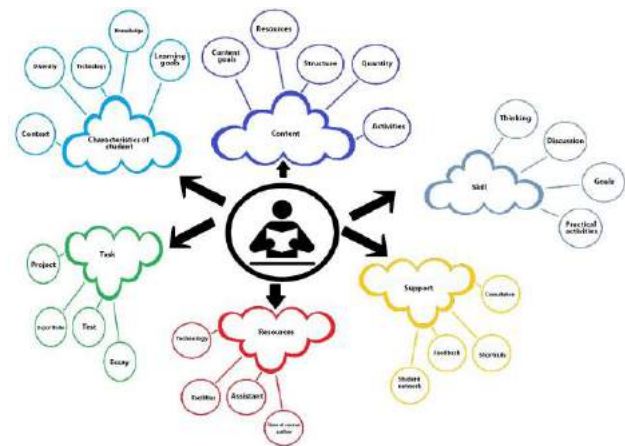


Figure 3. Components of personalized learning process

Personalized learning process allows students to use some of the activities in the teaching process where they will show their knowledge. Usually it is recommended to use questions and answers, where the student can look up the answers from other students if the student thinks that he/she did not answered correctly and in this way they can check and improve their knowledge. It is recommended that the student in the system have the ability to input any perception of a teaching material, whether the student considers that the learning process is too difficult or easy according to the knowledge he/she possesses and activities through which he/she has passed. In this way, the author gets another feedback from the student that can be used in user modeling and preparation of teaching materials for future lessons or for the next generation of students, or to modify the existing process of learning. [5] Verification activity of acquired knowledge of the student, which usually follows after each learning activity, is usually implemented through different types of tests. For the purpose of efficiency, it is preferred to use automated tests, which for each student generate different questions from predefined set of possible questions and on the basis of obtained answer the system immediately

provides the test result showing the wrong and correct answers to the student. However, in the case of the use of tests with open responses, that is, in which the student enters textually his/her answer, an automated evaluation is not possible, and then it has to be done by tutors, that is, trained staff who monitor and evaluate the performance of each student.

Application of tests is not suitable for all subjects, or is not sufficient for evaluation of achieved level of knowledge and skills in certain disciplines. In these cases, it is necessary to develop and implement specific methodologies of automated evaluation of students, which are not based on the answers in the tests, but on an assessment of the student's problem solving. The next chapter provides the way of evaluating programming skills of students, which was developed at the Metropolitan University.

5. THE JAVA GRADER FOR LAMS

Programming courses and application development at the Belgrade Metropolitan University require homework assignments and tasks to practice within the Java development environment (NetBeans, Eclipse). Students submit their homework reports to their tutors or professors for review, who must take the received files and re-open through the development environment and run programs developed by students. This type of work is very time-consuming for tutors who review each home work of each student.

The external grader for the Java programming language (Java External Grader) enables simpler process of making tasks for practice and even some homework. It was developed as a LAMS activity that can be set in the context of the learning process (sequence) without additional posting links and going to other sites. Student performs programming tasks in Java directly in LAMS, and evaluation of his work gets immediately after the posted task is done (as information from the system). Teacher or tutor may subsequently access and check the answers given by students. The system automatically checks the entered programming code and as a result prints to the student whether the entered answer is in accordance with the desired response to the question. This will largely shorten the time required for the creation and verification of tasks for practice and homework (student accesses to the task for practice, where he receives the text of the task and then realizes it in a development environment) and therefore teachers and tutors can spend their time to quality making of the learning processes and objects in them. This type of external grader does not exist in other open source LMS systems for distance learning but it is necessary to implement integration with some existing software. [10]

Using external grader and through its additional improvement (introducing more classes, developing testing of multiple methods), course authors can create a learning process that will allow students to do their whole homework on the system without the needed development environment and earn all the points directly on the LAMS (without additional systems, accessing and sending e-mails). Safety of the external grader depends directly on the LAMS. The created user accounts and defined user

roles in the LAMS apply for the external grader as well. User with a specific role in the LAMS gets only options provided for this user role. Also, students have access only to their answers and it is not possible to see other students' answers on activities. This approach allows safe doing of tasks and storage of information entered by students. Unauthorized access to information shall be registered by the LAMS and it is possible to find such a user account and to suspend it.

A problem that has not been resolved concerns the opening of other files and environments besides the LAMS. In this way the student can open the document or find a solution on the Internet and copy it as the answer. Another way of misuse means that the same student accesses from different user accounts and solves quests. This problem generally occurs in all systems that do not have the solved testing process of students where the student sees a window with questions without the possibility of opening new pages in the browser or files from his/her computer.

Systems for distance learning do not support the verification of the program code but students are required to submit solutions to professors or teaching assistants in file format from the development environment. By implementing an external grader, the role of the professor refers to the creation of the task and eventually checking the answers. Students can independently do tasks and check their solutions according to the parameters without the help of the professor or teaching assistant. Also, the professor can define homework that the student may do directly without additional development environment. The aim of this software is to improve learning processes at the Metropolitan University, to provide additional content that has not been available in subjects dealing with programming in the Java programming language and to improve the experience of students in working with LAMS. This has improved the function of LAMS as a system for e-learning with additional options that are available to the authors of the course. Also, observing the other available activities that can be entered as part of the learning process (sequence) administrative part related to the external grader is much smaller, simpler and more intuitive.

The primary idea of external grader of the Java program for LAMS is to allow verification of the Java program code directly in the LAMS. Author of the course defines one or more tasks according to the needs of the creating test. Each task consists of:

- text of the task
- entered solution in the form of a method of the Java programming language that is checked by the system
- parameters based on which the system checks the answers
- expected results according to set parameters

An activity of the external grader may contain one or more tasks. Tasks are presented within one page in the order defined by the author. The order of the task can be changed after creating all tasks. When the author has set the specified verification activity within the lesson, the student accesses to the activity and enters his/her solution of the task in the form of method. The student gets feedback whether he correctly entered the method (the correct syntax). Once the student has received

confirmation that the method is correctly written, the system prints whether the answer meets all parameters which verify the correct answer in the method. If the results of the entered method with defined parameters print the result that has been specified previously, the student has done the task correctly. If at least one of the results is not met, the entered solution is not correct. The student can leave partially completed solution and in the accordance with the response to be evaluated or continue the path throughout the learning process.

After selection of activities, the test is shown to the student. The left side shows a learning process which in this case contains only one activity while the right side shows the tasks. The user enters his solution of the task in the form of a method of the Java programming language.

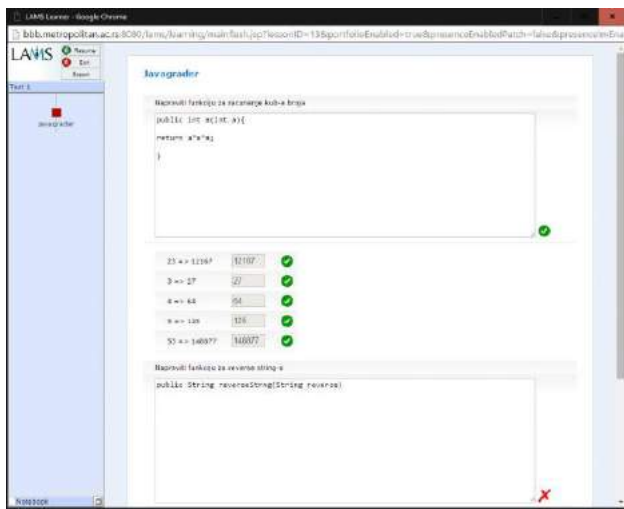


Figure 4. Validation of the answer in the external grader

The student has correctly answered the question and the system displayed information that the entered method is syntactically correct and that the parameters entered in the method of the student correspond to the expected results in the task. (Figure 4)

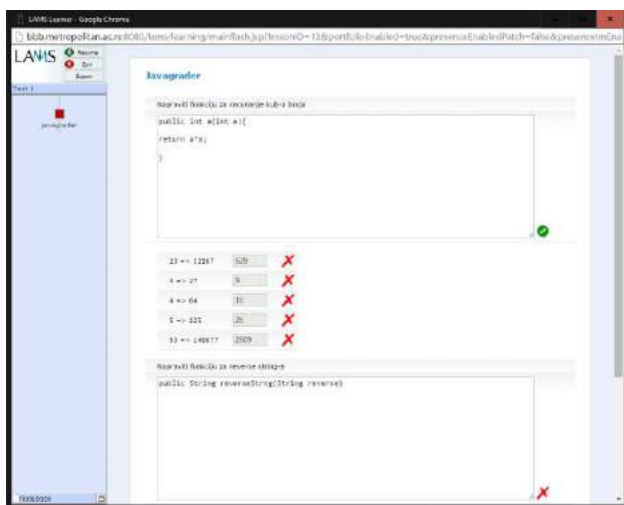


Figure 5. Method entry and syntax validation

Figure 5 shows the case when the student enters the syntactically correct method of the Java programming

language and gets information that the method is correct but the results do not match, which means that it is not a method that is required for an answer and the student must modify the method to meet the expected results.

Student can answer each question in the test but also he can answer only one question. Also, it is possible to enter parts of the method that may show that the student has some knowledge in the work but he failed to complete the task. After completing the test, student by clicking the "Next activity" button moves to the next activity and in this case he ends the entire learning process.

6. PROBLEMS OF PERSONALIZATION OF LEARNING PROCESSES

Adaptability of the learning process and proper sequencing of learning activities is one of the potential problems. Problems often appear in teaching materials, where knowledge levels are not properly defined by the author as well as the overloading of material and the inability to reuse it. If the teaching material is written for only one level, it can not be used in personalized learning processes beyond that level. The problem occurs when the system needs to create different personalized learning processes for defined topic. The system performs a search of the teaching material and if there is no learning object that fits the student model for which the system creates the learning process, the system will not create and display a learning process. [6]

Most of personalized learning system is based on control by the tutor (professor). If the professor does not create properly teaching material that is entered into the system, does not determine the levels of teaching materials and does not provide appropriate tasks to check the student's knowledge systems can not create an appropriate learning process and student model. Also, another problem that arises is reflected in the undergoing of students through personalized learning process. If the student using the navigation and a few clicks in the system goes through the learning process without staying at the teaching material, the system can get bad information and create a student model. In this case, the system displays the more advanced learning process to the student impairing the student model which can be corrected by collecting information from the next learning process or through intervention of tutor.

Systems do not have a solution for solving the problem of semantic adaptability and personalization. Also, the system for personalized learning should address pedagogical aspect of learning. The analysis shows that in the traditional way of teaching a student asks 0.1 question within an hour, while on the system for e-learning, student can require a response (or ask) to about 120 questions within an hour.

In the accordance with the above analysis, it is necessary to create teaching materials and set learning processes so that the student has the answer or explanation at every moment during the teaching process. If this is not possible, re-engagement of teachers in the learning process is necessary.

Adaptive learning systems can be used as support for online e-learning or as additions to systems for e-learning.

Implementation challenges are more operational than technological. From the technological point of view, it is possible to create a system and determine criteria according which the system will display teaching materials. On the operational side, disadvantages that appear are related to the situation when students progress at different steps. It may be that a student in one part of the personalized learning process achieves a great progress while in the second part there is a drop, so it is up to the system to provide accurate personalized learning process according to the demonstrated knowledge.

System used for personalized learning processes must have clearly defined answers to the students. If a student goes through a learning process, takes test or answers questions, after the activity he has to receive feedback from the system. Feedback shows the student whether he answered correctly to a given activity and any deficiencies that may occur. Also, when moving to another level of the learning process, the system must notify the student. In this way, the student will always know his position in the learning process and properly determine the speed and course of his learning.

Solution of the problem of implementing the concept of personalized learning can be achieved defining teaching strategy in the system, the professor through his engagement can predict possible problems and solve them within learning processes, define additional activities that will represent the results of the student's work in the learning process. Personalized learning process is based on the constant improvement of teaching materials, collaboration with students and the system, as well as through the validation of student models.

7. CONCLUSION

Student models are needed to implement personalized e-learning. But, to provide needed data for student models, validation of their learning is necessary. Validation of learning outcomes after each of learning activity, may provide branching of learning paths in a learning process model of an online lesson. Based of achieved validation results, students follow different learning paths. When students learn programming, validation activities should use automating graders of their programs. In this paper, a newly developed Java Grader was used as an integrated software component of LAMS [11]. With this, LAMS now may offer e new LAMS activity that validates students programs written in Java. Based on the validation results, different braches of a learning processes may be specified and different learning paths may be designed. LAMS will guide students to different learning paths based on validation of their programming skills, when the developed Java Grader is used for validation as a new LAMS activity.

Teaching material structured as learning objects of fine granularity is necessary to support personalized learning processes. BMU has developed a large number of small learning objects with fine granularity used in learning activities of learning processes. Each designed online lesson may have a complex learning process with branching, after each validation activity [4]. Validation of Java programming skills of students is now possible with the developed Java Grader, now offered as a new LAMS

activity. This is one of the steps necessary for development of personalized e-learning processes in online programming courses.

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ALGORITHM FOR PERSONALIZED LEARNING PROCESS

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Abstract: *The optimization of e-learning process plays an important role in the modern studies. Every student is characterized by personal skills, knowledge, opportunities, motivation, cognitive aspects and learning history. For these reasons, each student needs to receive different learning content, which will optimize student's process of learning and give the best possible result in term of received knowledge. In this paper is proposed algorithm as an effective and flexible approach for intelligent personalization of e-learning routes, as sequences of Learning Objects (LOs) that fit students' knowledge. As a proof of concept software is being created. It uses algorithm which classify students in one of three groups based on test's results, which every student must to solve before start of the learning process. After classification is done, students are gathering learning sequence based on student's group. Sequence consists of LOs personalized prepared for every student. The proposed model has been evaluated in a simulated e-learning environment.*

Keywords: *E-Learning, personalized learning routes, learning objects, linear model for classification, k-nearest neighbour's algorithm*

1. INTRODUCTION

The functionality of learning systems has been growing very fast during last decade, with rapid development of technology. There are some popular platforms for learning, like Tutor[4], Moodle [2] or Sakai [3], but there is still a need for platform which is oriented on personalized learning system and content [5]. Personalization of learning concept is much more sophisticated problem, than personalization of system [6]. The optimization of e-learning process plays an important role in the modern studies. Every student is characterized by personal skills, knowledge, opportunities, motivation, cognitive aspects and learning history. For these reasons, each student needs to receive different learning content, which will optimize student's process of learning and give the best possible result in terms of received knowledge. Optimization can be obtained in different ways. For this study, authors proposed algorithm for personalization learning process. Personalized learning is a central design principle for a transformed education system [1]. The focus of personalized learning process is not on the technology, but on the learner's motivation and engagement. The technology is there just to support, not guide the learning process.

Each student is unique and learns in different way. Personalized learning system should be built on the idea that the student can design his own learning path (indirectly or directly), has flexible learning anytime and anywhere, has quality teachers who motivated and engaged in the learning process. Learning

environments should be able to notice how each student learns best and to generate the most appropriate learning path for him.

For generated personalized learning environment it is necessary knowledge of the student's progress tracking, passed exams, taken courses, etc. Gathering of that information can be assured to the development algorithm and tools for e-learning platforms. This paper proposed an algorithm for generating personal learning path.

Paper is organized as follows. Section 2 gives literature review. Section 3 describes mathematical background and algorithms used for concept of algorithm that we proposed. Algorithm is proposed in section 4. Example of using algorithm is presented in section 5. Paper concludes with section 6.

2. LITERATURE REVIEW

There are many publications in the area of artificial intelligence addressed to e-learning domain about personal learning process. Usually, proposed algorithms analyse behavioural of students. They applied sophisticated algorithms which support interactions with students and give the best learning outcomes. Some of authors describe their algorithms in papers [7, 8]. Chen presents application of Item Response Theory, which is used to determine learners' abilities and course materials difficulties in reasoning process. Similar approach by facilitates navigation through e-learning system using history of users interactions and behaviour.

Other algorithms to learning content personalization use semantic web technologies. Most of such methods use ontologies to standardize student model, monitoring progress, notes and passed exams [9, 10]. Such model is used mainly to predict, which part of knowledge should be learn by a student as a next one. This model is used as a base for algorithm proposed in this paper.

More advanced concepts are developed in paper [11]. Significant improvement in personalization was given by Xu[12], which created system based on model of autonomous agents. The system was designed using three layers, responsible for creation of adaptive interface for online users, exchange of information between intelligent agents and gathering of data. Each agent in the middle layer is responsible for different issues i.e. users activity, learner profile, modelling and planning. The communication of agents results in personalized behaviour of e-learning platform.

3. MATHEMATICAL BACKGROOUND

In this section linear model for classification and k-nearest neighbours' algorithm [14] are described. These algorithms is used in concept of proposed algorithm.

3.1. Linear model for classification

The goal in classification problem is to take an input vector \mathbf{x} and to assign it to one of K discrete classes C_k where $k = 1, \dots, K$. The classes are disjoint, so that each input must be assigned to exactly one class. There are classes of linear models which is used for solving classification problems. For this study least squares method was used for solving classification problem.

Prediction is based on large training set. Training set is consisted from N input vectors \mathbf{x} . The categories of the input vectors in the training set are known in advance. Every input vector \mathbf{x} is assigned with target vector \mathbf{t} . For instance, if we have $K = 3$ classes, then a pattern from class 2 would be given the target vector $\mathbf{t} = (0, 1, 0)^T$. We can interpret the value of t_k as the probability that the vector \mathbf{x} belongs to class C_k . Dimension of vector \mathbf{x} is arbitrary and depends of situation in which algorithm is used. Dimension of vector \mathbf{t} must be equals to number of classes.

The result of running the machine learning algorithm for classification can be expressed as a function $\mathbf{y}(\mathbf{x})$ which takes a new vector \mathbf{x} as input and generates an output vector \mathbf{y} , encoded in the same way as the target vectors. This function is linear combination coordinates from vector \mathbf{x} and form of function is given with expresion (1),

$$\mathbf{y}(\mathbf{x}, \mathbf{w}) = w_0 + w_1 \cdot x_1 + \dots + w_D \cdot x_D \quad (1)$$

where D denotes dimension of input vectors.

Algorithm has a goal to determine the precise form of the function $\mathbf{y}(\mathbf{x})$. For that, algorithm uses all vectors from training set. Unknown coefficients w_i are determined during the *training* phase, also known as the *learning* phase.

Once the model is trained it can be used for classification of new vector, which are said to comprise a *test set*. When coefficients w_i is known, function (1) can be used for generating output vector \mathbf{y} for new vector \mathbf{x} . Each coordinate in vector \mathbf{y} denotes possibility that \mathbf{x} is assigned to corresponding class.

a) Discriminant Functions

A discriminant is a function that takes an input vector \mathbf{x} and assigns it to one of K classes, denoted C_k . The simplest representation of a discriminant function is obtained by taking a linear function of the input vector so that

$$\mathbf{y}(\mathbf{x}) = \mathbf{w}^T \mathbf{x} + w_0$$

where vector \mathbf{w} is called a *weight vector*, and w_0 is a *bias*.

Each class C_k is described by its own linear model so that

$$\mathbf{y}_k(\mathbf{x}) = \mathbf{w}_k^T \mathbf{x} + w_{k0}$$

where $k = 1, \dots, K$. We can conveniently group these together using vector notation so that

$$\mathbf{y}(\mathbf{x}) = \widetilde{\mathbf{W}}^T \cdot \tilde{\mathbf{x}}$$

where, $\widetilde{\mathbf{W}}$ is a matrix whose k -th column comprises the $D+1$ -dimensional vector

$$\mathbf{w}_k = (w_{k0}, \mathbf{w}_k^T)^T$$

and \mathbf{x} is the corresponding augmented input vector

$$\tilde{\mathbf{x}} = (1, \mathbf{x}^T)^T$$

where $x_0 = 1$.

A new input \mathbf{x} is then assigned to the class for which the output

$$\mathbf{y}_k = \widetilde{\mathbf{w}}_k^T \cdot \tilde{\mathbf{x}}$$

is largest.

Task is to determine the parameter matrix \mathbf{W} by minimizing a sum-of-squares error function. Consider a training data set $\{\mathbf{x}_n, \mathbf{t}_n\}$ where $n = 1, \dots, N$, and define a matrix \mathbf{T} whose n -th row is the vector \mathbf{t}_n^T , together with a matrix $\tilde{\mathbf{X}}$ whose n -th row is $\tilde{\mathbf{x}}_n^T$.

b) Least squares for classification

The sum-of-squares error function can then be written as

$$E_D(\widetilde{\mathbf{W}}) = \frac{1}{2} \text{Tr}\{(\tilde{\mathbf{X}}\widetilde{\mathbf{W}} - \mathbf{T})^T (\tilde{\mathbf{X}}\widetilde{\mathbf{W}} - \mathbf{T})\} \quad (2).$$

Where Tr denotes trace of a matrix.

Our task is to find solution for function (2) which gives the least possible value of function (1). Setting the expression's derivative with respect to \tilde{W} to zero, we obtained the solution for \tilde{W} in the next form

$$\tilde{W} = (\tilde{X}^T \tilde{X})^{-1} \tilde{X}^T T = \tilde{X}^+ T$$

where \tilde{X}^+ is the pseudo-inverse of the matrix \tilde{X} .

We then obtain the discriminant function in the form

$$y(x) = \tilde{W}^T \tilde{x} = T^T (\tilde{X}^+)^T \tilde{x}$$

The least-squares approach gives an exact closed-form solution for the discriminant function parameters.

3.2. K-nearest neighbour's algorithm

Sometimes there is a need to determine the most similar elements from training set with a new one. There is a method which can be used for that. For this study, K-nearest neighbour's algorithm is used. This method calculates distances from new vector z to the all other elements from training set. For instance, Euclidian metrics can be used for calculating distance or some other metrics. The nearest K elements are these who have the smallest distances from new elements z . To do this, we consider a small sphere centered on the new vector z and we allow the radius of the sphere to grow until it contains precisely K data elements from training set. More about this method can be found in [14].

4. ALGORITHM

In this section an algorithm for personalized e-learning process is proposed. Algorithm uses linear model for students' classification and k-nearest neighbour's algorithm for generating learning path.

4.1. Structure of lessons

Each lesson is structured as a sequence of Learning Objects (LOs). In our case DITA Learning Objects are used. Every LO is independent piece of knowledge. LOs should not have connections to other LOs. Each LO is categorized by IEEE classification and has own level of knowledge. Level can be: Beginner, Middle or Advanced. When student is reading LOs he is tracked by time spending on each LO. Each LO should have at least 5 minutes of content and not more than 30 minutes of content [13]. By this time, we can conclude about students have pre-knowledge.

4.2. Concept of proposed algorithm

The student's learning path depends of his answers given on pre-lesson test. When student start with lesson for the first time, he must to do test. Test consists ten questions which answers are used for student categorization in one of three groups (Easy, Medium or Hard). Questions in test are divided in three groups. The first one has five easy

questions, second group consists three medium questions and two hard questions are part of the last one. Test's results are saved as a binary 10-dimensional vector. If student answered correct to some question, appropriate coordinate in vector is set to 1, otherwise 0. After student has finished the test, he was categorized in student groups by test result. Minimization the least squares method is used as a linear model for classification. Unknown coefficients in function (1) is calculated just ones, based on training set. Every time, after that calculus, function (1) is used with known coefficients and in constant $O(1)$ time gives as a result classification vector.

Training set for classification is generated by students's test where professor determined in which class belongs each one. We created a model which classifies new user based on training set. When student is classified, goal is to generate learning path for him. There is a need to find K students which have the most similar answers on their tests. For finding the K nearest student to new one, authors used k-neighbors algorithm.

The closest K students are then considered for creating a learning path for student that have just done the test. The simplest K students are members of same category as a new student. Learning path was built from LOs where average learning time by each of K user is at least 5 minutes.

Algorithm diagram is on Figure 3.1

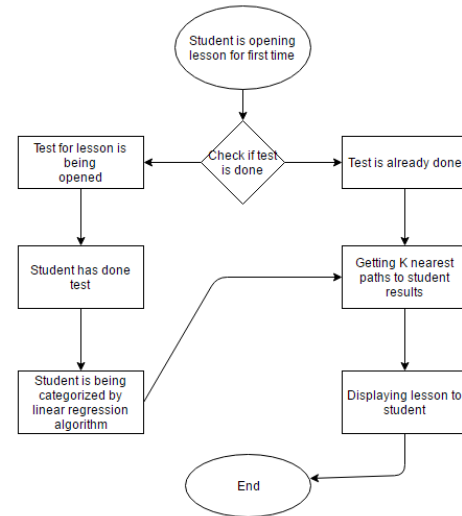


Figure 3.1: Proposed algorithm for personalized learning process

4.3. Implementation in LAMS

In this paper LAMS learning management system [15] of Metropolitan University is used for getting LOs of existing lessons. LAMS provides a teacher to create and deliver learning content, monitor student and assess student performance. LAMS also provides students to have ability to assess themselves during learning process [16]. LAMS and a system for the storage and manipulation of learning objects (LOs) which is usually realized as a Content management system (CMS). We used database

with already created DITA learning objects for testing our algorithm.

System for personalized learning process is created using PHP programming language with MySQL database, both for LAMS and for personalized learning system. From LAMS database we are using users, courses, lessons and learning objects.

Tests for students are created in our Smart Personalized Learning Management System (Smart PLMS). Smart PLMS is responsible for linear classification and finding the most similar K students which were used for generating new personalised learning path which is different for each student.

5. EXAMPLE

Training set is created for testing proposed algorithm. This set consists of 100 student's tests and professor's categorization for each of them. Notice that each test is 11 digits' binary vector. First binary number in vector is always 1 and others are question results. For each binary vector x we have target binary 3-dimensional vector t with class where student who is test owner belongs. Vector t contains one element with value 1 and the all others have value 0. Index of element with value 1 is the same as index of target class.

As a result of linear classification we are getting 11×3 matrix W . When matrix W is multiplied by student's test we get 3-dimensional vector z . Each coordinate in vector z denotes possibility that x is element of corresponding class.

When student access the Smart LMS system with his username and password all courses screen is displayed like on Figure 5.1.

Smart LMS
SYSTEM

CS322 Programiranje u C#
CS101 Uvod u objektno-orijentisano programiranje
Lekcija 01
• Lekcija 1 - Uvod u Csharp i .NET - 2015-16
Lekcija 02
• Lekcija 2 - Kodiranje GUI aplikacija u Visual Csharp-u - 2015-16
Lekcija 03
• Lekcija 3 - Objekti u Toolbox-u - 2015-16

Figure 5.1: Courses on Smart LMS

After choosing course and lesson, test for lesson is being showed. Example of test is shown on Figure 5.2.

After student has done the test, result vector T was generate. Test student was done the test and his answers are in vector T :

$$T = [1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 0]$$

Proposed algorithm calculated classification vector z with coordinates:

$$[0.1331198385 \ 0.7149755415 \ 0.418144297]$$

Test: Lekcija 01 - C#

Šta je unmanagable kod?

- ☐ Kod pisan u C++
- ☐ Kod pisan u Javi
- ☐ Bilo koji kod pisan van .Net okvira
- ☐ Kod pisan u VB.Net-u

Ako je Monitor klasa šta je to Samsung ViewSonic 19 inch?

- ☐ Objekat
- ☐ Struktura
- ☐ Memorija
- ☐ Monitor

Šta je managable kod?

- ☐ Kod koji je pisan van .Net okvira
- ☐ Kod koji je napisan u VB.Net-u
- ☐ Kod pisan u C++
- ☐ Kod koje je pisan u .Net okviru

Figure 5.2: Example test for C# lesson 1.

The highest result is the student's category. In this case, the highest possibly has second class. Soour student is part of Middle knowledge category. This result in accordance with our expectations, because student gives correct answers to questions from easy class (first five questions) and two from three questions from medium class. This test student didn't know answers to questions from advance class.

After student is being classified into category, there is a need to find K nearest student with similar test result. In our study, K is set on value five. For calculated K nearest student, we use Euclidean's metric. When five the most similar students to new one is known, last step is to generating learning path for him. If there are no five nearest students, student is getting learning path with all learning objects and then he is tracked for later K nearest tests. For generating learning path, it is necessary to determine for each LO will it be visible for student or not. We considered five vectors with times for each of five the most similar students which student spent on reading and learning each LO.

Dimension of these vectors is equal to number of LOs in that lesson. These vectors are not binary, there elements denote time spent by student, learning from corresponding LO. Time is expressed in seconds. If pervious student didn't read some LO, element on corresponding position is set on value 0. Finally, the output from proposed algorithm is binary vector, same length as total number of LOs in lesson. This vector consists information about

which LO will be present student and which are not. On figure 5.3 there is an example of generated learning path for student.

After student finishes the lesson he has possibility to view all other LOs that were not used in his learning path. This enabled student to view learning objects that are maybe useful for his learning. Student that has custom learning path is also been tracked by time spending on each LO so K nearest student's results are getting better after each student finishes lesson.



Figure 5.3: Example of generated learning path for student

6. CONCLUSION

The goal of personalized learning process is student learning outcomes. This paper presents new approach to personalization of learning content implemented to the new platform which uses same resources as existing LAMS platform. Thus, each student obtains new learning content, which is personalized to its needs and abilities, and improves efficiency of learning process. Created software is prepared to be used in distributed environment of e-learning platforms, however it requires implementation of web services, which would publish the courses from different platforms on the Internet.

Acknowledgment

The work presented here was supported by the Serbian Ministry of Education, Science and Technological Development (project III44006).

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SYSTEM FOR LEARNING OBJECTS RETRIEVAL IN ONTOLOGY-BASED DATABASE COURSE

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Abstract: The aim of this work is to present how implementation of an ontology model in the online course based on learning objects (LOs) can be used to provide personalized learning material for the learner. In this model, learning materials are organized using its developed ontology, while its structure is visually presented as a graph so that it is easier for the learner to navigate through course topics. Each topic consists of a sequence of LOs and is represented as a node in the graph. Different types of relations were used: (i) relation between topic and corresponding subtopics describing that a subtopic is a part of another higher-level topic (ii) relation between the topic and its corresponding LOs noting that content of an LO is a part of a certain topic and (iii) relation between LOs which provide an information that LO has a pre-requisite LOs. Lexicon of LOs' keywords is also presented and mappings between the keywords and topics in the ontology are performed. Each keyword is linked to a corresponding topic, and vice versa – each topic in the ontology consists of at least one keyword. Benefits of using described relations are to allow easier navigation through learning material for the purpose of providing personalized content for adaptive learning. The scenario of the ontology usage during the learning process is also described through the ontology for Database course is presented.

1. INTRODUCTION

The rapid growth of e-learning has changed traditional learning behavior and presented a new situation to both tutors and learners. While traditional e-learning systems are used to publish learning materials in the format of written lectures, the tendencies of the new e-learning systems are steering towards the personalization of learning materials for each student [1]. A personalized e-learning system refers to an education system that focuses on learning that is tailored to the needs, attitudes, and interests of every learner [2]. The process of personalization of e-learning does not involve only the ability to customize the learning environment, but also to personalize many other aspects of the entire learning experience such as how the content should be delivered, how students will be evaluated, what feedback mechanisms will be offered etc. Personalized learning is a key strategy for improving student engagement and academic achievement [3].

An approach that represents a good candidate to achieve personalization in learning is to divide learning materials into smaller modular units that are referred to as learning objects (LOs). LOs can be defined as "any digital resource that can be reused to support learning" [4]. The idea of using eLearning system based on LOs is to create

learning material that is: (i) interoperable (can "plug-and-play" with any system or delivery tool, (ii) reusable (can be used or adapted for use in multiple learning contents), (iii) accessible and (iv) manageable (can be tracked and updated over time). Personalized systems do not provide only additional possibilities for direct access to the learning content in LOs, but also is suitable for an adaptive instructional design that relies on frequent evaluation and alternation [5].

Besides using modular reusable units of learning material, another requirement for achieving personalization is the usage of ontology. Ontology is a science that studies explicit formal specifications of the terms (concepts, relations, functions, and instances) in some domain of interest [6]. Representing knowledge in the form of ontologies enhances the management and retrieval of the learning material within personalized eLearning system and has very important role in the automatic processing of learning material [7].

In the relevant literature, there are a lot of proposed approaches which consider different ways how ontology can help the process of personalized learning. Monachesi et al. proposed LT4eL system, which uses ontologies in order to improve the reusability of available LOs within a Learning Management System, while allowing cross-lingual retrieval [7]. Their work approaches solving this

problem of multilingual environments by using a multi-language lexicon.

Chung and Kim describe ontology-based e-learning system which allows learners to build adaptive learning paths using the curriculum, syllabuses, ontology of course and topics [8]. By comparing student-learning outcomes before and after applying ontology approach to the class, authors conclude that the ontology-based teaching and learning enhances the learning outcomes.

Taking into discussion the particular case of the Computer Science field and its ACM classification system, Brut presents an ontology-based system and a search mechanism that establishes the relevance of each material for a certain topic, but results of system evaluation are not shown [9]. Capuano et. al considered ontologies as a basis for personalization of the IWT eLearning system which uses ontologies, annotated LOs and learner profiling to automatically assemble and deliver personalized content. [10]. They concluded that the introduction of personalization led to a relevant increase in the percentage of students who successfully completed an exam.

The objective of this paper is to present how the ontology can enhance the flexibility of the learning process in the online course and provide personalized learning material that is delivered to a learner. In order to verify the defined objective of this paper, the model of course material retrieval using ontology based on the ontology for a Database course specified by IEEE Computer Society's Information Technology 2008 Curriculum Guidelines for Undergraduate Degree Programs is presented [10].

The paper is organized as follows: Section 2 describes the ontology model for the Database course that consists of hierarchical components such as curriculum, course, course topics and its subtopics, LOs, and the corresponding relation between them. Section 3 describes the model of LOs retrieval demonstrated on the example of the ontology of the Database course. Described model enables students to find the most suitable learning path by navigating through ontology regardless of whether a learner is a beginner or not. Section 4 concludes the paper.

2. ONTOLOGY MODEL DEVELOPMENT FOR DATABASE COURSE

This work is using results of the previous work done by Cvetanovic and Raspopovic who developed the domain ontology for the key concepts for the Database course based on the body of knowledge defined in IEEE Computer Society's Information Technology 2008 Curriculum Guidelines for Undergraduate Degree Programs [11]. For the Database course, Information Management knowledge area defined in IEEE curriculum was used. In this particular knowledge area, ontology is defined at several levels, starting from high-level topics and branching out in hierarchical fashion all the way to the smaller subtopics. Several ontology components of hierarchical ontology architecture are given (Figure 1): (i) curriculum, (ii) courses, (iii) topics, (iv) subtopics and (v) LOs. LOs represent the smallest components in this

hierarchy and they contain learning content. The features of each component in the ontology are described with appropriate metadata.

An ontology that is developed for any domain, or in this case knowledge area, should conceptualize and contain elements that include information about the academic program where this area is thought, courses that utilize this knowledge area, key topics, learning outcomes and pedagogy methods used in the delivery of the learning material (teaching methods, delivery modes, etc.).

Similarly to the knowledge area that contains its ontology, the course also has its ontology containing topics, subtopics and belonging LOs.

Topic ontology described the topics and the subtopics that are thought during the course. In order to achieve reusability of learning materials, each subtopic may be further divided into smallest units - LOs. LOs are described by metadata consisting of a title, author, objective, education level, a level of difficulties, interactivity level and type, copyright, keywords etc.

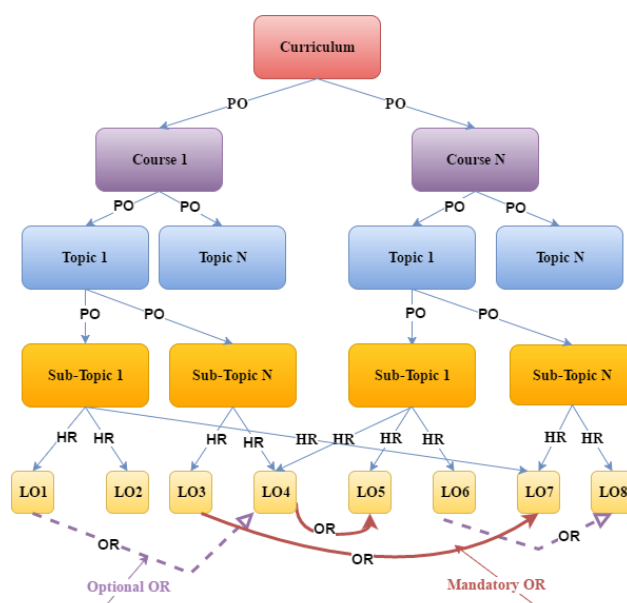


Figure 1 - The model of database ontology

Relations between ontology components are also specified. Three types of relations were used (i) "part of" (PO) relation used between different topics that describe that a subtopic is a part of another higher-level topic (ii) "has resource" (HR) relation used between a topic/subtopic and LOs means that LOs content explains the corresponding topic or subtopic (iii) "order relations" (OR) between LOs. OR relation is used in two cases: (i) it can be used to represent a mandatory relation providing an information that LO has a pre-requisite LO, which should be learned before accessing that specific LO (ii) or it can be used as an optional relation that represents only a recommendation which LOs may be learned before and that are typically learned by students who want to gain deeper knowledge. These relations (PO, HR, OR) are shown in Figure 1 (mandatory and optional relations are depicted by a single red line and a dotted purple line respectively).

It is important to say, that optional and mandatory relations can be established between LOs that do not belong to the same topic, which enable that LO content from a course can be reused in other courses as recommended or mandatory learning material.

In order to present the importance of ontologies in LOs retrieval, a lexicon of keywords is created and corresponding mapping between lexicon and ontology is established. This mapping has the aim to link each keyword from lexicon to a corresponding topic in the ontology and inversely to connect each topic in the ontology to at least one key word. Overview of the ontology and associated keywords in the lexicon is presented in Figure 2.

In this phase of the project, lexicon contains only keywords that are manually related to the specific LOs as metadata description. In order to provide a lexicon with keywords connected by meaning, synonym relation between correspondent terms needs to be established.

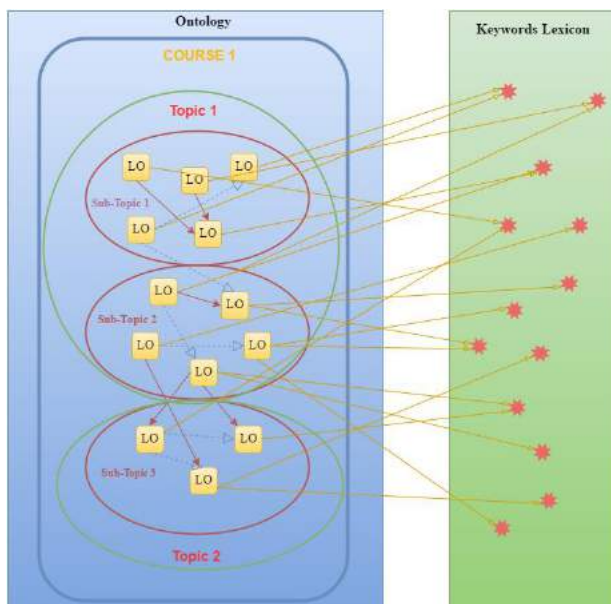


Figure 2: The relation between ontology and lexicons of keywords

Figure 2 depicts that keywords do not only describe LOs to which they are directly connected but are also based on *PO relation* in the ontology, correspondent subtopics, topic, and course. For example, Topic 1 in Figure 2 includes Subtopic 1 and Subtopic 2, which are described by keywords allocated to LOs belonging to these subtopics. Set of keywords that describe Topic 1 is obtained as the union of keywords that describe Subtopic 1 and Subtopic 2.

The defined model of the Database ontology and the relations between ontology and lexicon keywords has a very important role as a good basis to retrieve learning material to provide personalized learning.

3. MODEL OF LO RETEIVAL FOR THE DATABASE COURSE BASED ON ONTOLOGY

During the learning process, personalization can be achieved by retrieval of course material utilizing the course ontology and structure. Two types of retrieval are available:

- Ontology-based retrieval that enables users to see LOs content that belong to topic from ontology based on their search query
- Keywords retrieval that enables user to see LOs content related to keywords relevant to specified search query.

During the learning process learner can combine these two types of retrievals in order to get personalized content satisfying their learning needs. The retrieval is suitable for all learners: (i) non-beginners when learner has some knowledge about the given topic and (ii) beginners when learner is introduced to the topic for the first time. In both cases, learner starts the learning process by ontology-based retrieval. The objective of the ontology-based retrieval is to determine a starting topic. The process of finding starting topic is different for beginners and non-beginners, and it is described below.

Beginner, who learns a course for the first time, starts learning by selecting the highest level topic in the ontological model of the course. Thus, the learner has the ability to retrieve entire knowledge domain for a course. Figure 3 demonstrate the case when a topic from the highest level in the ontology model for the Database course is selected at the beginning of the learning process. In this case, six key subtopic are presented: (i) Information Management Concepts and Fundamentals (IMCF), (ii) Database Query Language (DQL), (iii) Data Organization Architecture (DOAR), (iv) Data Modeling (DMOD), (v) Managing the Database Environment (MDBE), and (vi) Special Purpose Databases (SPDB).

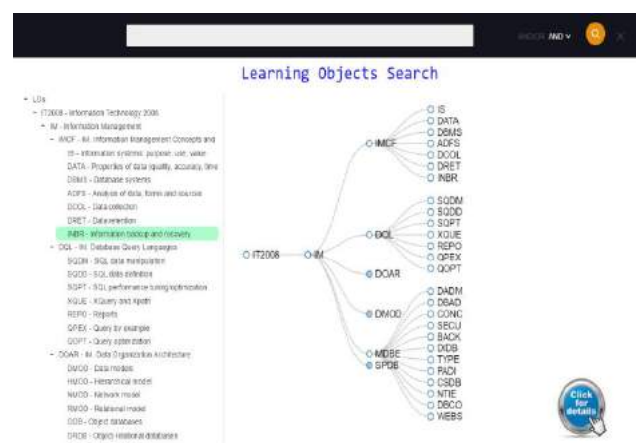


Figure 3: Database ontology in an LOs retrieval system

From the presented ontology, learner selects a topic that wants to learn first. The topic can be chosen by using the textual presentation of ontology (on the left side in Figure 3.), graph presentation (on the right side in Figure 3.) or the list of all topics in the search field (top menu in Figure 3).

An advanced learner who has some knowledge about the topics of the course, and wants to improve knowledge on a certain topic, can directly choose a topic by selecting it from the list of all topics in the search field.

After a topic is selected, the learner has the opportunity to see selected topic's subtopics on the first lower level. The subtopics for "IMCFIM Information Management Concepts and Fundamentals" topic from Database course is presented in Figure 4. The subtopics on the next lower levels can also be presented to the learner by clicking on the button "Show related topics", positioned on the right side of topic's name. By showing related topics, the learner has an option to navigate through the ontology until the topics on the lowest level are reached or student estimates that relevant topic for learning is found.

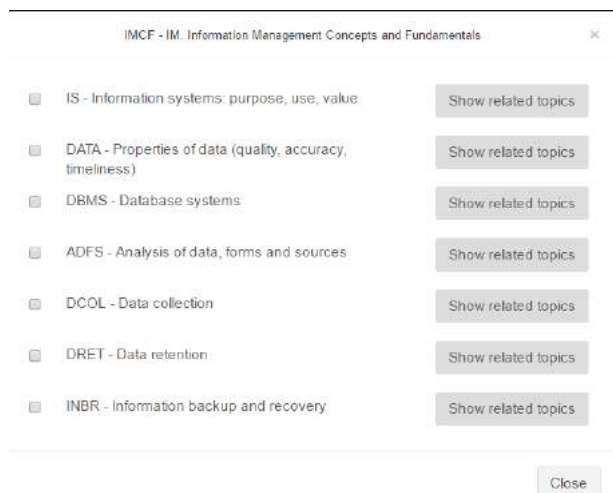


Figure 4: Related topics for the topic "IMCF - IM. Information Management Concepts and Fundamentals" on the first lower level in Database course

If a learner wants to see the learning objects for the selected topic in order to read their contents, he/she has to check the field on the left side on the topic name. Learning objects for the topic "DCOL - Data collection" from the Database course are presented in the Figure 5.

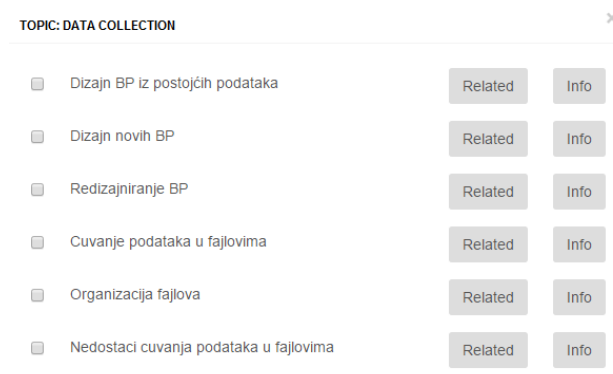


Figure 5: Learning resources for topic "Data collection"

Learner, from this point, can continue learning in different ways:

(i) In order to see the learning resource of a particular LO, learner can click on button "Info" for the relevant content for learning to be presented (Figure 6.)



Figure 6: Learning resource for a particular LO

(ii) By clicking on the button "Related", learner has the possibility to see the list of related LOs for the selected LO. In Figure 7, related LOs for learning object "Drop table" is presented. Relations **mandatory** and **optional** in the given example of the Database's LO "Drop table" mean that learner has to learn LOs "Alert table" and "Delete table" before learning "Drop table", without considering a specific order. At the same time learner has an optional LO to view at this point and this LO is "Rollback." In order to see the learning resources for related LO, learner has to double click on it (in Figure 6).

(iii) Learner also has the possibility to return back one level up by checking the field on the left side of the LO's name. By doing this, learner goes back to the starting topic (presented in Figure 4.) and can continue learning process by selecting other topics.

It is recommended that beginners complete learning process by going through all LOs.

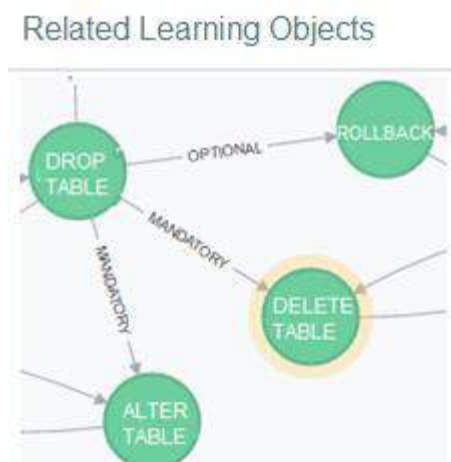


Figure 7: Related LOs for LO "Drop table"

On the other hand, when a learner has some knowledge about a topic for which many learning resources are offered, learner has an option to focus only on the topics of personal interest. Then, the previously extricated learning resources by ontological retrieval can be retrieved again by keywords that are specified by learner's queries. In a query, one keyword or many of them combined by logical operations AND/OR must be defined. (Figure 8)

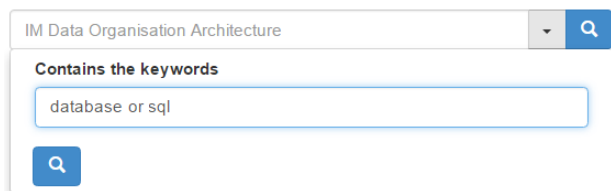


Figure 8: Search by keywords

The keywords search results will be represented as a list of topics (Figure 4) where all relevant topics containing LOs with queried keywords will be presented. These topics may be a part of the Database course and other courses in the curriculum. In such a way, learner has the ability to examine, not only learning resources from the given course but also other topics of interest that are related to it.

4. CONCLUSION

This paper addressed how a model of ontology can contribute to achieving personalized e-learning system and can enhance the learning process. This work proposed ontology-based LOs retrieval model, which was demonstrated on the example of the Database course. Used ontology-based model of retrieval is focused on the reusability and sharing of LOs, which can be easily used for other curricula and courses when needed. Part of the inheritance model should also define methods that will effectively determine whether the prerequisite knowledge is successfully learned.

In particular, the ontology-based retrieval has a possibility of integration with relevant Learning Management Systems (LMS) and shows the potential of ontologies in the application domain of learning material retrieval. Retrieval of LOs stored in LMS is based on existing lexicon of keywords which allows mapping of ontology to corresponding LO content in LMS.

Future work will focus on model improvements and including proposed model retrieval in the context of social learning environment in order to support not only learning activities from the LMS but also collaboration and communication between tutors and learners during the learning process.

ACKNOWLEDGMENT

The work presented here was supported by the Serbian Ministry of Education, Science, and Technological Development (project III44006).

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DEVELOPMENT OF FLIGHT SIMULATION EDUCATIONAL GAME

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Abstract: *In this paper we are describing the development of educational simulation game with audio-visual environment for flight simulation for a light aircraft at given airport using 3D game technology. The developed serious game is designed for the students initial familiarization how to control airplane flight. The development project was organized by a spiral model in which the cycles represent the individual student projects as a part of the education process. The paper describes the co-operation between the designer and developer (students of BMU) while creating a functional project.*

Keywords: *e-Learning, Educational systems, Educational games, Flight simulation game*

1. INTRODUCTION

Modern learning involves adaptive personalized learning to be more appropriate to human nature in comparison to the most popular learning method – Reading, considering that studies show how readers remember twice as more if they listen, rather than read, this increases five-fold if observation is involved [1].

Given that the goal of every teacher and every scientific institution is to provide the best possible education, there has been an increase of simulator usage in teaching. Simulators are computer programs (such as games or animated flowcharts), or dedicated devices that model some aspect of real life situations (For example: flying an aircraft), and can be manipulated to observe the outcome of different assumptions or actions, without exposing the experimenter to any danger or risk. Studying is the most effective when a student is placed in a real laboratory environment by use of simulators that allow practical exercises. Because of this reason, there is an increased tendency towards multimedia lectures, and one of these types of lectures involves simulators working on principles of serious games. Students who study lectures based on serious games and simulation can gain faster and more efficient knowledge, than in a traditional way [1]. Analysis have shown that teachers and students using such courses have more motivation to work, have better learning outcomes in comparison to the classes that are not based on realistic simulations and games. We must take into account that not every type of course is suitable for this kind of approach, but students listening to courses that can implement this approach had a easier time mastering the subject and often asked for it's implementation in conducted Surveys. In order to create a

functional simulation game, it is mandatory to start with learning objectives and create a detailed plan of simulation objects, to create a pleasant graphical presentation of given object and its environment, to program movement and object physics in a way that best mimics their real world counterparts.

This paper will present the creation of a flight simulation game that that uses the keyboard (rather than a dedicated hardware on training flight simulators) using Unity 3D game engine.

The simulator can be usefull to the BMU students, as well as to students of civil engineering and military aviation. Making a video game requires a combination of artistic and technical knowledge. The domain of so-called “serious games” is even more demanding, since it requires good comprehension of teaching goals, laws of physics and mechanics, along with the usual requirements of making a video game.

In order to cope with the complexity of creating a “serious game”, and it's multi-disciplinary requirements, the project described in this paper involved a students of Design, and a students of Software engineering.

This article will show experiences in using computer games in teaching and education in the BMU, where a doctoral student and graduate student work together using basic research techniques to solve the given problem. The contribution of this paper is showing different approaches to learning that have been shown as more useful for students in learning and employment.

2. USING THE SERIOUS GAMES IN TEACHING

Serious games and their potential as a teaching tool were first accounted for in a book „Serious Games“ by Clark C. Abt in the year 1975.[2] The autor of the book states: „We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement“. This educational potential shouldn't be focused only on video game design and IT, but also sports,military etc.

Considering the long history of focus towards creating a harmony between learning and having fun, the design of multimedia learning poses a question how can serious games be different from Edutainment (content designed to educate and entertain at the same time), entertainment education or e-learning. Michael and Chen [3] committed a analysis of using serious games in education, and reached a conclusion that this form of education far outshines the “traditional” approach. There is no more need to learn materials by rote.

Most designers and researchers agree that serious games are taking a step forward from Edutainment, in a sense that Edutainment games present a sub-category of serious games. This research classifies edutainment games as games belonging to a family of serious games, created for use in K-12 education. These games focus on transferring standard knowledge (like those in textbooks) using games as a method of motivating students. Seeing as e-Learning includes disciplines like Psychology, pedagogy, computer and information sciences, serious games can be used to enhance this type of learning, making it more adaptable and personalizable.

One of the biggest advantages in e-Learning is the flexibility in time and location of learning, and if we would use the broadest definition, we could say that E-learning falls under computer-based learning, and that would mark serious games as its sub-category.



Image 1: Relation between serious games and other related education concepts

The team project in this article istied to a serious game – a Airplane simulator.

The plan was to use a student project (commonly consisted of homework and individual and team projects) as a training to master the concept of creating a functional serious Game (in this case: an Airplane simulator).

In order to create a game, we first need to create design, and comprehend the behavior of a plane, and transfer that exact behavior that into code.

BMU has multiple programs that engage in making videogames and their design. Those would be: Interactive media at FDA (Faculty of Digital Arts), Computer Games at FIT (Faculty of Information Technologies) at bachelor level, Computer science at FIT at both master and doctoral course level [4].

The Interactive media course is focused on arts, and its basic goal is to teach students how to create animated 3d object in a virtual environment. These techniques are based on tools for drawing and modeling (Photoshop, Illustrator, Maya, 3D Studio Max) and basic uses of game engines (e.g. Game Maker Studio, Unity 3D)

The Computer game course on FIT is based on computer science and software engineering fields, with a focus on creating software and programing intelligent objects. Master and Doctoral studies put a focus on advanced 3d modeling and programing of complex object behaviors.

3. CREATING FLIGHT SIMULATOR AT BMU

The first flight simulator, not based on wind, was used in 1910 for training and could be considered a structure. This simulator consisted essentially of two barrel halves, one placed on a pedestal and the other which represented a swinging cockpit. The pilot sat in the upper half barrel, which was moved manually and then had to control various flight attitudes (orientation relative to the Earth's horizons).

The most commonly available computer based Aviation simulator (games) are:

- Microsoft Flight Simulator X
- Strike Fighters 2 and its expansions
- IL-2 Sturmovik
- Lock on Flaming Cliffs 2
- DCS Black Shark
- DCS Black Shark 2
- DCS A-10C Warthog
- Flaming Cliffs 3
- Rise of Flight
- IL-2 Cliffs of Dover
- Wings of Prey
- Falcon BMS
- Flight Pro Sim

Some of these simulators are used as training for pilots, and require use of a joystick and a wide range of additions that enhance the simulation of flying a real plane

In order to create a simulator, it is necessary to develop a detailed creating plan for simulation object, the object must be graphically represented (must draw object, or modeled it object...), after that we must programmed the movements, physic and environment for object... Scripts for this project are created in JavaScript and 3D Unity framework. 3D model is created in Maya.

In order to create a functional simulator, it is mandatory to create a detailed plan of simulation objects, to create a pleasant graphical presentation of given object and its

environment, to program movement and object physics in a way that best mimics their real world counterparts. The project was created in the Unity 3D framework environment, Models we're created using Maya.

Unity 3D (U3D) is a framework used in development of video games and other 2D and 3D content. It was created by Unity technologies in 2005. This framework allowed small teams of programmers to create games that would otherwise require a substantial number of people. Unity is a simple and effective environment for developing simulations that has support for multi-platform development. It is based on the C/C++ programming languages.

It is powered by a strong graphical engine and a suite of tools that allow intuitive and fast ways to create functional worlds for different platforms. At this time, unity can be used to develop software for iOS, Android, Windows, Blackberry 10, OS X, Linux, Browsers, Flash, PlayStation 3, Xbox 360, Windows Phone 8 and Wii U

Unity is a great productivity tool, and it can dramatically decrease time needed to fix programming mistakes, and by that decrease the costs associated with software development. It is used for organizing available resources, adding lighting and effect, physics and animation, testing and maintaining project, as well as publishing the end-version of our software.

Resources include: 3D models, Materials, textures, sounds, pictures, programming scripts and fonts. It supports a wide array of formats, making it's resource system robust and intelligent. All resources are hierarchically organized in scenes

Scripts are used for describing resource behavior – a scene is created by code and resources become interactable. We can tie multiple scripts to an object, which promotes reusability of code. Unity supports C#, Javascript programming languages, and they can be used together inside a same project.

For the purpose of this simulator, a thesis of our FDA student was used [10]. This thesis covered the subject of visually modelling an Airport and cockpit of a plane. Afterwards, a simulation was created in Unity 3D (airport, planes, moving elements, primary scripts)



Image 2: Primary version of the simulator

Airport of the town Vršac was used as the object of our model. This airport hosts the national pilot academy for civil aviation.

The plane used for training is the Light Cessna 172, hence this is the plane used for our 3D model. The FDU student created the planes primary movement without take-off [10].

A student of FIT made the scripts for the given model, hence allowing a realistic depiction of movement and take-off of the plan, by adding

- Control of basic maneuvers (roll, pitch, yaw, forward)
- Acceleration of planes movement forward by using a voice
- Control of the nose wheel of the plane by using pedals.
- A realistic depiction of the instrument board
- Scripts for animating the needles on the instrument board

4. CESSNA 172

The developed flight simulator 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 skyhawk 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.



Image 3: Cessna 132 overview

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

The look of the cockpit is shown below



Image 4: Cessna 172 cockpit

5. GETTING TO KNOW THE FUNCTIONING OF THE AIRCRAFT FOR SCRIPTS WRITING

The plane has 3 wheels, one of which is used for steering, and two for holding the planes weight

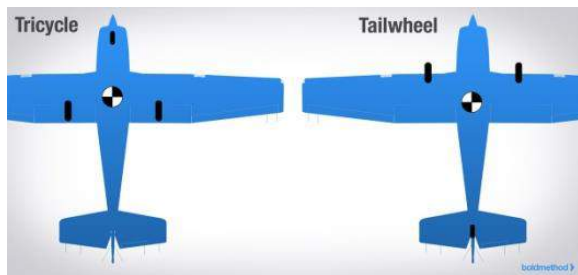


Image 5: Tricycle landing gear and tailwheel landing gear

With the so-called tricycle alignment, the steering wheel is housed in the front of the plane, rather than the back. Relations and scripts which will be shown can be used with both alignments, but the tricycle alignment will be shown.

On the ground, a pilot uses the pedals to move the ~~earry~~ nose wheel right and left in order to steer the plane in a desired direction.

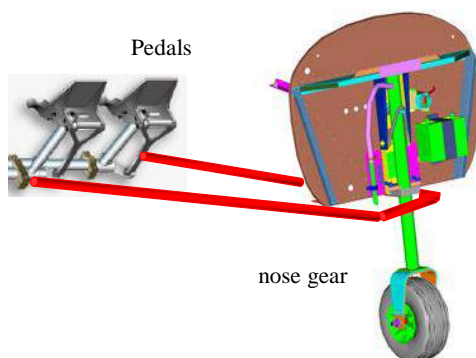


Image 6: Nasal wheel is controlled by pedals

It is important to note that the pedals also steer the rudder of the plane, which has a secondary role on the ground (since the plane is slower on ground than in flight, and hence, the aerodynamic forces are less intensive)

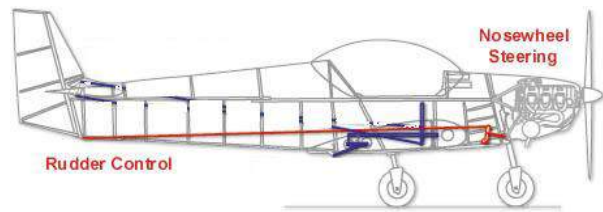


Image 7: Rudder is managed by rudder pedals

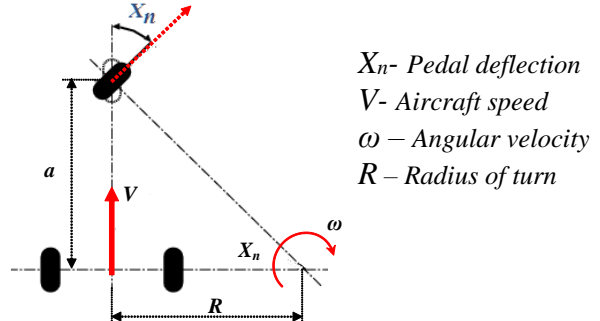


Image 8: Units of the taxiing (movement of aircraft on the ground)

Let us begin with the known relations (sizes are indicated in the figure)

$$V = R \omega$$

$$a = R \tan X_n \approx R X_n$$

thus affirms

$$\omega a = \omega R X_n = V X_n$$

If a is the distance between wheels, we can assume that:

The Angular velocity is proportional to the speed of the airplane V and pedal deflection (nasal wheel) X_n .

So we can state

$$\omega = r_{max} V X_n$$

where we have introduced the constant $r_{max} = 1/a$,

Now we can write the code to update the state of the plane after the pedals have been moved. Let's suppose that the plane is moving forward as well as to the side in order to reach Niš (or Novi Sad) from Belgrade. As with the car or other ground vehicles, the plane also adjusts height (in order to take off, land or move over an obstacle), but this was already done. Earlier scrips allow for the flight forward, as well as changes in altitude, but moving to the sides (the way the plane acts in these situations) is yet to be implemented.

The first idea is that we need to use the peddals to move the rudder, same as we would with a boat. But it's not that easy. This can be explained in the Wright brothers manner, if the plane flies straight, the wings are horizontal and generate the so-called lift force which keeps the plane in the air by balancing it's weight.



Image 9: Flights and forces in turn

If we have plane in turning whose radius is R and it moves with constant velocity V . By what degree should the plane be tilted (tilt angle is ϕ) in order to achieve a turnaround?

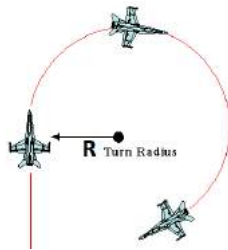


Image 10: Airplane in turn

The flight speed turning is proportional to the angle of inclination ϕ and inversely proportional to the speed of the plane V .

Another thing that needs to be noted is that in order to improve the plane we also need to make the needles of the control board operational.

First we need to make the needle (for example: cube), we make the plane behind her and apply the picture of the background(the scale) and implement the script for the needles movement.

The needle will now move over the point in her center, not over the point in the end(as do most needles), in order to fix this, we need to:

1. Make the needle.

We create the cube and scale it so it looks like a needle in U3D. If we want a more realistic look, we need to create a needle in Maya, export it in the fbx format and import it in U3D

2. Create a game object (GO) and name it „Indicator“

The point of this is that the needle(cube) can rotate over the point at the end, not in the middle (where the default coordinating point is set)

We set the cube in a new GO, and move it so the point on the end is located in the middle of the GO

3. Creating a test script

Using the arrows $<-$ and $->$ we rotate the indicator (the needle) in one direction.

4. Creating the size scale

We find an appropriate image of the instrument board, we separate the picture into a file (taking care that the dimensions are appropriate for the size of the textures, 32x32,64x64 etc.) and import it into the U3D project

After this, we create a plane, and put it behind the needle, then we drag&drop the background image of the instrument.

6. CREATING SCRIPTS FOR AIRCRAFT SIMULATOR UPGRADE

The behavior of GameObjects is controlled by the Components that are attached to them. Although Unity's built-in Components can be very versatile, you will soon find you need to go beyond what they can provide to implement your own gameplay features. Unity allows you to create your own Components using scripts. These allow you to trigger game events, modify Component properties over time and respond to user input in any way you like. That means that simple definition for scripting in Unity is how a programmer defines the behavior for object in the game.

Unity supports two programming languages natively:

- C#
- UnityScript, a language designed specifically for use with Unity and modelled after JavaScript.

Application programming interface (API) is a set of subroutine definitions, protocols, and tools for building software and applications. A good API makes it easier to develop a program by providing all the building blocks, which are then put together by the programmer.

The scripting reference is organised according to the classes available to scripts which are described along with their methods, properties and any other information relevant to their use. API in Unity are grouped by namespaces they belong to, and can be selected from the sidebar to the left. For most users, the UnityEngine section will be the main port of call.

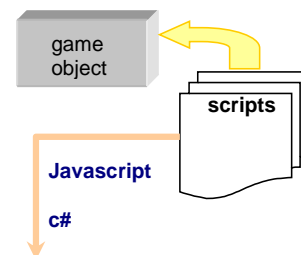


Image 11: Behaviors of objects are defined by the scripts



Image 12: Beta model

Before it came to work on the already modeled aircraft which was created for the purpose of graduate thesis,

primarily we created the airplane model in the order to better understand and create scripts which would operate the plane. It is necessary to define what exactly a plane should work and how that can be programmed. That is created by defining the beta model for testing scripts which can be seen in the following figure.

After creating script for beta model and after the testing, script code is transferred to existing model - primary model.

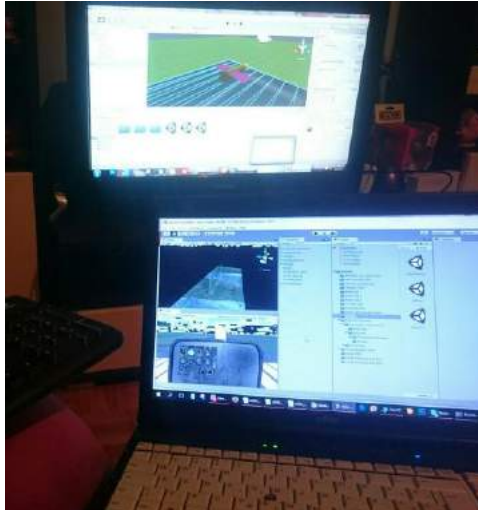


Image 13: Beta model preview and script transferring at the primary model

After creating the scripts and after using those scripts in the existing model, we have a plane with the ability to take off by using realistic physics (Image 14). The first part of image depicts the take-off and second the flight.

5. CONCLUSION

In this paper, we adopted approach that can be used in traditional and e-Learning, using serious games as a teaching tool, as well as a presentation of powerful teamwork between the FDA and FIT students at BMU.

The simulation game created for the purposes of this article demonstrates the increased interest for competition of specific project even when they exceed the bounds of the teaching plan.

The study shown provides encouraging results and a high interest of faculties students to work at teams and to create a final product at the end of completing the course, considering that the students successfully created the first version of the flight simulator which is planned to support VR technology and an ability to adjust flight controls for other types of aircrafts in the future, it can be said that this type of learning gives students stimulus for further work and therefore greater experience in working on real problems to graduates, helping in future employment.

From what we learned, we can say that serious games in cooperation with e-Learning present the future of learning and can be expected to become a standard in the advanced adaptive learning.



Image 14: Takeoff and flight

ACKNOWLEDGMENT

This work was supported by Ministry of Education, Science and Technology (Project III44006).

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ADVANTAGES AND CHALLENGES IN PRESENTING MATHEMATICAL CONTENT USING EDX PLATFORM

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Abstract: In recent years, rapid improvement of educational and internet technologies has contributed to faster development of Open Educational Resources. OERs have had significant impact on lifelong learning and on the availability of learning content. Despite worldwide trends, in Serbia the idea of implementing OER materials in higher education is still new. This paper presents a pioneer project in this area, creation of OER course “Preparation for entry exam”, using the edX platform. The course “Preparation for entry exam” is aimed at presenting course materials to help freshmen prepare for entrance exam. In this paper advantages and challenges in the process of creating such a course will be discussed. Special attention will be paid to presenting mathematical content within open educational platforms. The paper also assesses this course from the pedagogical and didactical points of view.

Keywords: OER, edX, course, mathematics

1. INTRODUCTION

At UNESCO's Forum, in 2002, Open Educational Resources (OERs) have been defined as digitised materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research [1]. OERs have been used for different topics and they can be in various forms from simple texts, pictures and videos to entire courses.

In this paper we discuss OERs related to Mathematics in Serbian. All over the world there are a lot of mathematical OERs and many of them are presented through Massive Open Online Courses (MOOCs). Among MOOCs we can distinguish cMOOCs, which are decentralised, network-based, with non-linear structure, and xMOOCs, where courses are hyper-centralised, content-based, linear, and followed by automated, multiple-choice testing of learners' understanding of the content [2, 3]. xMOOCs have become more popular after expansion of platforms such as edX, Coursera or Udacity, which are suitable for creating and using MOOCs. In this paper we present the xMOOC course “Preparation for entry exam”, which was created using the edX platform.

2. BAEKTEL-EDX PLATFORM

Course “Preparation for entry exam” (*Priprema za prijemni ispit* in Serbian) is created within the Open edX platform which is used as the educational platform of choice within the Tempus project BAEKTEL (Blending Academic and Entrepreneurial Knowledge in Technology Enhanced Learning). This project has put together partners from Western Balkans and EU universities from Serbia, Montenegro, Bosnia and Herzegovina, Italy, Slovenia and Romania as well as two partners from industry [5]. The idea of the project was to establish a system for creating, publishing, maintaining and searching of OERs both from academic institutions and enterprises. An important part of this system is the Open edX platform, which was adapted for the needs of BAEKTEL project (edX-BAEKTEL platform). This edX-BAEKTEL platform offers some advantages suitable for creating, publishing and using course such as “Preparation for entry exam”. For example, [4]:

- 1) Improvement of the quality of learning materials through peer review processes and use of modern technology.
- 2) Innovation in the teaching process, openness and availability with low costs.
- 3) Short periods for publishing learning material, while serving the needs of particular student populations such as those with special needs, with the benefits of contextualization.
- 4) Personalization and localization by optimizing the deployment of institutional staff and budgets, and serving students in local languages.
- 5) Involving students in the selection and adaptation of OER in order to engage them more actively in the learning process.
- 6) Encouraging creation of new educational models.
- 7) Promoting the institution and individuals who are creating OERs.
- 8)

3. COURSE “PREPARATION FOR ENTRY EXAM”

Course “Preparation for entry exam” is aimed at presenting course material to help freshmen prepare for entrance exam. The course is available within EdX-BAEKTEL platform¹ (Image 1). We believe this is a suitable way for making preparation materials accessible to a larger community of potential students. Such a course allows them to access free and open materials anytime from anywhere. The course contains the following sections: *Courseware*, *Course Info*, *Discussions* and *Progress*. *Courseware* contains course learning materials, *Course Info* contains updated course news and information, *Discussion* is the section for mutual communication between enrolled students and there is also a *Progress* section, which allows students to monitor their progress within the course.

¹Edx- BAEKTEL-Preparation for entry exam
<http://edx.baektel.eu/courses/course-v1:UB+UB8+2016/courseware/28a75ec7a9a44eedae3231b804e229f4/>

Priprema za prijemni ispit UB

YOU ARE ENROLLED IN THIS COURSE

VIEW COURSEWARE



Image 1: Access to course “Preparation for entry exam”

The learning materials are divided in 13 subsections. Every subsection presents one mathematical theme. Subsections contain a theoretical part and a part with exercises. The theoretical part contains basic axioms, theorems and formulae related to a specific mathematical topic. Usually that part of the course is static and it does not require any interaction between user and course. It is the part of the course where students can find necessary knowledge for that topic. Another part of the subsection is

Rešenje jednačine

$$\log_3(\log_2(\log_5(x))) = 0$$

pripada intervalu:

☐

(0, 8)

☐

(8, 16)

☐

(16, 24)

☐

(24, 32)

?

CHECK

SHOW ANSWER

the part for exercise, which contains tasks that represent relevant and purposeful examples for the specific mathematical topic. The students are first given the opportunity to try to solve tasks by themselves. Tasks solutions are usually given in the multiple choice form (Image 2). There students can check their solution and then see the detailed, step by step solution process, if needed (Image 3).

Rešenje

$$\log_3(\log_2(\log_5(x))) = 0$$

$$\log_2(\log_5(x)) = 1$$

$$\log_5(x) = 2$$

$$x = 25$$

Dakle, rešenje pripada intervalu (24, 32).

CHECK

HIDE ANSWER

Image 3: Solution of the task

Image 2: Multiple choice task at course

4. PRESENTING MATHEMATICAL CONTENT USING EDX-BAEKTEL PLATFORM

Over the last few years, mathematical content on the web is increasing, which means that production and exploitation of mathematical content using information technology (IT) is in progress [6]. Experts stress the importance of using TPACK framework (Image 4) in creating mathematical content. TPACK has been presented as a system which interconnects and intersects technology, pedagogy, and content knowledge [7]. According to this model technological knowledge has an

important place in creating mathematical content. However, creating mathematical content usually requires specific knowledge in using technologies, which poses an additional challenge in creating such content. For example, a creator of materials might be capable of using a specific software successfully in solving some tasks, but would need additional knowledge in integrating that software with other resources and pedagogical requirements [8].

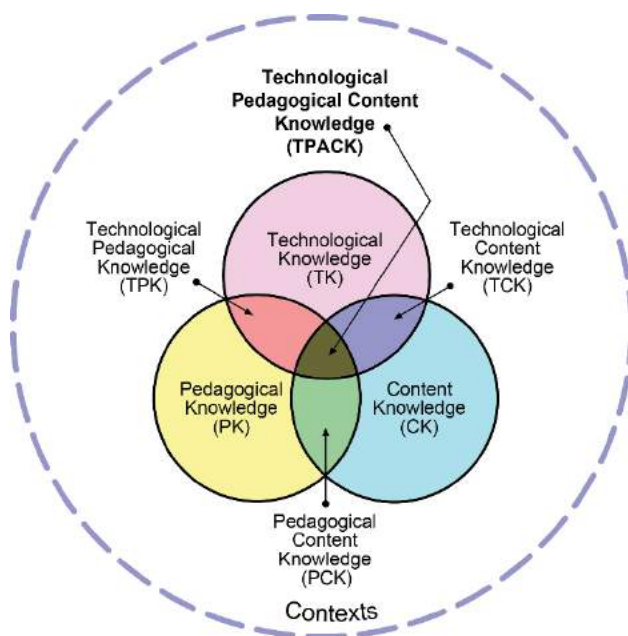


Image 4: TPACK framework(<http://tpack.org>)

In this section we give a detailed description of the necessary knowledge and skills for creating mathematical content within the edX-BAEKTEL platform.

edX-BAEKTEL platform contains two main components. The first one is a portal aimed for course enrolment and usage of course materials, and the second (edX Studio) is a backend control panel for creating and updating published materials [5]. edX Studio allows creating and combining different types of content, such as text, video, task or discussion. In the course “Preparation for entry exam” we mostly used a combination of text component and task component. The text component contains an editor for writing plain text, with basic editing functions, such as choosing fonts and size of text, adding pictures and links and setting up indentations. Besides the basic editor, the creator of materials can use HTML view of text. In that case the creator has more opportunities in editing text but it demands creator’s basic knowledge of HTML.

Task component offers a few on-board frameworks for different types of tasks. For example, there are possibilities to create multiple choice task, task with text or numerical input, checkbox task or tasks with hints and feedbacks. The platform offers additional advanced options for task design like circuit schematics builder, image mapped input, peer assessment etc. These additional options require some basic programming in Python. All these types of task work with edX tags which annotate the type of content: a question, a response, a

possible response and etc. Also there are possibilities for customizing the weight of each problem, number of attempts, feedbacks, randomization of offered answers and time between attempts.

A common situation in creating the course “Preparation for entry exam” was writing mathematical expressions and formulae. Mathematical formulae are written in LaTeX form between mathjax tags. Within the edX-BAEKTEL platform the usage of mathjax tags is required, which informs the system that there is a mathematical formula (Image 5). MathJax presents a cross-browser JavaScript library that displays mathematical notation in web browsers using LaTeX document preparation system.

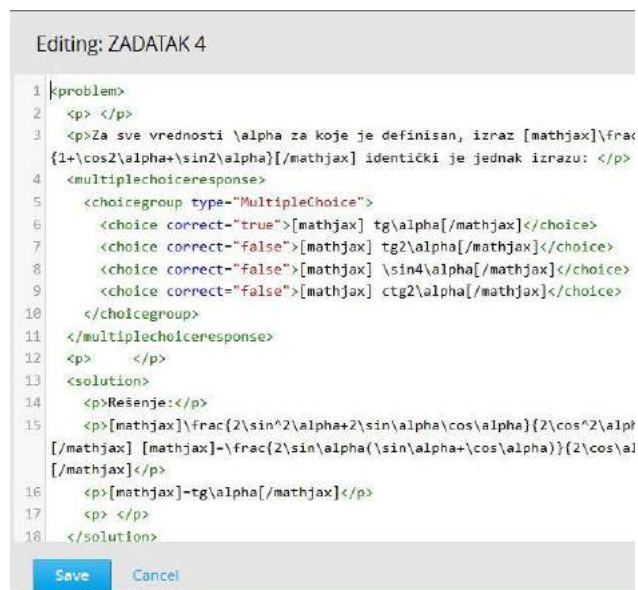


Image 5: Example of tasks editing

According to [5] edX-BAEKTEL platform presents a very good environment for creating courses from a didactical point of view. Some of the didactical principles are present in “Preparation for entry exam”. Dividing content in sections, subsections, lessons and units provide a clear structure of course material, which is in line with the didactic principle of systematization and gradualism in the teaching process. Didactical principle of awareness within the teaching process is represented through the tasks, where activity of users and some kind of interaction between users and platform is required, which contributes to the active role of students [9].

The edX-BAEKTEL platform thus offers favourable functionalities, although the interface is not user-friendly with respect to mathematical content writing. Also, for more complex questions deeper technological knowledge is needed. It may be noticed that edX-BAEKTEL platform is a suitable platform in general but for some specific topics, such as mathematics, additional improvement are needed.

5. TERMS RESOURCES IN EDX-BAEKTEL MATHEMATICAL COURSE

The Termini application has recently been launched to serve as a support for the development of terminological dictionaries in various fields. The realization of the application was based on the ASP.NET Framework for C# programming language and MVC design pattern, as well as HTML and JavaScript, whereas SQL Server served as support for the database. The application is located at <http://termi.rgf.bg.ac.rs/> and consists of 5 specific units: browse, search, update, bibliography and profiles. Termini currently supports the processing and presentation of terms in Serbian and English, but support for other languages is also planned.

On the Browse page all terms verified by editors can be viewed. The page is visible to all users regardless of whether they are logged in or not. On the left side of the page a hierarchical display of the vocabulary terms is available. Besides its name, each term has its synonyms, abbreviations, description and bibliography. In case that the description of a term contains a Latex fragment, the fragment will be interpreted, which helps in the presentation of mathematical formulae (Image 6).

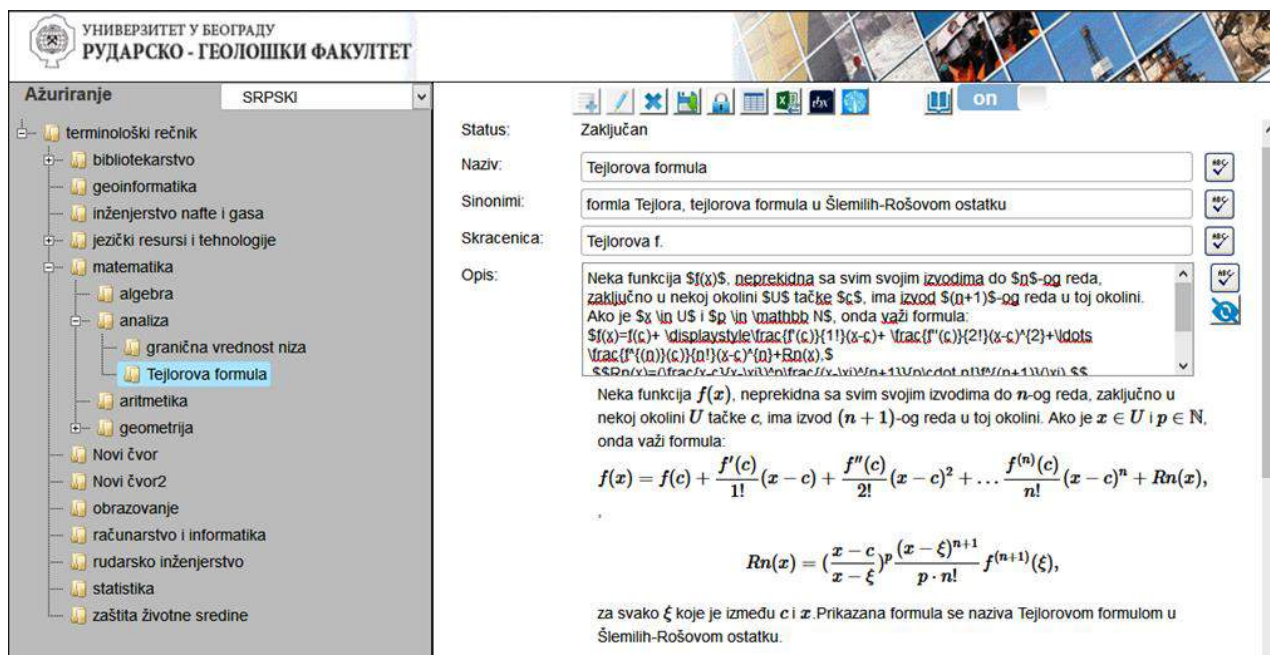


Image 6: Display of mathematical content through Termini editor

Termini is used with the “Preparation for entry exam” course, as it represents a suitable dictionary for mathematical terms. An additional option in Termini is the possibility of creating an export link to a term, which can be embedded in an HTML page. This provides for establishing a connection between a term within the course and its definition in Termini dictionary. From the user’s point of view this addition to mathematical content within the course can be very useful as some kind of reminder for specific or infrequent mathematical terms.

User can open a pop up window with definition from Termini resources by dragging the cursor over the term in the course (Image 7). Also, there is a link which allows the user to see the term in Termini application with additional information, such as synonyms, hyperonyms, hyponyms, abbreviations, description and bibliography.

ZADATAK 1 (1 point possible)

Jednačina tangente kružnice

$k: x^2 + y$ Tangenta je prava koja u datoj tački dodiruje krivu.[...]

koje su paralelne pravoj

$$p: 2x - y + 1 = 0$$

Image 7: Pop up window with definition of term

6. DISCUSSIONS AND SUGGESTIONS

Despite the advantages of OER courses their usage is still at a low level in Serbia. There are not many OER courses in higher education in Serbian and there are almost none suitable for elementary and secondary school. It is interesting to note that the course “Preparation for entry exam” was suggested to more than 300 students, but only 155 students have enrolled. There can be many reasons for that situation, such as unsuccessful promotion of the course and its content, lack of students’ habit to use OER courses, lack of interest of students for additional learning materials or students’ fear that their work will be evaluated by their future teachers. Also, internet access

and minimum of informatics education was required for usage of this course. After ten years of introducing OER, this idea is still not quite adopted, probably because it does not mean just adding a new tool, but rather changing a learning paradigm. But there are still open questions what can be done to improve and promote OER in Serbia and to explore crucial reasons for scarce use of OERs.

Also from a technical point of view, the edX-BAEKTEL platform needs some improvement for creating mathematical OERs. Besides the need for a more user friendly editor and more possibilities in presenting mathematical content, there is also a need for engines which support searching of mathematical content. Currently, there is a search engine for searching mathematical content within edX-BAEKTEL course does not exist. A prototype can be WikiMir-mathematics information retrieval system, which is based on keyword, structure and importance of formulae in a document [10]. For such search adequate resources as mathematical term bases are needed. According to [11] there is a great difference between natural languages and mathematical terms. For instance, in Serbian natural language the word "prava" is an adjective but within mathematical terms in Serbian it is a noun. Thus, there is a need for developing a Semantic, Multilingual Termbase for Mathematics (SMGIoM) [11], a semantic term base with strong terminological relations and an explicit and expressive domain ontology. Such a resource would facilitate quick search and analysis of mathematical content. To date, there is no publicly available resource for mathematical content management in Serbian.

7. CONCLUSION

This paper discussed OER materials in Serbian, and the open issue of their acceptance among students. Also we have analysed edX-BAEKTEL platform possibilities for creating and publishing mathematical content. The paper offered an example how different resources can be combined in creating mathematical learning content, such as using the Termi application for mathematical terms. Some challenges in creating mathematical courses within the edX-BAEKTEL platform were pointed out. The lack of engines and resources for deeper analysis and search of mathematical content in Serbian was emphasized. Future work will be based on a more comprehensive research related to awareness of importance of OER materials in Serbian learning environment. In parallel, improvement of lexical resources for mathematical content in Serbian will be continued.

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TOWARDS TRANSLATION OF EDUCATIONAL RESOURCES USING GIZA++

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Abstract: *E-learning courses are becoming progressively popular. Thanks to the Internet and new technologies, education has never been more available to everyone. The main obstacle to studying new subjects is often the language, given the number of different languages in which educational resources are published as well as the corresponding cultural context. That is why the tools for translation of e-learning courses and translation support are nowadays one of the most important topics in this area. E-learning course translation is a very special service that requires specific subject-matter expertise and high technical skills from everyone involved. This paper presents the current state of research in course translation. The translation of electronic courses is an ongoing activity at the University of Belgrade Faculty of Mining and Geology and the first results using the GIZA++ tool for training statistical translation models will be presented. The paper also describes the translation memory in the form of parallel sentences or phrases required by GIZA++ for the learning algorithm.*

Keywords: *E-Learning, GIZA++, translation memory*

1. INTRODUCTION

Massive Open Online Courses (MOOCs) are becoming very popular recently. More than 200 universities around the world are involved in their creation, with the involvement of more than 500 Universities, more than 4200 courses on offer and around 35 million users being actively registered [1]. MOOCs have major contribution to lifelong education. They are a tool to help identify and fill the gap that exists in the digital skills of workers across Europe. The language barrier is the biggest obstacle that stands in the way of the development of online courses as the majority of such courses are offered in English. Thus a growing need for translating MOOC content. The solutions provided so far have been fragmentary, human-based, and implemented off-line by the majority of course providers. [2]

TraMOOC (Translation for Massive Open Online Courses) is a Horizon 2020 collaborative project aiming at providing reliable machine Translation for MOOCs. The main result of the project will be an online translation platform, which will utilize a wide set of linguistic infrastructure tools and resources in order to provide accurate and coherent translation to its end users. [3] TraMOOC constitutes a

solution to online course content translation that aims at eleven target languages, is automatic – i.e. it is based on statistical machine translation (SMT) techniques – and is therefore easily extendable to other languages, adaptable to various types of educational content genre, independent of course domain, and designed to produce translations online via its integration in the use-case platforms.

TraMOOC translation includes all types of text genre included in MOOCs: assignments, tests, presentations, lecture subtitles, forum text, from English into eleven languages, i.e. German, Italian, Portuguese, Greek, Dutch, Czech, Bulgarian, Croatian, Polish, Russian, Chinese, which constitute strong use-cases, many of them hard to translate into and with relatively weak machine translation (MT) support. Phrase-based and syntax-based SMT models are developed to address language diversity and support the language independent nature of the methodology. For high-quality MT and to add value to existing infrastructure, extensive advanced bootstrapping of new resources is performed, while at the same time innovative multi-modal automatic and human evaluation schemata are applied. For human evaluation, an innovative, strict-access control, time- and cost-efficient crowdsourcing set-up is used, while translation experts,

domain experts and end users are also involved. Results are combined into a feedback vector and used to refine parallel data and retrain translation models towards a more accurate second-phase translation output. The project results will be showcased and tested on the Iversity [4] MOOC platform and on the VideoLectures.NET digital video lecture library. The translation engine employed in TraMOOC is Moses [5], the most widely used SMT toolkit available in academia as well as in commercial environments, mainly due to its flexibility, modularity, open-source licence, and competitive translation results. [2]

2. RELATED WORK

Coursera, a leading MOOC provider [5], has announced a partnership with ten top organizations from eight countries to translate complete course lectures across multiple disciplines for students around the world, for free. There are three basic approaches to course translation: human translators (traditional), translation using CAT (Computer Aided Translation) tools and machine translation. It is, of course, possible to combine some or all of them.

Leading translation companies, philanthropic organizations, mobile carriers, nonprofits, corporations and universities have joined forces in this partnership. The organizations started with translating selected courses into: Russian, Portuguese, Turkish, Japanese, Ukrainian, Kazakh, and Arabic, as the most popular languages for Coursera students. General approach is that each Coursera Global Translation Partner starts with translation of 3-5 selected courses.

For multilingual support Coursera [7] uses Transifex [8] continuous localization platform, as a cloud-based tool that hosts Coursera's translatable content and allows partner organizations and individuals to easily contribute course translations from anywhere. At this moment, support for user interface in five languages is available, but the long-term goal is to have platform localized to global audiences.

Students can log in to Coursera and check options for type of language support with information about translation offerings in the coming months. In this phase, course lectures are translated via subtitles while all other course material, including quizzes and assignments, are in the source language.

Coursera welcomes at the moment 145 partners across 28 countries offering over 2,000 courses. By joining forces with top organizations globally to produce fully translated course lectures, Coursera with translation partners is producing high-quality education accessible to anyone, anywhere – regardless of what language they speak.

3. TRANSLATION OF EDUCATIONAL RESOURCES - CURRENT APPROACHES

For translation of eLearning resources both language translation, and eLearning skills are necessary. The translation team needs knowledge of various software platforms and custom formats. Data exchange with different platforms can be technically challenging, since there is no common format and schema. [9]

The understanding of adaptation of languages for text and speech is also required, as many eLearning courses have an

audio component. Recommendation is that the translation team works closely with the course authors, in order to fine-tune the translation. In order to keep the original style of the course, it is recommended to recruit translators that better capture the essence. Vocabulary, word choices, general style must remain similar in all translated versions. Reference materials from course authors are also helpful, as well as previous translations, glossaries, style guides, translation memory files.

With an iterative and agile approach to translation it is possible to adapt as problems arise or courses are changed during translation. Proper planning is essential. General guidelines and workflow for eLearning course translation should start with an initial representative segment as a pilot, in order to evaluate the quality of the translation and formulate suggestions for the improvement of the rest of the translation. The translation needs several reviews before publishing or preparation for voice recording. [10]

A Computer Aided Translation (CAT) Tool is based on collection of aligned sentence pairs in the form of Translation Memory, which facilitates and speeds up the translator's work. Main key functions of a CAT tool that speed up and improve translation are: [11]

A CAT tool segments the source text in segments, usually sentences, and uses them to filter and preview the matching segments in a suitable way, usually in specific box, next to or below the source text.

The source text and translation of each segment are saved together, processed and presented as a translation unit (TU).

Translation memory (TM) is a database in which CAT tool saves the translation units, so that they can be re-used for later translations. If there are segments that do not match 100 %, the search functions of CAT tools can find them through special "fuzzy search" features.

CAT tool has support for terminology look-up, display and insertion of the search results into the text being translated.

4. ENVIRONMENT FOR TEXT ALIGNMENT

Preliminary phase for the text alignment (parallelization) consists of XML document (eXtensible Markup Language) preparation according to TEI (Text Encoding Initiative) consortium guidelines. In practice, this step is comprised of marking the divisions, titles, paragraphs and segments using text or XML editing software with support for DTD (Document Type Definition) scheme validation and well-formedness check. This part can be automated using finite-state transducers, but manual intervention is still necessary.

The next key step is aligning the text – parallelization. The aim is to determine for each text segment which segment of the translated text correlates with the segment in the original text. The task is thus to establish the connection between originals and their translations. In this process, segments are paired that sometimes represent whole sentences and sometimes just their parts, depending on the complexity of the sentence or the translation itself.

Parallelization can be performed using ACIDE software [11]. As an end result, three documents are created with

extension `_f_id`, `_s_id` and `_fs`. The first two represent the original documents, whose `seg` labels are tagged with the

```
<div>
<p>
<seg id="n15">1. An Ocean of Digital Words</seg>
<seg id="n16">A society of information offers almost
a limitless amount of information to everyone.</seg>
<seg id="n17">Without the usage of intelligent,
efficient applications for information extraction,
which are based on highly advanced techniques and
methods, one can benefit only from the smallest part
of potential offered by new technology (Piskorski
1999).</seg>
<seg id="n18">If we define information as a result of
collecting, processing, manipulating and organizing
data in order to present new knowledge to the
recipient, than it can be said that a piece of data
```

attribute `id="nx"`, where `x` represents the serial number of the segment. Examples are shown in the image 1.

```
<div>
<p>
<seg id="n15">1. Okean digitalnih reči</seg>
<seg id="n16">Informatičko društvo stavlja na
raspolaganje gotovo neograničenu količinu informacija
svakom pojedincu.</seg>
<seg id="n17">Bez upotrebe inteligentnih, efikasnih
aplikacija za ekstrakciju informacija koje se zasnivaju
na vrlo naprednim tehnikama i metodama, pojedinac nije u
mogućnosti da iskoristi ni delić nesagledivog
potencijala koji nude nove tehnologije (Piskorski 1999).
</seg>
<seg id="n18">Ako informaciju definišemo kao rezultat
sakupljanja, obrade, manipulacije i organizovanja
podataka sa ciljem da se primaocu predstavi novo znanje
```

Image 1: examples of segmented XML texts: English left and Serbian right

Document with the extension `_fs` contains the information about paired segments. The method used in the alignment is based on the number of characters (length of the segment). This approach is very successful (on the average as much as 96% correctly paired segments). Mistakes in pairing, however, must be corrected manually, which is done through the Concordancier software. [13]

The next step is the production of a TMX document [14]. The document consists of `<header>`, `<body>`, `<p>` (paragraph), `<tu>` (Translation Unit) and `<tuv>`

(Translation unit variant) elements. [15] Metadata code (element `<prop>`) is attached to each aligned sentence (element `<tu>`) in order to establish a direct relation to metadata and the original (pdf, edX, docx,...) form of resource document, article, course or other resource. Image 2 presents one part from the TMX document with ID: 1.2010.1.4.

From aligned TMX documents is easy to produce parallel text form for tools like Giza++, or JSON format suitable for web services and Mongo and other NoSQL databases.

```
<tu>
<prop type="Domain">Gucul-Milojević, 2010, vol. XI:1, ID: 1.2010.1.4</prop>
<tuv xml:lang="en" creationid="n15 " creationdate="20110513T151548Z">
<seg>1. An Ocean of Digital Words </seg>
</tuv>
<tuv xml:lang="sr" creationid="n15 " creationdate="20110513T151548Z">
<seg>1. Okean digitalnih reči </seg>
</tuv>
</tu>
<tu>
<prop type="Domain">Gucul-Milojević, 2010, vol. XI:1, ID: 1.2010.1.4</prop>
<tuv xml:lang="en" creationid="n16 " creationdate="20110513T151548Z">
<seg>A society of information offers almost a limitless amount of information to everyone. </seg>
</tuv>
<tuv xml:lang="sr" creationid="n16 " creationdate="20110513T151548Z">
<seg>Informatičko društvo stavlja na raspolaganje gotovo neograničenu količinu informacija
svakom pojedincu. </seg>
</tuv>
</tu>
<tu>
<prop type="Domain">Gucul-Milojević, 2010, vol. XI:1, ID: 1.2010.1.4</prop>
<tuv xml:lang="en" creationid="n17 " creationdate="20110513T151548Z">
<seg>Without the usage of intelligent, efficient applications for information extraction, which
are based on highly advanced techniques and methods, one can benefit only from the smallest
part of potential offered by new technology (Piskorski 1999). </seg>
</tuv>
<tuv xml:lang="sr" creationid="n17 " creationdate="20110513T151548Z">
<seg>Bez upotrebe inteligentnih, efikasnih aplikacija za ekstrakciju informacija koje se
zasnivaju na vrlo naprednim tehnikama i metodama, pojedinac nije u mogućnosti da iskoristi ni
delić nesagledivog potencijala koji nude nove tehnologije (Piskorski 1999). </seg>
</tuv>
</tu>
```

Image 2: An example excerpt from a TMX document

5. TOWARDS MACHINE TRANSLATION FOR SERBIAN

Moses is a statistical machine translation system written in C++ with library that enables usage of Moses in the JavaScript language. Loading multiple translation systems into the same node process is provided. This means the same process can hold multiple distinctly different translation models (e.g., Chinese to English in IT and

English to French in medicine) at the same time, and be able to use those models to translate user-given sentences or paragraphs on-demand. [5]

GIZA++ is an extension of the program GIZA which was developed by the Statistical Machine Translation team during the summer workshop in 1999 at the Center for Language and Speech Processing at Johns-Hopkins University (CLSP/JHU). GIZA++ includes a lot of

additional features. The extensions of GIZA++ were designed and written by Franz Josef Och.

GIZA ++ is installed on the Faculty of Mining and Geology as part of Moses, which is hosted as a virtual machine. It uses the Linux operating system. GIZA is quite a demanding tool, and it therefore requires extra resources. Its execution process requires a larger amount of RAM, which in our case was 16GB.

Corpus Preparation

For our research we used five text collections, three of them being scientific journals and two resources produced within international projects. Total number of documents is 299 in English and the same number in Serbian, while the total of aligned sentences is 67,206.

Haddow et al. [16] give a general MT system overview with details on the training pipeline and decoder configuration using Moses toolkit. [5] In this research we followed their approach, albeit with available resources for Serbian.

To prepare the data for the translation system, we had to perform the following steps:

tokenisation: This means that spaces have to be inserted between (e.g.) words and punctuation.

truecasing: The initial words in each sentence are converted to their most probable casing. This helps reduce data sparsity.

cleaning: Long sentences and empty sentences are removed as they can cause problems with the training pipeline, and obviously mis-aligned sentences are also removed.

Tokenisation launch was initialized by the following sequence:

```
~/mosesdecoder/scripts/tokenizer/tokenizer.perl -l en \
< ~/corpus/training/edX.en \
> ~/corpus/edX.tok.en

~/mosesdecoder/scripts/tokenizer/tokenizer.perl -l sr \
< ~/corpus/training/edX.sr \
> ~/corpus/edX.tok.sr
```

The truecaser first requires training, in order to extract some statistics about the text:

```
~/mosesdecoder/scripts/recaser/train-truecaser.perl \
--model ~/corpus/truecase-model.en --corpus \
~/corpus/edX.tok.en

~/mosesdecoder/scripts/recaser/train-truecaser.perl \
--model ~/corpus/truecase-model.sr --corpus \
~/corpus/edX.tok.sr
```

Finally cleaning and limiting the length to 80 was performed:

```
~/mosesdecoder/scripts/recaser/truecase.perl \
--model ~/corpus/truecase-model.en \
< ~/corpus/edX.tok.en \
> ~/corpus/edX.true.en
```

```
~/mosesdecoder/scripts/recaser/truecase.perl \
--model ~/corpus/truecase-model.sr \
< ~/corpus/edX.tok.sr \
> ~/corpus/edX.true.sr
```

```
~/mosesdecoder/scripts/training/clean-corpus-n.perl \
~/corpus/edX.true sr en \
~/corpus/edX.clean 1 80
```

Language Model Training

A language model (LM) is used to ensure fluent output, built with the target language, in our case English. Following script creates *lm* folder, positions in it and finally execute command that will build an 3-gram language model.

```
mkdir ~/lm
cd ~/lm
~/mosesdecoder/bin/lmplz -o 3 <~/corpus/edX.true.en >
edX.arpa.en
~/mosesdecoder/bin/build_binary \
edX.arpa.en \
edX.blm.en
```

Finally, we came to the main event - training the translation model. To do this, we ran word-alignment (using GIZA++), phrase extraction and scoring, created lexicalised reordering tables and Moses configuration file, all with a single command. Before starting the command, we created a working folder in which results were stored.

```
nohup nice ~/mosesdecoder/scripts/training/train-
model.perl -root-dir trainedX \
-corpus ~/corpus/edX.clean \
-fsr -e en -alignment grow-diag-final-and -reordering
msd-bidirectional-fe \
-lm 0:3:$HOME/lm/edX.blm.en:8 \
-external-bin-dir ~/mosesdecoder/tools >& edX.out &
```

After starting the command it takes some time to get to the results. In our case, it took about 90 minutes. The result is a file that contains paired Serbian and English words with a factor of accuracy for translation from Serbian to English and from English into Serbian. In the background of Image 3 GIZA++ program the output result of machine translation is shown as a “phrase table”, which is analysed in a custom made C# application, filtered, sorted and exported as excel file (Image 3, front). A “phrase table”¹ is a statistical description of a parallel corpus of source-target language sentence pairs, created during the training process.

The frequencies of n-grams in a source language text that co-occur with n-grams in a parallel target language text represent the probability that those source-target paired n-grams will occur again in other texts similar to the parallel corpus. This can be perceived as a kind of dictionary between the source and target languages. Phrase tables and reordering tables are translation model components. Depending on parameters chosen for training process, different phrase translation scores² are computed, but the main are:

inverse phrase translation probability $\phi(sr|e)$
inverse lexical weighting $\text{lex}(sr|e)$

¹ http://www.statmt.org/moses/glossary/SMT_glossary.html

² <http://www.statmt.org/moses/?n=FactoredTraining.ScorePhrases>

direct phrase translation probability $\phi(\text{en}|\text{sr})$
direct lexical weighting $\text{lex}(\text{en}|\text{sr})$
phrase penalty (always $\exp(1) = 2.718$)

To estimate the phrase translation probability $\phi(\text{en}|\text{sr})$ we first sort the extract file is sorted to ensure that all English phrase translations for a Serbian phrase are next to each other in the file. In next step, one Serbian phrase at a time, collect counts and compute $\phi(\text{en}|\text{sr})$ for that Serbian phrase sr. To estimate $\phi(\text{sr}|\text{en})$, the inverted file is sorted, and then $\phi(\text{sr}|\text{en})$ is estimated for an English phrase at a time.

Additional phrase translation scoring parameters can be produced in output: lexical weighting (direct and indirect), word penalty, phrase penalty, Lexical weighting features estimate the probability of a phrase pair or translation rule word-by-word. The word penalty ensures that the translations do not get too long or too short. The phrase penalty feature is a global feature that counts the number of used phrases for all phrase tables cumulatively.

Apart from machine translation, aligned words and multiword expressions can be used for searching and exploring translation variants in large parallel corpora [17]. Volk et al. argue that automatic word alignment allows for major innovations in searching parallel corpora. Some online query systems already employ word alignment for sorting translation variants, but they describe the system for efficiently searching large parallel corpora with a powerful query language [18].

In [19] another approach for extraction of semantically related word pairs, ideally translational equivalents, is presented, from aligned texts in SELFIEH, a Serbian-

English corpus of texts related to education, finance, health and law, aligned at the sentence level within Intera project. The corpus was lemmatized and the method applied on lemmas of word forms from the corpus, by extracting candidate translational equivalents through a ranking based on lemma frequencies.

Similar experiments with the alignment on the word level were performed also on the Intera English/Serbian corpus [19, 20] with and without lemmatisation and PoS tagging. Authors report the most suitable measure:

$$\text{ranky}(x) = (C(x|y) / \sum_i C(i|y)) * (C(x|y) / C(x))$$

where V is the set of word forms i of a target language for which $C(i|y) > 0$, $C(x)$ is the frequency of occurrences of a word x in the target language, while $C(x|y)$ represents the frequency of a word x from the target language occurring in the same segment with the chosen word y from the source language. Summing is done for all words of the source language. This formula represents a variant of the geometric average.

The SELFIEH corpus is part of Biblisha digital library and is used in this research, and a comparison of results is in progress.

Machine translation research using Giza++ and its usage for eLearning material is in its initial phase, but it is clear that the most effective way of translating is obtained using all three methods of translation (Computer Aided Translation, machine translation and human translation).

autonomna pokrajina, odnosno jedinica , autonomous province, or unit 0.6 0.2 0.2 0.6 0.2 0.2				
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bez obzira na pol, rasu , regardless	daljem tekstu	further text	0,935484	0,935484
bez obzira na pol, , regardless of the	daljem	further	0,935484	0,935484
bez prava odlučivanja . , without deci	tekstu	text	0,935484	0,935484
bez prava odlučivanja ; , without deci	u daljem tekstu	in further text	0,935484	0,935484
bez prava odlučivanja , without deci	u daljem	in further	0,935484	0,935484
da počne sa radom i da , commence operi	,u	, in	0,913043	0,942029
da počne sa radom , commence operati	zakonom.	law .	0,925926	0,925926
dalje obrazovanje i samostalno učenje,	iz stava	from paragraph	0,886792	0,962264
dalje obrazovanje i , further educatio	izuzetno od stava	Exceptionally from paragraph	0,818182	0,818182
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davanje podrške razvojnog planiranju i	aktom o osnivanju	the establishment act	0,818182	0,818182
davanje podrške razvojnog , providing	skladu sa ovim i posebnim zakonom	accordance with this law and separate laws	0,818182	0,818182
davanje podrške , providing support	predmeta	subjects	0,866667	0,733333
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Image 3: The result of machine translation using GIZA++ tool

6. CONCLUSION

Massive Open Online Courses (MOOCs) are becoming very popular. Since they are mostly in English, there is a need to translate them into other languages. GIZZA++ is the right tool for that, but it needs a parallel corpus of significant size, that depends from language and domain. First a DTD scheme needs to be used to validate and check well-formedness. Then it is necessary to pair the text – parallelization. The aim is to determine which element of the text correlates with the translation of the element in the corresponding textNext, the following 3 steps are taken: tokenisation, truecasing and cleaning. At the end, the language model (LM) is used to ensure fluent output, and is thus built with the target language.

The presented method yielded promising results, but bigger corpus is needed for better results. Therefore, great efforts are being made for additional text alignment and augmentation of Biblisha library. The detailed evaluation will be performed when we reach at least 100000 sentence pairs. Our aim is to publish SMT based web service (API) and integrate it with eLearning systems that we use: Moodle and edX,

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TERMINOLOGICAL AND LEXICAL RESOURCES USED TO PROVIDE OPEN MULTILINGUAL EDUCATIONAL RESOURCES

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Abstract: Open educational resources (OER) within BAEKTEL (Blending Academic and Entrepreneurial Knowledge in Technology enhanced learning) network will be available in different languages, mostly in the languages of Western Balkans, Russian and English. University of Belgrade (UB) hosts a central repository based on: BAEKTEL Metadata Portal (BMP), terminological web application for management, browse and search of terminological resources, web services for linguistic support (query expansion, information retrieval, OER indexing, etc.), annotation of selected resources and OER repository on local edX platform. In order to successfully cope with multilingualism within the network, especially where terminology is concerned, a language support system is developed within the BAEKTEL metadata portal. In this paper we will describe the linguistic component of the system, the resources and tools used as an educational system as a whole and to improve the visibility of resources in the Internet. This component consists of morphological dictionaries, WordNet, domain specific terminological resources such as GeolISSterm, RudOnto, aligned texts in TMX format, corpora etc. Special attention will be given to Termini, newly developed application for terminology management.

Keywords: Open Educational Resources, Lexical resources, Natural Language Processing, Terminology

1. INTRODUCTION

Natural Language Processing (NLP) has a two-faceted approach to education where one involves e-learning and computer-assisted learning and instruction and the other consists of NLP tools for analysis and use of language by machines [1].

The usage and application of the research done in the field of the NLP has been present in the domain of education from the 1960s. One of the first advances made in this direction was the pioneering work of Ellis Batten Page who is considered to be the father of automated essay scoring. With the increasing number of students attending universities and numerous possibilities provided by e-learning applications, the Technology Enabled Assessment (TEA) has shown significant growth as well. Further on, Intelligent Tutoring Systems (ITS) were developed and incorporated in the learning process, while later work also included spoken language technologies. The advances in these fields allowed for a more time effective assessment

through TEA, which is a considerable advantage for both students and teachers, immediate constructive feedback for learners through ITS, with further enhancements with the development of spoken language technologies.

One of the major examples of applied NLP in e-learning are the open-access MOOC¹ platforms which are changing the face of distant learning and education altogether by erasing geographical and spatial constraints, leaving the traditional education model behind [2]. Interactive forums and teaching assistants rely greatly on various NLP tools to help them cater to a large number of students from all over the world. These tools may include assessment of text and speech, writing assistants, automatic generation of exercises, wrap up questions and online instructional environments [3]. The main goal of NLP tools in education is to automate time-consuming, laborious teachers' tasks such as curriculum creation or assignment assessment and do so in a timely manner. Time a teacher can spend with a student is usually very limited, with a detriment to students, resulting in insufficient interaction and feedback. These tools help overcome these hurdles at an advantage for both

¹ Massive Open Online Course - an online course aimed at unlimited participation and open access via the web

students and educators. The model of digital education also allows for a modern peer-to-peer education where students educate themselves and each other, exploring, developing and building skills without constant input from or intervention by teachers [2]

It is important to note that NLP requires multidisciplinary collaboration in all domains of its application. Other than indispensable intertwinement found on the crossroad between linguistics, psycholinguistics, computer science, engineering and statistics, as we go more in-depth, experts from more narrow fields are required. For example, NLP tools for language learning must connect to Second Language Acquisition (SLA) and Foreign Language and Teaching (FLTL) research with insights from Cognitive Psychology and Empirical Educational Science.

This paper will more thoroughly introduce how the terminology and ontologies are used in combination with NLP tools for the purpose of education. Exactly due to the tendency of global, digitized, education, it is of great importance that the terminology is acquired systematically in all languages involved, which would lead to equivalent opportunities and up to date education materials.

Firstly, a brief history and current state of the art of terminological resources are presented, followed by an overview of BAEKTEL (Blending Academic and Entrepreneurial Knowledge in Technology enhanced learning) resources, lexical resources, the process of terminology extraction and a presentation of TERMI, an application for terminology management.

2. TERMINOLOGICAL RESOURCES

Terminology is considered to be a young interdisciplinary scientific field. The interest in it arose in 1930s when an electrical engineer, Eugen Wüster, became engaged in publishing papers concerning terminology as an individual discipline. Its interdisciplinarity involves linguistics, more precisely, lexicography, cognitive and communication sciences, but also disciplines from different areas, e.g. mining or mathematics.

Definition of terminology varies from one dictionary to another. Macmillan Dictionary defines it as “the words and phrases used in a particular business, science, or profession”². According to ISO 12620 terminology is “The set of designations belonging to the language of a given subject field”.³ Terminological theory arose through practical experience and as such was supported by information sciences. There is widespread theory of four basic periods in development of terminology, the origins, the structuring of the field, the boom and the expansion [4].

Those stages are closely related with the development of computers. Consequently, we have different stages of computer usage, from input terminals through processing terminological data with personal computers, to the Internet expansion. The last one ensured the infrastructure for online terminological resources, such as electronic dictionaries and term bases, which can be monolingual,

bilingual or multilingual. Additionally, it strengthened the need to standardize the one-profession-vocabulary, because of rapid development in scientific research which constantly produces new terms which need to be translated in other languages. There is a huge amount of texts available on the Internet which is growing daily and needs to be translated for different purposes, at the same time paying attention to terminology rules which regulate the choice of the most appropriate term. Inevitably, this requires standardisation so more accurate translations are produced. To summarize above mentioned, terminology now constitutes a very important field of Natural Language Processing while the work that has been done in the field of terminology has become to be an indispensable, widespread used resource.

The standards related to terminology management are often used by the localization and translation industry as well as public translation and terminology units and organizations.

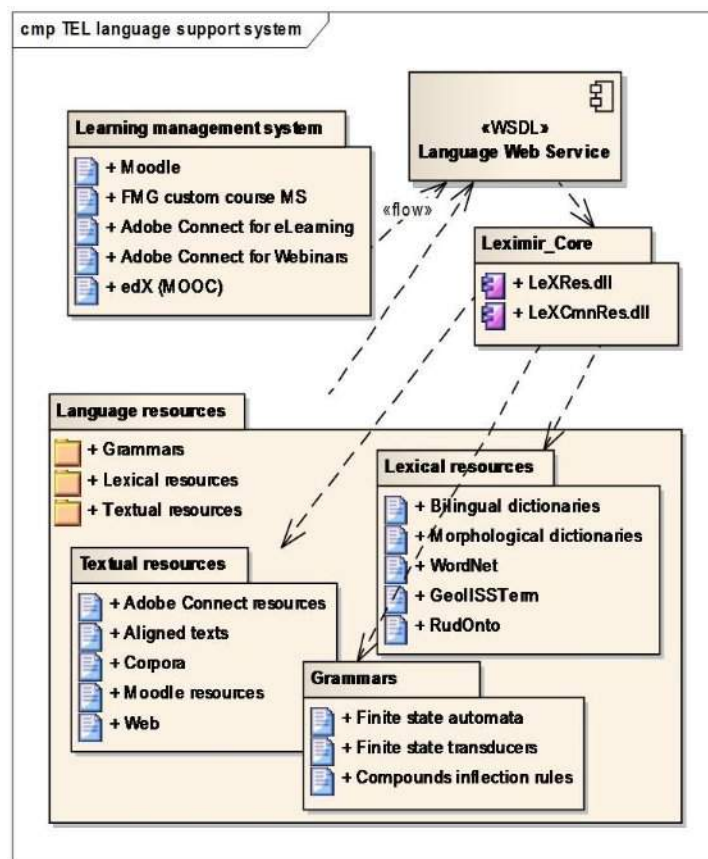


Image 1: BAEKTEL language support system [5]

3. BAEKTEL

To enable productive multilingual cooperation, open educational resources (OER) produced within BAEKTEL project will be available in different languages, mostly in languages of Western Balkans, Russian and English [6].

University of Belgrade (UB) hosts a central repository based on:

² Available at: <http://www.macmillandictionary.com/dictionary/british/terminology>

³ Available at: <http://www.isocat.org/rest/dc/4024>

- Σ BAEKTEL Metadata Portal⁴ (BMP)
- Σ terminological web application for management, browse and search of terminological resources,
- Σ web services for linguistic support (query expansion, information retrieval, OER indexing, etc.),
- Σ annotation of selected resources,
- Σ OER repository on local edX platform.

The BAEKTEL language support system consists of several software components administrating in the same time language resources: grammars, lexical and textual resources (Image 1).

4. LEXICAL RESOURCES

Morphological dictionaries are meant to be used by computers in the process of query expansion. Their usage is necessary because of the rich flexion of Serbian language and other similar languages of Western Balkans. Partners in BAEKTEL project produce materials in Serbian, Bosnian and Montenegrin language. When it comes to morphology, the aforementioned languages are quite similar, therefore it is possible to use the Serbian morphological dictionary. Serbian morphological dictionaries include semantic markers which allow the distinction between ijekavian, ekavian and ikavian pronunciation. Dictionaries cover both general lexica and proper names. Serbian morphological dictionaries are found in LADL (Laboratoire d'Automatique Documentaire et Linguistique) format. There are two types of dictionaries: dictionary of simple words and dictionary of compounds.

Two main components of dictionary of simple words are DELAS and DELAF. Here we have an entry found in Serbian dictionary of simple words: **učiteljica, N651+Hum+GM:fs4v**. The first part of entry is a lemma: učiteljica. N is a sign noun (part of speech), 651 is an inflectional class, +Hum is a marker for human entity and +GM is a marker for gender. After that, there is a part of entry for grammatical categories. F is gender feminine, s is sign for number - singular, 4 is code for accusative case and finally v is code that describes animacy, in this case animate.

The main components of dictionary of compounds are DELAC and DELACF. Entry the compound dictionary: **lekar(lekar. N2:ms1v) akušer (akušer. N2:ms1v),NC_NXN+Comp+Hum** where we can find descriptions of two words. Description given in brackets describes grammatical categories of simple words. Lekar is a noun, male, singular, nominative case and animate. Akušer is also male, singular, nominative case and animate noun. There are markers for a compound noun and human entity.

According to data from 2014, Serbian morphological dictionary of simple words consists of 133,361 lemmas. Their production is 4,581,657 word forms. The number of units covered by Serbian morphological dictionary of compounds is 13,717, or 262,686 word forms [7].

RudOnto and GeolISSTerm are developed at the Faculty of Mining and Geology, University of Belgrade [8].

RudOnto is a terminological resource that covers domain of mining. It is organized as a taxonomy of terms. Each term is followed by a definition, its synonyms, and bibliographical reference to their source, as well as equivalent terms in other languages.

GeolISSTerm⁵ is a thesaurus of geological terms with entries in Serbian and English, developed as a part of the GeolISS project. It contains more than 3000 dictionary entries.

Another important lexical resource is the Serbian WordNet. A WordNet network is composed of synsets, or sets of synonymous words representing a concept, with basic semantic relations between them forming a semantic network. Each synset word is denoted by a "literal string" followed by a "sense tag" which represents the specific sense of the literal string in that synset. Interlingual index (ILI) enables the connection of the same concepts in different languages. The Serbian WordNet covers about 20 000 synsets [9] from different specific domains (e. g. law, biomedicine, mythology, culinary etc.).

5. TERMINOLOGY EXTRACTION

Bearing in mind rapid changes in scientific domains and new terms production, automatic terminology recognition and extraction has become an important task. The extracted terms are then included in ontologies.

Even though attention has been raised to the fact that many authors from the research communities have different perceptions of what ontology in this sense encompasses [10], a definition brought by [11] roughly sums up that the ontology is a term used to refer to the shared understanding of some domain interest which may be used as a unifying framework to solve the problems of poor communication and surpass the difficulties in identifying requirements. Thus, an ontology can be perceived as a set of concepts, their definitions and inter-relationships. Applications of such ontologies, alongside with the automatic term extraction, which will be further discussed, can be found in machine translation, automatic indexing, building lexical knowledge bases and information retrieval [12]. Once they are extracted, completed ontologies represent an important education resource.

In order for these ontologies to be as efficient as possible, it is of great importance that they are constantly reviewed and updated. In the today's world of rapid changes in technology and information exchange, taking up such enterprise manually is an incredibly laborious and time-consuming task. Traditionally, this kind of undertaking would be done by a terminologist who would list potential term candidates to include in the ontology and would then proceed by consulting a domain expert to arrive at a final list of validated terms [13]. Other problem that also arises is that such lists, based solely on human assessment, are often being questioned among experts and have the risk of being unsystematic and subjective [12], [14]. Automatic term extraction is a process that is meant to facilitate this painstaking task and identify terms less obvious to humans by using computer aided techniques. For now, the automatic extraction is used as a preliminary process, to

⁴ Available at: <http://meta.baektel.eu/>

⁵ Available at the address: <http://geoliss.mprpp.gov.rs/term/>

identify term candidates, but is expected to replace manual term extraction completely.

Due to the rich morphology of Serbian language and the complexity of terms (they are the most often composed of two or more words called multi word units) it is not a simple process.

Members of Language Resources and Technologies Society developed semiautomatic approach for term recognition, extraction and lemmatization. Picture 1 illustrates steps in terminology extraction. Crucial resources are morphological dictionaries and grammars. They are combined with some statistical measures for term extraction. The first step is analysis of terms in existing term base mentioned before (RudOnto, GeolISSTerm). It was recognized 14 most productive patterns that represent structure of MWU terms. They are represented in form of transducers applied on domain corpus to extract terminology. Examples of patterns are presented in [15]. After applying these transducers on domain text extracted potential terms were evaluated.

Results presented in previous paper were satisfying enough to speed up the development of a terminological dictionary.

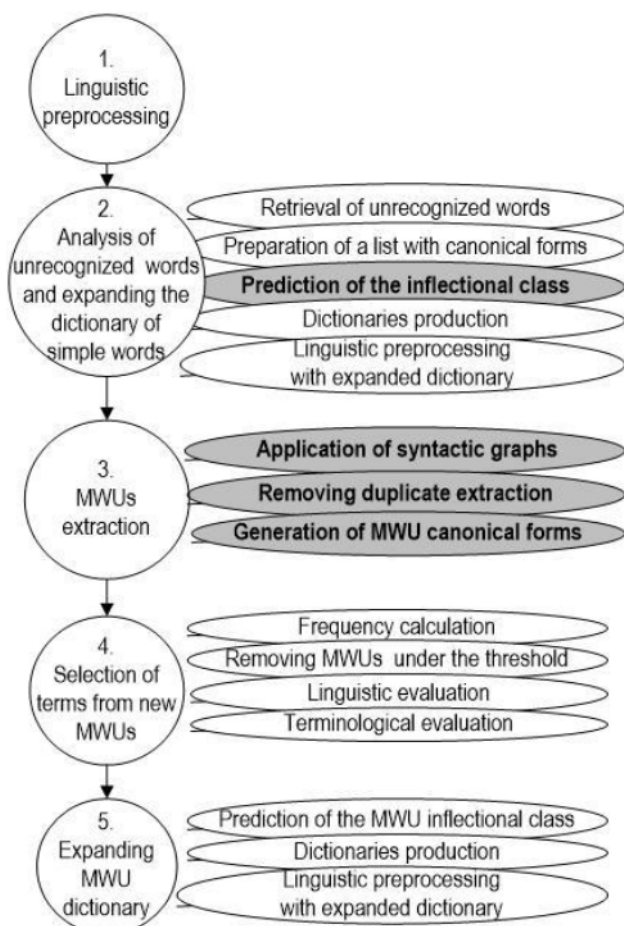


Image 2: Diagram of terminology extraction [15]

6. TERMI – AN APPLICATION FOR TERMINOLOGY MANAGEMENT

Termi application is developed at the University of Belgrade Faculty of Mining and Geology, with the support of BAEKTEL project. It is available at the following address: <http://termi.rgf.bg.ac.rs/>. It provides terminology management, regardless of term domain.

The application consists of three basic web pages which manage terminology: browse, search and update. Additionally, there are pages which manage profiles, bibliography and a login page.

Each term comes with the name, definition, synonyms, abbreviations and a bibliographic source. Each term, except the top term in dictionary tree, has a hyperonym term, while each term can have an arbitrary number of hyponym terms.

Term name is also a link that leads to a page that presents a complete overview of the term with information about it (translations, descriptions, synonyms, acronyms, hypernym concept, hyponym concepts, bibliography).

Important preference for OER-s, is the possibility to embed link to specific term. The result is tooltip with a definition and translation of term with link to the term in Termini.

5. CONCLUSION

Lexical and terminological resources offer priceless aid for better understanding of the available OER contents. Presented resources are also helpful in a sense of appropriate translation option. Successful methods used in automatic term extraction can be applied to units that belong to the general lexica, as well. The potential expansion of such resources would inevitably lead to a more fruitful information retrieval and extraction, providing an invaluable education resource, applicable in all of its domains. In the further work bilingual terminology extraction will be considered.

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HOW TO OFFER ALSO ONLINE AN UNDERGRADUATE UNIVERSITY DEGREE

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Abstract: This paper describes the implementation of the online version of an undergraduate university degree in Security of Computer Systems and Networks, already activated at the University of Milan in traditional, classroom based fashion.

In particular, the paper focuses on the process followed to transform classroom lectures into online materials – preserving didactical contents while facilitating asynchronous fruition by remote students – and on the additional supports planned to help these students to keep the correct study pace.

Some results after ten years of online experience – both in terms of student characteristics and performance and in terms of economical revenues of the initiative – are also included.

Keywords: E-Learning, Online course, Undergraduate degree.

1. INTRODUCTION

The Department of Computer Science of the University of Milan (Italy) activated in academic year 2003/2004 – in a campus located in Crema (a small town 40 kilometers east of Milan) – an undergraduate degree in Security of Computer Systems and Networks (from year on called SSRI, acronym of the Italian name of the degree: *Sicurezza dei Sistemi e delle Reti Informatiche*).

Such a degree was – and still is – the unique Italian undergraduate offer explicitly devoted to ICT security; for this reason, the degree immediately appeared interesting especially for people already employed full time in ICT companies and willing to deepen their competences in a field of ever increasing importance. The possibility of attracting these professionals, spread over the whole country and not able to attend traditional classroom lectures (thus very different from the “usual” university students) suggested to exploit the feasibility of offering the whole degree also online, using suitable e-learning models and technologies: to this purpose, the Rector of the University charged the staff of teachers working in the Crema campus and CTU (the university interdepartmental center devoted to support teaching with technologies, with an already long experience in e-learning) with the task of implementing the first online version of a complete undergraduate degree of the University of Milan. To support the design of the didactical model and of the online material, the university team has been complemented by consultants from Isvor KnowledgeSystem, a company specialized in the production of e-learning courses.

Next section of this paper reports the didactical model adopted for SSRI online, and details the design process required to each professor to produce the online version of her/his course. In section 3, the management structure

of SSRI online is described, with particular attention to the supports that have been planned and offered to the community of online students to help them to keep the correct study pace. Section 4 gives some insights into the characteristics of population of online students, while section 5 summarizes the economical results of SSRI online after ten years of life. Some conclusions are drawn in section 6.

2. SSRI ONLINE DESIGN

As deeply discussed in [3] and [4] the first step required to implement SSRI online has been performed by a group of instructional designers (coordinated by CTU) who concentrated on de-structuring each single course of SSRI (composed by classroom lectures as well as exercises and laboratory sessions) and recomposing it in a way suitable to online fruition.

The structure adopted for each online course has been a hierarchy of autonomous elements, constituted by:

1. **modules** – main topics treated during the course;
2. **didactical units** – various aspects required to fully understand each main topic of the course;
3. **activities** – steps required to online students to complete each didactical unit.

Each teacher of SSRI has been asked first to perform what we called *macro-design* of her/his course, i.e., decomposition of the course into a few modules, each composed by a few didactical units.

Main purpose of this macro-design was twofold:

- definition of a sort of “table of contents” of each course, useful to online students to orientate themselves during studies;

- clear identification of the learning objectives of each element of the course, necessary to help online students to concentrate on the critical aspects to be grasped.

Once the macro-design was completed and agreed with the instructional designers, each teacher has been asked to work on the *micro-design* of her/his course, identifying the activities necessary to complete each didactical unit of the course.

The most important activity required to online students is obviously to follow an **online lecture**: among the various multimedia techniques allowing to create online lectures, we decided to adopt for SSRI online the following ones:

- sequences of slides synchronized with teacher's voice;
- desktop capturing, synchronized with teacher's voice;
- blackboard-like behavior, where the teacher records her/his voice and her/his handwriting on the screen.

All visual materials are prepared by teachers following some guidelines (e.g., slide templates), and lectures are recorded autonomously by teachers using programs (e.g., TechSmith's Camtasia Studio®, Adobe's Captivate®, etc.) that allow the synchronization of desktop activities and teacher's voice; recording is done on tablet PCs, allowing also blackboard-like behavior by teachers. Post-production is limited to a consistency check of the final lecture and to some aesthetical interventions (e.g., smooth transition between slides).

It is worth noticing that the average duration of each lecture is around one fourth of the corresponding classroom lecture, since teachers are required to "distill" the most important aspects of their didactical message in order to limit the student fruition time and to avoid inattentions.

Video recording of the professor has been considered inadequate, since her/his gestures tend to distract the student from the didactical message to be passed: for this reason, videos have been used only for the initial message of each professor, showing her/himself to students and briefly telling the purpose of the course.

Besides multimedia lectures, some textual/graphical lecture notes (i.e., papers, book chapters, etc.) to integrate online learning with traditional offline reference tools have been allowed.

To allow online students to verify their level of learning, each online lecture is followed by practical activities:

- exercises, i.e., open-answer questions asking the student to discuss a topic, to design an element, to write a piece of code, etc. Correction of these exercises is in charge of the Course expert tutor, mentioned in Section 3;
- tests, i.e., closed-answer questions automatically corrected by the CTU platform where SSRI online is offered, which keeps track of the progresses of each student.

Meetings between students and professors are limited to

course introduction, midterm tests and final exams.

It is worth mentioning an additional type of support – deeply described in [1] – allowing students to remotely and asynchronously perform practical lab activities: OVL (the Open Virtual Lab) designed and implemented for the courses dealing with computer networks configuration. Using virtualization, this support allows online students to practice with configuration and behavior of a large number of network devices (e.g., switches, routers, firewalls, servers, clients, etc.) remotely, with the same learning effectiveness of students accessing a real lab.

All the materials prepared for online students are hosted by an e-learning platform (Ariel.net) implemented from scratch by the technical staff of CTU. As discussed in [3], qualifying functionalities of such a platform are:

- the support of one-to-one as well as one-to-many communications, both asynchronous and synchronous. Besides traditional e-mail and forums, also a private messaging system among students and tutors integrated into each single didactical activity (instant messaging), a virtual bulletin board reserved to tutors to post general interest messages, a virtual classroom support for synchronous meetings among students and tutors/teachers;
- a controlled access to courses by students, forcing them to follow only courses planned in the current quarter period;
- self-planning of learning activities by each student, who has a suggested learning plan, but who can change this plan according to her/his own needs. The plan is accessible by tutors, who can then track student work and intervene in case of evident pace loss;
- both online streaming fruition of audio/video elements, as well as download for offline fruition;
- the support of the exercising phases of students, tracking their advance and their results;
- the ability to support the individual learning process of each student, through a tool allowing each student to annotate her/his own instance of the online material;
- handling of logistical aspects as subscription lists to intermediate tests and final exams, recording of obtained grades, etc.

3. SSRI ONLINE MANAGEMENT

SSRI online is formally an undergraduate university degree like the classroom ones, thus it is in charge of the usual management structure of all other Italian degrees, mainly based on the *didactical council* composed by all university professors teaching a course.

However, online students meet teachers only for final tests and exams, thus daily help for clarifying course contents must be supplied online.

To guarantee a prompt answer to students, SSRI online defined the role of **Course expert tutor**, a content facilitator for each course and for each group of 40/50

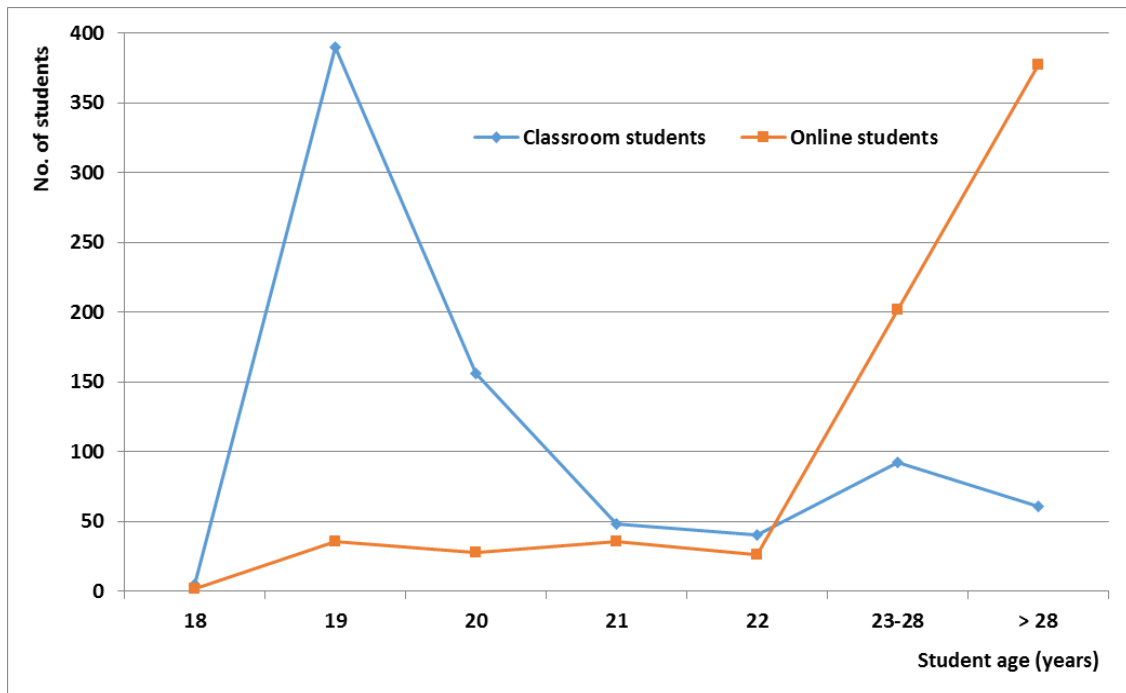


Image1: Number of SSRI students per student age

students, normally selected among young staff or prospective staff members. Main duties of Course expert tutors are:

- to clarify course key concepts;
- to evaluate student exercises or open tests;
- to answer any question useful to improve the student competences;
- to support teachers in developing the course contents, and in managing exams and face-to-face meetings with students.

Interaction channel used by Course expert tutors are:

- the **courseforum** (one for each course) used to promote discussion about course topics and day-by-day peer tutorship;
- **e-mail** messages;
- an **instant messaging system** developed ad-hoc, used by students to pose questions directly related to a given learning step.

However, course content tutorship is not enough, as discussed e.g., in [2], [6] and [7]. Particular attention should be given to the community of online students as a group of people sharing tasks, problems and goals without physically meeting. To this purpose, a **Process tutor** has been defined in SSRI online, acting as e-moderator, process facilitator, adviser/counsellor. Main duties of the Process tutor are:

- to monitor all the relationship processes developing inside the online community;
- to support any logistic process involving interactions between students and SSRI secretarial/managerial staff;
- to manage a preferential channel of communication

with students.

Interaction channel used by Course expert tutors are:

- the single **generalforum** for the overall community of learners;
- **e-mail** messages.

4. ONLINE STUDENT CHARACTERISTICS

A first interesting picture about the characteristics of SSRI online students is given in Image 1, reporting the number and age of people enrolled to SSRI online over the first ten years of its life, compared with the people enrolling to the classroom version of SSRI.

It can be seen that the two populations have almost no overlapping, since classroom students are mainly young people entering the university immediately after terminating their high schools, while the large majority of online students is composed by pretty older people, coming back to studies after several years.

This means that the online version of a university degree does not “compete” with its traditional, classroom version in terms of enrolling students: on the contrary, it attracts a significant number of additional students that would never come to the university without the chance of distance learning. Thus, we can expect that the investment necessary to implement such a distance learning environment is likely to be rapidly compensated by the additional incomes deriving from tuition fees of online students.

Another interesting aspect of SSRI students is given in Image 2, showing the provenance (i.e., the home address) of both online and classroom people enrolled to SSRI:

- from the area surroundings the Crema campus, where the classroom lectures are offered;
- from the Italian region (Lombardia) where Crema is

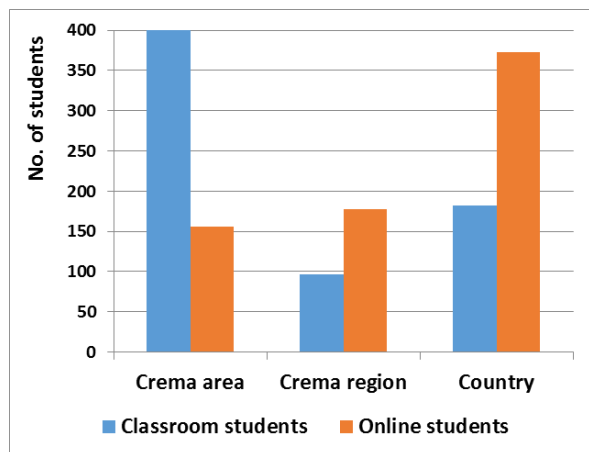


Image 2: Provenance of SSRI students

located: a 24 thousands square kilometers area with Milan as regional capital;

- from the rest of Italy.

It is easy to see that most of the classroom students come from the Crema area, while most of the online students live far away from Crema and decided to enroll thanks to the possibility of distance learning. Thus, there is no “competition” between the two versions of SSRI even in terms of geographical area the students come from.

A deeper analysis of online students, including their performances in terms of passed exams and degree completion is reported in [8]. It is here sufficient to show in Image 3 the behavior of students enrolled in the last few years as far as the attainment of the final degree is concerned: it is easy to see that the percentage of graduated online students is far lower than the one of classroom students, and this is justified by their condition of employed students stealing time to families and vacations to study. However, final grades of graduated online students are around 4.5 points higher than the grades of classroom students (99.04 vs. 94.62 on a 110th scale): in other words, online students capable of finishing their studies without delays even while working have to be particularly motivated, high-quality students, better than their classroom counterparts.

5. SSRI ONLINE ECONOMICAL RESULTS

As discussed in [5], the economical results of SSRI have been evaluated ten years after the activation of the online version of the degree.

Main costs required to setup the initiative were:

- an extra salary granted to all teachers producing the online lectures described in section 2; such extra salary was estimated, looking at the production costs of distance learning courses, as € 2,000 per course ECTS credit (thus, a teacher of a 6 ECTS credits course earned € 12,000 for the production of the online version of her/his course and its revision in the following three years);
- the consulting contract with the already mentioned Isvor KnowledgeSystem, the company specialized in the production of e-learning courses (a total of € 348,000 for the support during the first three years of SSRI online design and activation).

Main yearly costs to manage the initiative consist in tutorship:

- each Course expert tutor (one tutor for each course and for each group of 40-50 students) is paid 2,000 to 3,000 euros per year, depending on the number of ECTS credits associated to her/his course;
- the single Process tutor is an administrative person hired full time for the job, costing € 36,000 per year.

Estimating costs, we did not take into account salaries of staff already employed by the university and partially involved in the implementation of SSRI online, since those salaries were already planned in the university budget far before designing SSRI online and because no extra staff has been hired for this purpose.

As far as incomes are considered, the two main sources are:

- student enrolment fees, varying on the basis of the economic situation of each student family; following the considerations made in previous section regarding the type of students enrolling to SSRI online (i.e.,

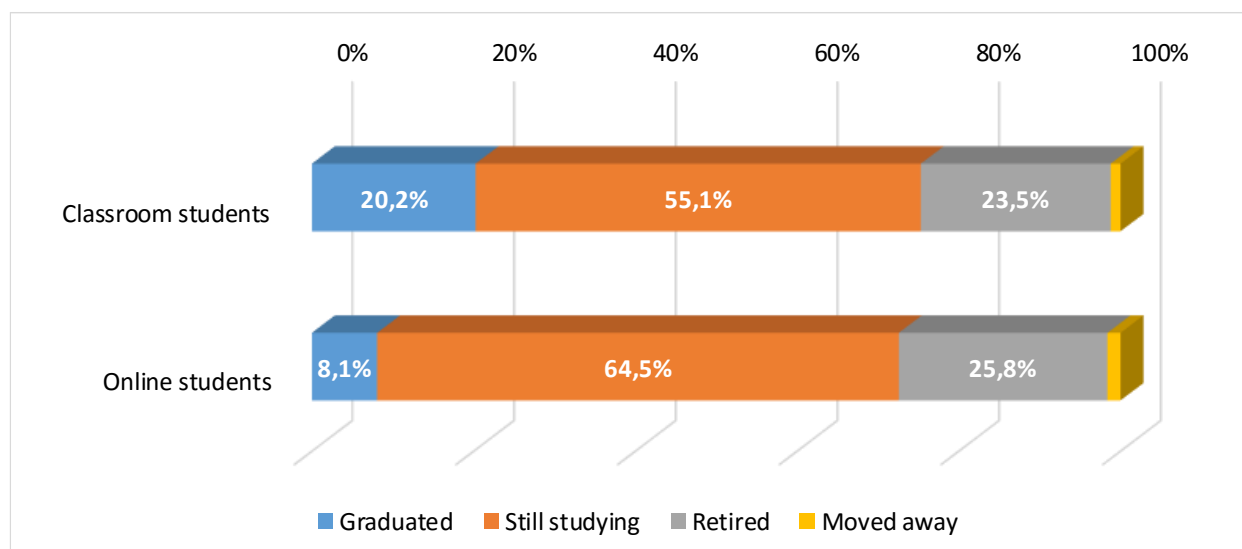


Image 3: Present situation of SSRI students enrolled in the last few years

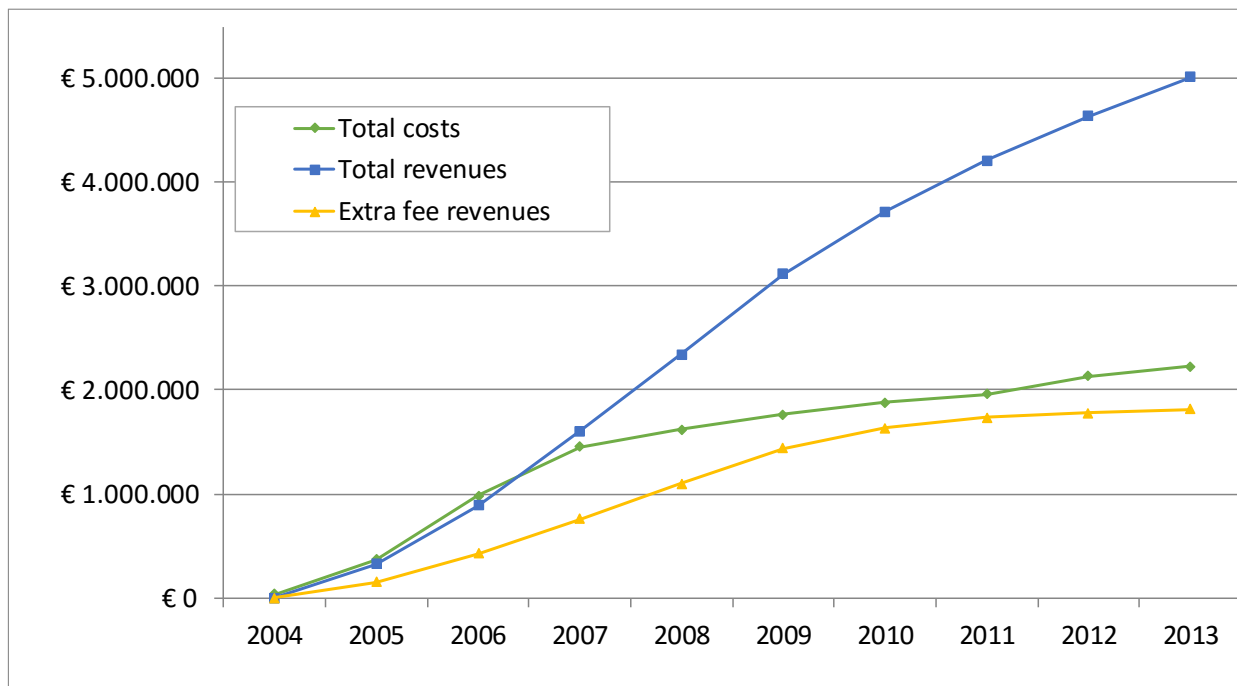


Image 4: Trend of SSRI online costs and revenues over the first ten years of activation

persons very different from “normal” university students, that would have never enrolled to a classroom degree) we considered as net income all those fees;

- extra fee for online services (lectures, tutorship, reserved exams during weekends to avoid to employed students the necessity of using holidays; such a fee has been established by the university management at € 1,500 per year, regardless of the economic situation of each student family.

The resulting trend is shown in Image 4. It is easy to note that:

- apart from setup, the yearly cost becomes stable and reasonably low;
- revenues from extra fees lower in the second part of the decade (but this is due to a reduction in the number of students due to contingencies already overcome, mainly thanks to an information campaign on social networks resulting in a sudden increase of students on the last few years);
- the breakeven has been reached very quickly (less than three years after SSRI online activation) and the net income after ten years is almost three million euros.

6. CONCLUDING REMARKS

The activation of the online version of an undergraduate university degree in Security of Computer Systems and Networks has been summarized in this paper. Main conclusions we may draw from this experience are the following.

For sure, the implementation of a complete three-years degree in e-learning is a complex process, involving several competencies (to be eventually found outside the university) and requiring clear commitment by the staff of

teachers, asked to deeply revise their didactic material to be adapted to the different fruition environment. And of course ALL teachers involved in the degree must commit themselves to the online version, to guarantee a complete offer to students.

An aspect not to be underestimated is the web platform hosting all the materials produced by teachers and supporting interactions between students and institution: regardless of the technological choice made (commercial product, customization of free software, implementation from scratch) it is mandatory to provide staff human resources guaranteeing its continuity of service and its updating during time.

Careful attention must be paid to human resources involved in supporting the community of online students. To this purpose, tutorship is the most important issue, not only in terms of technical aspects (i.e., help for students about the topics of every single course of the degree) but also in terms of relationship inside the community of online students and between them and the university organization.

Even from a purely budgetary point of view, the online implementation is a critical decision: the university has to plan for around half a million euros investment to guarantee high-quality production of the overall degree and to disseminate information about its existence to potential students.

It must however be noticed that these potential students practically do not overlap with the population of young people enrolling to classroom university degrees: the large majority of online students are in fact older people already employed. In other words, there is no risk for the university to pay for an initiative that will steal participants to its traditional degrees.

This means that if the topic of the degree is appealing enough for people already employed, the availability of

an online version has an excellent chance of guaranteeing a significant return even in terms of incomes.

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BOOKS OUT - DIGITAL BOOKS IN

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Abstract: A recent trend has introduced digital books in schools in Israel and abroad. Digital books are received with enthusiasm and great hopes but also some concerns. What is the digital book? Is it simply the conversion of a printed text to text that appears on the screen? What are the reasons for the use of digital books? What benefits and disadvantages arise in the use of digital books in schools? How can digital books be used for maximum benefit in the classroom? What is the significance of using digital books in teacher-training? These and other questions will be addressed during the presentation of a study conducted among teachers who teach mathematics with the assistance of the "Ksharim and Heksarim" [Skills and Contexts] program for Israeli elementary schools.

Keywords: Digital books, 21st century skills, technological tools, learning program.

1. INTRODUCTION

Digital books (e-books, electronic books, dynamic-books, digital books and talking books) are books produced in digital form including information presented in various media, readable through various technologies. Although it is often just an electronic duplicate of a printed book, in other cases it is a purely digital version. Why use a digital book? The trend in the education field is to encourage use of digital books as an innovative and varied learning environment that allows the planning and organization of learning in a different manner than the environment offered by a printed book. A digital book is a tool that can be used to teach 21st century skills and to foster independent learning with intelligent use of technological means suited to the learner's needs [1]. In addition to the traditional teaching of the different disciplines (Mathematics, English, Sciences etc.) studied in school, learning is also conducted through digital books providing challenging and significant learning in a digital environment that runs in parallel to the use of printed books.

Advantages inherent in the use of digital books include the presentation of information in a variety of media readable through different technologies. Although the digital book is often the electronic version of a printed book, in other cases it is a purely digital version. This technology serves to produce meaningful learning, broadening the learning contents in the book with contributions by the teacher and the student, representing information in a variety of media: text, pictures, film, applications etc. [2].

A digital book serves as an interactive environment, allowing for feedback and evaluation to be given and received [3]. Educational information is constantly available at any time and through any end receiver. The characteristics of the digital book therefore permit significant learning, while there is also the possibility of continuous updating of information and learning activities

provided by those who developed the book, and a wide-spread environment is provided that allows interdisciplinary learning, with both online and off-line learning, and access to learning contents that can be adapted for diverse students. The digital book is characterized as technology in the service of significant learning, offering advanced learning processes of investigation and critical thinking; a learning experience that is relevant and meaningful for the learner's life, permitting planning of dynamic and flexible learning, a system for the management of teaching and learning, supervision and evaluation, and offering possibilities for collaboration through a range of technological tools. It helps the learner to develop digital skills and literacy. Pedagogic advantages of the digital book include a reduction of the weight of the school students' satchel so that less damaging to health, it also costs less than a hard copy book. Thus too the online teacher can work with mobile computers/labs as the end tool for a group of students. Digital books can be integrated in the learning program of a particular discipline and become an integral part of the teaching, learning and evaluation processes [4].

However, Eshet-Alkalai and Gheri [5] review studies on readability and show that reading digital presentations is significantly slower than reading from printed formats. Online reading on Internet creates a larger cognitive burden on the reader in comparison to reading a printed text so that readers remember printed text better than text read from a digital format.

The present study investigated digital book reading habits when printed books were also used in parallel to the digital books, consideration is given to the teacher's years of teaching experience, the frequency of use of digital books, whether digital books assist teaching in the classroom and whether the teachers are satisfied with this learning program.

2. METHODOLOGY

Participants were 291 teachers teaching mathematics in elementary schools in Israel with the assistance of digital books. The teachers responded to a questionnaire administered to them through Google.docs during the second semester of the 2015-2016 academic year. Their responses to the questionnaire were analyzed with SPSS analytical software program.

3. FINDINGS

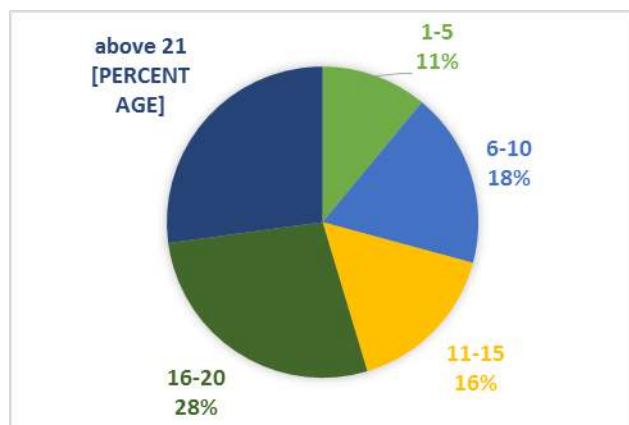


Image 1: Teachers using digital books, by years of teaching experience

65% of the teachers who teach with digital books are veteran teachers with more than 16. years' experience in teaching.

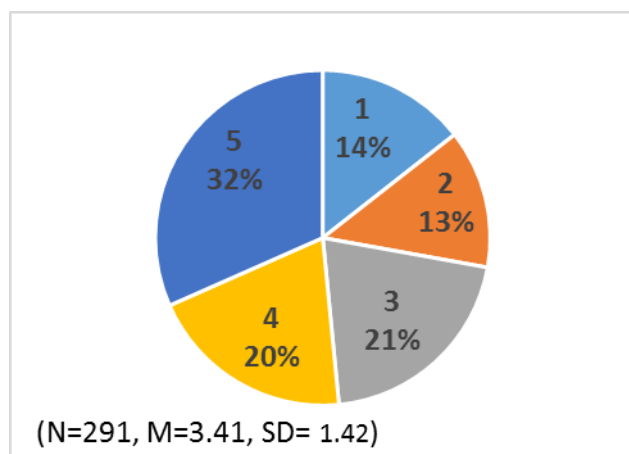


Image 2: Frequency of use of digital books, by number of occasions per week

52% of the participants used digital books in their teaching more than once a week.

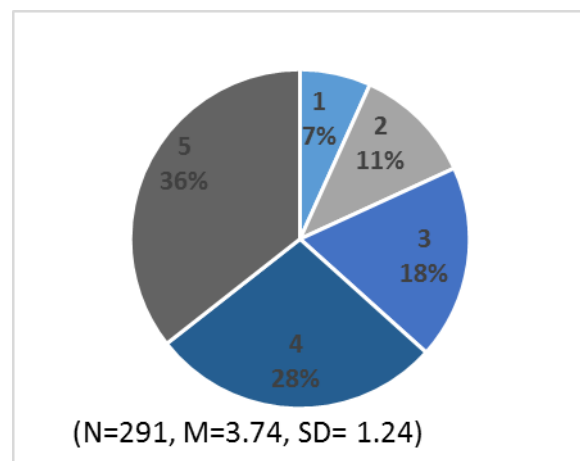


Image 3: Does the use of digital books assist teaching in class?
64% answered yes-definitely yes

Table 1: Questionnaire statements which received high mean grades (among all participants)

Questionnaire statement	Number of respondents	Mean	SD
I am satisfied with the <i>Skills and Contexts</i> program	291	4.07	0.92
I think that the <i>Skills and Contexts</i> program develops mathematical thinking	291	4.05	0.89
Does the use of digital books assist teaching in class?	291	3.74	1.24

There were differences between teachers from different types of settlement in degree of satisfaction regarding the use of digital books: Teachers were categorized by the size of the settlement in which they lived: towns (N=57); medium sized settlements (N=39) and small settlements (N=75). Kruskal-Wallis a-parametric tests for independent samples were run to test difference between these three groups. Significant differences were found between the three groups for "extent of satisfaction from the program" and "use of digital books helps teaching in class".

A significant statistical difference was found between the groups in the extent of satisfaction from the use of digital books:

$$X^2(2) = 6.66, P < 0.05$$

The highest mean satisfaction was found in medium sized settlements ($M=4.39$, $SD=0.75$). Mean satisfaction rates were slightly lower for small settlements than for medium sized settlements ($M=4$, $SD=0.98$) and the lowest satisfaction rates were in towns ($M=3.97$, $SD=0.84$).

5. CONCLUSION

Analysis of the data and the questionnaire indicated that there the teachers were satisfied with the use of digital books and it also transpires that insofar as the digital books are used in classrooms in elementary school then there is more teacher satisfaction from the use of these books.

The analysis also indicated that in large towns there is greater satisfaction and satisfaction also increased respectively when the teacher was more experienced. This may be explained due to the desire of the veteran teachers (more than 16 years teaching experience) to revitalize their teaching while on the other hand the new teachers have not been trained for this work or fear the introduction of the technological facet into their teaching in the classroom and so they use digital books less.

In general it seems that the trend to teaching with digital books is in advanced stages and that the world of traditional books is rapidly undergoing change and may even perhaps gradually disappear in coming years. The advantages of digital books were explained above and also emerged from the literature. The use of digital books mediated by the adult reading the electronic book provides a unique contribution to the improvement of buds of students' literacy beyond the mediation provided

when reading a printed book and beyond the support of a digital book alone. The use of innovative software such as electronic books together with suitable mediation by an adult should promote pupils' reading abilities and their achievements in the field of written and spoken language.

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E-LEARNING VS. DIGITAL LEARNING?

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Abstract: *Digital natives and digital immigrants are now the vast majority of employees and customers, hence the drivers of digital transformation can be found in societal and behavioral changes. Understanding digitalization as a powerful and transformative process able to trigger fundamental changes in corporate learning implies a high significance for related business performance indicators. This research paper explores how the digital transformation and the emergence of digital immigrants and natives are affecting corporate training as well as related business performance indicators like sales targets, overall growth or innovation. The underlying methodology is a comparative examination of how well current learning methods and technologies are fitting for the specific target groups of digital natives and immigrants. The paranthesis of this paper has therefore the aim to contrast the findings with current standards, definitions and overall perception of digital learning in order to falsify their validity in the digital age.*

Keywords: *E-Learning, Digital Learning, Digital Natives, Digital Immigrants, Digital Transformation*

1. INTRODUCTION

Ever since various forms of digitally supported learning methods emerged in the mid-nineties of the last century, the landscape of learning has changed substantially due to technological and societal developments. The term E-Learning itself was coined in order to describe learning methods supported by any kind of computer or digital technology [1]. Since the year 2000 the terminology used got widened due to the rising abundance of possibilities created by technological developments: *Distance or online learning* became a popular term for describing the ability to use the Worldwide Web for training and education. Massive Open Online Courses (*MOOC's*) enabled universities to offer their curriculum on a broader scale and to manage resources more efficient. *E-Testing* made it possible for corporations and institutions to handle standardized examinations in a more productive manner [2]. This few named examples are just an extract from terminology of a vividly growing but never standardized industry. But this fact itself indicates the complexity or rather difficulty to unify the various methods and technologies under one specific terminology and overall valid conceptualization. The emergence and unveiling of *mobile internet*, respective devices such as *smartphones* and *tablets* as well associated phenomena like *social media*, made it clear that underlying societal and behavioural changes have occurred and that forms of communication, learning or working are a subject of fundamental modification [3]. This development is generally described and named as digital transformation or digitalization, which refers not only to the digitalization of learning but to various spheres of society and business [4]. In order to analyse and describe how these changes are affecting corporate learning and general business

performance indicators, the following questions obtrude and shall be scrutinized in the course of this research paper: How does the digital transformation affect customers and employees? What impact has the digital transformation on corporate learning and to what degree are business performance indicators affected? How well do current learning methods and technologies fit the needs of a new generation of digitally literate employees and customers?

2. DIGITAL NATIVES AND DIGITAL IMMIGRANTS

Societal as well neurological research show that technological innovations or inventions, especially computer technology and the Internet, have a profound impact on the human brain structure as well as on societal values and social behaviour in general [5]. Such an insight indicates that the way students or trainees learn is also changing. Further the question rises if the learning subjects are transformed or does the "*what is being learned*" changes as well, since the logical recourse of innovative inventions suggests that learning content must also change. An enlightening example for this logical recourse is the fact that in undergraduate education curricula handwriting has become a far less important skill than basic computer literacy. Other examples can be found in vocational training, where the decreasing demand for antique professions like printers or tailors has been superseded by modern professions like programmers or webmasters [6].

This affected generations, typically described as *Millennials* or *Generation Y*, had been born after 1980, they grew up with computers and have been using the internet since the 1990's. Their perception of technology, society, economy but as well as their utilization has profoundly changed compared to the generations before

1980/1990 [7]. But the terminology above is not conclusive and merely an attempt of describing the societal phenomenon with a catchy phrase. Therefore gradually and over time additional, more specific terminology was coined. The Millennials can be separated into two groups, which aim to be consistent with their respective degree of digital literacy as well as their age: *Digital Immigrants* and *Digital Natives*. The first term describes the generation born in the later second half of the 20th century, who either got accustomed to digital technology as adults or grew-up with the emerging technologies during the late 1980's and 1990's [8]. Therefore *Digital Immigrants* can be described with the following attributes [9]:

- Adopting of new, especially web-based, technologies
- Obtaining information from classic sources such as news outlets and traditional newspapers, although using respective websites, newsfeeds etc.
- Preferring personal communication, e.g. talking to people in person
- Preferring single tasking and traditional "focused" collaboration approaches
- Preferring privacy and personal space
- Preferring logical learning and training approaches
- Preferring information and teaching subjects to be presented linearly, logically and sequentially

As for the group of *Digital Natives*, who are born during or after the digital age (around the year 2000 and later) different attributes can be enumerated [10]:

- Attaching permanently to devices (smartphones mainly) and permanent online activity
- Multitasking and rapid task-switching, real-time interactions
- Preferring online socialisation
- Preferring multimedia content and online information services instead of traditional news outlets, newspaper sites etc.
- Preferring intuitive, instant and "fun" learning
- Preferring information and teaching subjects presented in pictures, sound, video instead of text or textbooks

Considering that both groups are the majority of contemporary populations in most OECD countries and the fact that big parts are within high income/high-value consumer groups of the population the impact for corporations must be described as very significant [11]. First the significance of this two groups is within their potential as consumers and clients. Since their consumer behaviour is heavily altered by the digital transformation, for example due to the ability to compare offers online or to rate products and share this information with others, most companies had to adapt their marketing strategies in order to keep up with such consumer behaviour changes. Second both groups are the backbone of contemporary employees. Especially it has to be considered that *Digital Natives or Immigrants* are required as digitally skilled workers in order to handle the digitally literate consumers and satisfy the market needs of a more and more digitally shaped economy [12]. There can be little

doubt about the enormous impact of the current digital transformation on education and related industries, mainly due to the fact that students, trainees, employees and customers belong to new generations of digitally literate humans, which implicates changes of their behaviour as consumers or employees but as well as societal changes in general.

3. IMPACT OF THE DIGITAL TRANSFORMATION ON CORPORATE LEARNING AND RELATED KPI'S

Facing new societal realities and changed market circumstances due to the entry of *Digital Immigrants* and *Digital Natives* into labour force, corporations started to adapt their strategies for a variety of fields. From product design to marketing and public relations to recruiting or corporate training: Literally all spheres of business have been affected by the digital transformation: Corporate learning and training are particularly affected because of their unique role as the spearhead or the foremost touchpoint with a new generation of employees [13]. Though it has to be considered that corporations are not able to avoid such an encounter with the digitally literate nor can corporations afford to ignore these groups if they do not want to lose their future prospects for serving markets full of digitally literate or even entirely digital native but financially solvent consumers. The main impact on corporate learning therefore can be identified within KPI's (*key performance indicators or generally business performance indicators*) measuring effectivity of the training delivered [14]. The case example of a sales organisation which used to train their employees with textbooks, manuals or in coaching classes might face severe difficulties achieving their sales targets when the very same training methods are applied to *Digital Native* employees. The sales organisation might even use CBT's (*computer-based training*) or WBT's (*Web-based training*), but offering the teaching subjects in a digital form does not mean the subject itself or the methodology fits the digitally literate generation's needs. For example, if textbook manuals are replaced with online available PDF's, the methodology does not change but merely the medium which carries the information. However if the findings in the previous section are considered, this would mean that such an approach might be working with certain parts of the *Digital Immigrants* but it would definitely be a strange learning approach to truly *Digital Natives*. Their preference for multimedia content, engaging and intuitive, even playful and fun learning methods or online communication indicates that the whole underlying understanding of learning/ teaching methodologies has to be reconsidered. The motivation for such reassessments of corporate learning methods and techniques, irrespective of strategic considerations, is mainly a financial one. This financial motivation might be seen two ways; the first one being the failure of achieving relevant KPI benchmarks such as sales targets or customer attrition, as described in the case example above. The second perspective on the financial motivation is a fairly traditional one: Corporate learning and training are cost drivers! Taking in account that, at least for the OECD nations, the market situation, compliance and

regulatory issues as well as technology developments are demanding more complex business solutions the following rule can be applied: The more complex the business, the higher are training and/or employee recruiting as well as corresponding on-boarding costs [15].

This means that a corporation, which is unaware of the impact of the digital transformation, might be investing in their corporate learning and training but at the same time wasting precious resources due to inept learning methods applied or a misguided understanding of their target group's needs [16]. Further research work is required to determine the effects of the digital transformation on business indicators as such innovation or human resource KPI's. So what conclusions can be derived from such a contemplation?

There are two main identifiable attributes of the digital transformation impact on corporate learning and its corresponding business performance indicators:

First a strategic one; where corporations which do not engage in reviewing and adapting their strategies regarding *Digital Natives* and *Digital Immigrants* as employees might face severe consequences for their future business growth and market position.

The second attribute of the impact is a financial one, where corporations might misdirect their investments in corporate learning or training and basically teach their target groups with outdated and ineffective methodology. Especially if it is considered that classic methods as classroom training are far more costly than *E-Learning*. In addition corporations ignoring the impact of the digital transformation might face the situation that their employees do not achieve their KPI targets due to unsuitable or misallocated corporate training [17]. Not to speak of employee motivation or hiring costs, which are heavily related to the abovementioned attributes.

4. E-LEARNING VS. DIGITAL LEARNING?

Incorporating the findings of the previous chapters, it becomes evident that, the question of how well current corporate learning methodology fits the needs of a generation of digitally literates, is of great bearing. Devoid of completeness it is impossible to answer the abovementioned question, simply due the fact that there is a multitude of corporations and ways of dealing with the impact of the digital transformation. Nevertheless a cursory trial of analysing and answering shall be possible. This can be tackled with a historical retrospective of the terminology used in the training and learning industry. As mentioned in the introduction the terminology developed gradually and under changing circumstances new descriptive terms were added. But one general and widely used term remained unchanged, becoming even more popular the more *Digital Immigrants* and *Natives* entered the markets of labour and consumption: *E-Learning*. The word itself describes any kind of learning/teaching method using computers or the internet. Being coined in the early nineties of the last century *E-Learning* became dominant and fashionable during the last decade, though it never was standardized in its definition [18]. Here lies the difficulty of the term itself and how it is understood by the broader public as well as

experts and especially training or education managers.

E-Learning is still being understood and used as a digitalized depository for learning/teaching methods from the 20th century. For the Digital Native generation any E-Learning would need to be adapted to their needs, preferences and particular skillsets. Taking in account that this group understands learning differently, instead of textbooks as PDF's they must be offered with more engaging and intuitive content. For example embedded audio or video content, Gamification, Mobile Learning, Adaptive Learning or Social Learning are just a few keywords associated with the learning worlds of the digitally literate generations. The options are already vast and increasing with an ever-growing introduction of new technologies and applications. Hence corporate learning and training should focus on *Digital Learning* instead of sticking to old-fashioned but inadequate methods just offered in a digital manner.

Having in mind that the digital transformation changed society, customers and employees it is remarkable how inert the respective terminology and its understanding is being adapted. If the finding that the impact of digital transformation has tremendous financial implications for corporations is added to this contemplation, this inert gap becomes evident. That might have a concerning reason: For great parts the impact of digital transformation might not have been understood by corresponding corporate experts and managers. This can probably be linked to the consideration that most corporate managers are of a certain age, therefore not strictly belonging neither to *Digital Immigrants* nor *Digital Natives*. On the other hand this would be a simplified explanation ignoring the statistical facts about population compositions and the general need for technology adaptation during the last two decades. The most plausible explanation is rather simple: The digital transformation is fast, erratic and manifests itself in a multitude of shapes depending on the specific situation of the respective corporation [19]. Therefore it can be assumed that not only the terminology, such as the word *E-Learning*, might be outdated and inapt but the whole understanding of the digital transformation and the corresponding phenomena of *Digital Immigrants* and *Natives* in relation to corporate learning. Of course this statement has no general validity nor is it final, since the assessment would really depend on the specific case of each industry or company. This findings indicate where much that *E-Learning* should be seen on far broader base of digital opportunities, and probably the term itself could be replaced with the far more suitable descriptive term: *Digital Learning*.

5. CONCLUSION

The ongoing digital transformation of the human society is affecting customers and employees in various ways. Societal and economical behaviour is being altered due to the impact of new opportunities created through new technological applications. This process is happening rather fast, erratic and can manifest itself in a multitude of ways. Corporations face an existential threat if the impact of digital transformation is not considered, since the changes have financial implications. Corporate learning and training can be afflicted by misallocation of resources

due to the disregard of the altered learning behaviour of Digital Immigrants and Digital Natives. Such a development is likely when corresponding corporate learning experts and managers do not fully understand the impact of the digital transformation. This finding manifests in the terminology used and its general understanding by experts and managers. E-Learning is still widely understood as a digital medium of learning concepts from the 20th century, although the predominant groups of consumers and employees are increasingly digitally literate millennials. This implicates a broader understanding of digital opportunities for learning/teaching and a whole new set of methods appropriate for *Digital Immigrants* and *Natives*. Therefore an adapted view and understanding is required, which could be reflected in the term Digital Learning instead of the old-fashioned E-Learning.

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PEDAGOGICAL MODEL FOR ENHANCING COMMUNICATION IN INTERNATIONALLY MIXED GROUPS IN VIRTUAL MOBILITY

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Abstract: Virtual mobility is considered as an alternative to physical mobility in terms of democratising access to international and intercultural study experience. One of the definitions (proposed in the Move-IT project) states that virtual mobility is 'the set of ICT supported activities that realise or facilitate international, collaborative experience in a context of teaching and/or learning'. Within the framework of a multicultural and multinational group, participating students should gain international experiences and competencies from the professional field, utilising the possibilities offered by global communication technologies. High level of interactivity and communication between students participating in virtual mobility is one of the fundamentals to reach that goal successfully.

The paper describes our experience in virtual mobility which resulted in the design of a successful pedagogical model. Evaluation results show that over 85 % of students coming from 38 countries indicate that through this virtual mobility experience they gained necessary skills for international communication.

Keywords: virtual mobility, online learning, virtual summer school, communication tools, pedagogical model

1. INTRODUCTION

DOBA Faculty is the largest online higher-education provider in Slovenia and has a 16-year tradition in online learning. The DOBA Faculty student body consists of 100 percent of non-traditional students. Virtual mobility courses were designed 10 years ago in order to create an opportunity for the institution and students to obtain international experience, who would otherwise be unable to gain said experience due to their work and family commitments. One of the main aims of introducing virtual mobility was also to identify the main success factors that influence course design, delivery and particularly communication in an international virtual context.

Virtual mobility at DOBA Faculty is implemented in three forms: virtual summer school, international week and joint implementation of courses with international higher education institutions. In the last 10 years there have been altogether more than 2.300 students from 41 countries participating in different kinds of virtual mobility courses.

This case study paper describes our experience in virtual mobility which resulted in the conception and implementation of a rather rich and successful pedagogical model. Analyses of virtual mobility courses and students' feedback show that the model successfully supports students cross cultural

competency development. The designed model is outlined through three pillars: people, content/activities and tools.

2. DOBA FACULTY ONLINE LEARNING PEDAGOGICAL MODEL

The study at DOBA Faculty is fully online supported and carried out in the Blackboard virtual learning environment, which is considered one of the most comprehensive, high-quality, and widely-used virtual learning environments in the world.

Implementation-wise, online learning is designed as a supported online learning model, which means that the students are provided tutor support throughout the duration of their studies.

From the pedagogical perspective, DOBA Faculty created a pedagogical model based on modern pedagogical theories and approaches, with the central principles being the principles of social constructivism and connectivism, collaborative and problem-based learning and learning by using online resources, which reflects the nature of the medium and meets the needs of employed students.

In this model, the monitoring of students' activities and attainment of objectives are predominantly based on concept-adapted continuous assessment of knowledge and tutor support during studies. We argue that the model is

student-centred which focuses on the following interrelated principles:



Image 1: Principles of online learning experience [1]

Online environments, which are less constrained by time and space, flexible and asynchronous, allow knowledge to be constructed, discovered and transformed by students [2]. Students have more freedom when exchanging ideas, opinions, facts, experiences and expectations. They can improve the richness and quality of the learning experience.

3. IMPORTANCE OF A HIGH LEVEL OF INTERACTIVITY AND COMMUNICATION IN A VIRTUAL LEARNING ENVIRONMENT

A number of researchers agree that one key element contributing to student learning success and satisfaction in online courses is related to learner interaction [3].

The degree of interaction among participants in distance courses is widely acknowledged to be an indicator of successful learning experiences [4]. Research indicates that greater interaction in an online learning environment contributes to student satisfaction.

Our experience in virtual mobility online courses over several years has demonstrated that meaningful, ongoing interaction fosters and increases student success and satisfaction regardless of a student's prior experience in virtual mobility and online learning. Asynchronous communication allows students to collaboratively gain knowledge and skills; it offers students the opportunity to be equally included in the study process and enables learning that overcomes geographical and time limitations. On the other hand, synchronous communication replaces the lack of live communication. The lack of personal contact is one of the major shortcomings of online learning.

Nevertheless, it would be unrealistic to expect that all students will interact and use the communication tools offered by the virtual learning environment. We need to consider the phenomenon of lurkers, who will never actively engage in the study process [5]. There are approximately 18% of lurkers in our online courses, who log into Blackboard regularly, read the course materials and follow the communication without interacting with the teacher, tutor or other students.

Weller [6] also points out the problems or dissatisfaction of students with e-learning. He speaks of a reluctance of several students, who previously studied individually, to collaborative learning and especially to situations such as team activities that are being assessed.

DOBA Faculty virtual mobility courses allow for several types of interaction and communication: interaction with the learning environment, interaction with the material, and interaction between the students, the teacher and the tutor. The interaction between the students, the higher education teacher, and the tutor is facilitated via communication tools, which enables asynchronous and synchronous communication.

While interaction in a face-to-face environment may occur naturally and without thorough planning, designing and implementing, interaction and communication in an online environment requires strategic planning. Interaction and communication in virtual mobility courses at DOBA Faculty is further described through the prism of people, content/activities and tools.

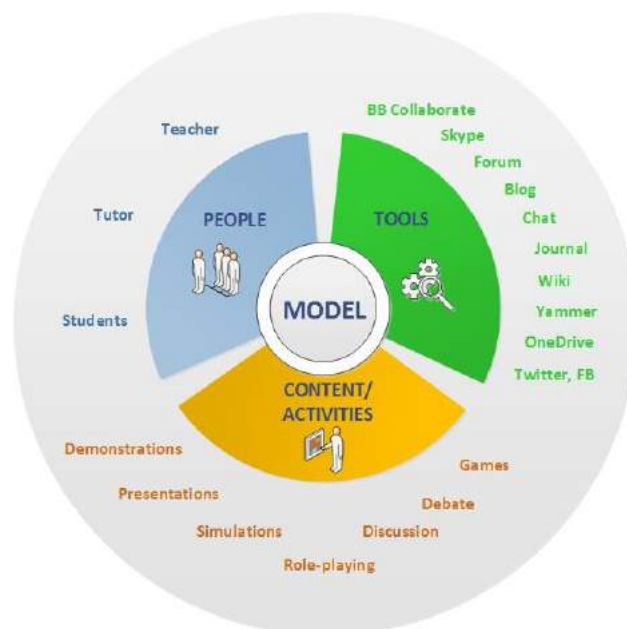


Image 2: Communication and interaction model

3.1. Teacher, tutor and student interaction in virtual mobility courses

The teacher's role has changed dramatically in the last years, from "the sage on the stage" to "the guide on the side" [7]. Teachers are moderators and facilitators [8]. Key focuses of teacher-student interaction in our virtual mobility online courses are: teachers to communicate the expectations for online participation and course procedures, to provide support and guidance, to help shape the conversation and keep it aligned with learning outcomes, to give timely content-related feedback, to give timely continuous feedback on students' performance and to grade. Feedback is given individually or to the whole group. Text, audio, or video is used to provide feedback.

Asynchronous and synchronous communication is provided (e.g. discussion boards/forums, emails, blogs, wikis, group or one-on-one virtual meetings, chat messaging and discussion forum...).

The cooperation between teachers and tutors is also of vital importance for the successful implementation of the online course. Before the start of the online course, teachers conduct coordination meetings with tutors in order to align expectations and discuss the features of the target group.

Tutor–student interaction is another type of interaction introduced in our virtual mobility course. The main activities of tutors are monitoring students' participation and performance, counselling, motivating, guiding and giving encouraging feedback. They also challenge students with topical issues and encourage discussion and debate. Moreover, they help each student to become a self-motivated and self-directed learner.

Feedback is given individually or to a group. Text, audio, or video is used to provide feedback. Tutor-student communication is mostly asynchronous (e.g. emails, forum posts...) when needed synchronous communication is introduced (virtual meeting, chat...).

Student-student interaction is carefully designed by teachers. Teachers create a lot of opportunities for students to interact with each other: e.g. synchronous/asynchronous discussions, post comments, virtual team work, sharing of ideas and practices, peer-reviews, etc. Our experience in virtual mobility online courses shows that various forms of student-student interactions are important, however, the quality of their interactions is even more important.

3.2. Activities to promote interaction and communication in virtual mobility online courses

Salmon [9] states that the virtual learning environment promotes student socialisation and networking, of course with careful planning of e-moderating. She developed the five stage online learning model, which includes access and motivation, online socialisation, information exchange, knowledge construction, and development. With each stage, it is not only the quality and effectiveness of learning that grow but also the frequency of student interaction. The online socialisation phase comprises of the sending and receiving of messages, which helps students create a community within the virtual learning environment or a group of people who are connected by the sense of working together for a common goal.

The teacher, as a course designer, structures and plans the virtual mobility online course and all students' activities within it very carefully while preparing the course in advance. In comparison to the traditional study mode, a lot of time and effort is dedicated to designing the course as an active learning environment in the context of relevant and interesting tasks and choosing the appropriate communication tools that support the tasks in order to

encourage and support students' interaction and communication.

Teachers have to select such course activities that enable students to gain experience in enacting or simulating the performance of competent professionals in the real world. According to Horton[10] the course activities can be classified in three types: activities to absorb, activities to do, activities to connect. Since in virtual mobility at DOBA Faculty we focus on the communication model, teachers choose mainly activities to do and activities to connect in order to achieve the learning objectives.

The designed activities require students to be in constant interaction and communication with the teacher, the tutor, as well as classmates. Most frequently planned activities to promote interaction and communication are comments, discussions, debates and presentations, virtual round tables, project based learning activities, team projects activities, role playing, brainstorming, etc.

Teachers also incorporate interactive and reflective writing activities which help to raise students' awareness of their own learning processes encouraging them to become actively engaged learners responsible for their own learning.

3.3. Communication tools for enhancing interaction and communication in virtual mobility online courses

In an online course, communication means frequent interaction and a constant presence in the virtual environment. While communication in a traditional learning environment is mainly limited to face-to-face sessions, communication in the virtual environment is an ongoing process, which takes place daily or even hourly during an online course. For this reason, it is important for teachers to thoroughly plan the communication dynamic and choose the appropriate tool that will support the course content and activity and most important, that will support achieving student learning outcomes.

A virtual learning environment and other digital tools DOBA Faculty uses to implement virtual mobility courses offer a wide range of possibilities for interaction and communication. Teachers choose tools according to different types of communication flows (e.g. teacher to students, student to the whole group, team of students to team of students, etc.) and types of activities (e.g. project presentations, simulations, games, role-playing, discussion).

Although the forum is still most commonly used tool in an online course, evaluation of virtual mobility courses at the faculty show that synchronous communication tools are being used (Blackboard Collaborate, Skype for Business, Yammer) more and more each year. Some other tools, which are often used, are Twitter, Facebook, wikispace, YouTube, Padlet, etc.

A number of tools can be introduced and used in virtual mobility courses, but it is important that students have no difficulties using them. Too many tools used during the

virtual mobility online can create students' "technologies overload". Both, difficulties in using tools and overload, may negatively affect the course.

4. VIRTUAL MOBILITY

DOBA Faculty implemented the first virtual mobility course in 2005. Virtual mobility represents the use of information and communication technologies to obtain the same benefits as a student would have with physical mobility but without having to travel [11].

Virtual mobility is a very broad term and once it is defined it also needs to be classified into several categories. Available literature does not provide a generally accepted classification into categories and virtual mobility is thus categorised from several different aspects. The most commonly used categorisations are the classification that categorises virtual mobility with regard to the use of virtualisation and the classification with regard to the course of mobility. While the first distinguishes between the totally virtual, partially virtual and dual or mixed virtual mobility [12], the second classifies virtual mobility into four types: a virtual course as part of a study programme or seminar at a higher education institution; a whole programme at a higher education institution; virtual student placements and virtual support activities to physical mobility [13].

A virtual study programme offered by a higher education institution gives students from different countries the opportunity to take such a study programme without having to go abroad for a whole academic year.

Virtual mobility at DOBA Faculty is implemented in three forms: within the framework of the virtual summer school, within the framework of international week and within the framework of joint implementation of courses with international higher education institutions.

5. CASE STUDY - VIRTUAL SUMMER SCHOOL AT DOBA FACULTY

The international virtual summer school at DOBA Faculty was first implemented in 2009. It takes place in the form of individual and team activities in Blackboard. Lectures, given by national and international lecturers, are attended online by all participants of the summer school regardless of the course they have chosen. Within the framework of a multicultural and multinational group, participating students gain international experiences and competencies from the professional field, utilising the possibilities offered by global communication technologies. Students from across the globe can join courses or parts of courses offered by DOBA Faculty and can have their institution recognise the completed study obligations.

The interest in joining the virtual summer school differs through the academic years. Below is the trend in the number of participating students in the virtual summer school for the last five years.

Table 1: Overview of participation; 5-year comparison

Study	Target group	total
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year	Students	Prospective students	International students	
2011/12	287	82	65	434
2012/13	245	55	42	342
2013/14	127	30	115	272
2014/15	179	70	125	374
2015/16	70	179	137	386

In the 2016 virtual summer school we received over 250 applications from international students all around the world. 137 international students from 38 countries took part, the majority coming from Kenya (43 students), Greece (14 students), Croatia (10 students), Estonia (9 students). Since DOBA Faculty offers its programmes in Slovenia, Croatia and Serbia, 179 prospective students came from these three countries.

Courses taken via virtual mobility at DOBA Faculty are interesting for students from three different aspects [14]. First, there are the topical content, the opportunity for exchanging knowledge and opinions and the possibility to establish business contacts. Secondly, the mode of implementation (virtual) is interesting and allows employed individuals to partake in the virtual summer school. Another important point is the intercultural aspect and the experience of international cooperation, as part of the programme is also intended for international students. Cross cultural communication is becoming more and more important in today's business since the success often depends on how good other cultures and social groups are understood.

After each course a survey is conducted among the participating students to measure their satisfaction with the implementation of the courses. We especially check why students decided to take the courses in the form of virtual mobility, which competencies they expect to develop and which communication tools they use. The results of this segment of the survey are presented below comparing the last three study years.

Table 2: Competencies that students expect to develop in virtual summer school; 3-year comparison

Students' expectations	2013/14	2014/15	2015/16
gain from participation in international teams	8,67 %	12,68 %	16,75 %
improve knowledge of online learning	17,89 %	11,27 %	12,43 %
improve knowledge of information technologies	7,56 %	2,82 %	2,63 %
improve intercultural competencies	35,65 %	39,44 %	32,12 %
improve communication competencies	30,23 %	33,80 %	36,07 %

As evident from Table 2, students expect from international virtual mobility to improve communication competencies (36,07 % of students) and intercultural competencies (32,12 % of students). This is followed by

the opportunities arising from participation in an international team and improved knowledge of online learning and information technologies.

These competencies will become increasingly necessary in any future workplace and students are more and more aware that they have to acquire this set of skills and competencies as part of their education. Almost 97,8 % students in the study year 2015/2016 answered that they would recommend the virtual summer school to a friend.

Table 3: Satisfaction with developed competencies in virtual summer school on a 1-7 scale (7 being the highest score); 3-year comparison

Satisfaction with developed competencies	2013/14	2014/15	2015/16
competencies for participation in international teams	5,8	6,1	6,2
competencies for online learning	5,6	5,9	5,8
information technology competencies	6,1	6,0	5,9
intercultural competencies	6,5	6,3	6,4
communication competencies	6,3	6,3	6,5

As evident from Table 3, students are very satisfied with the competence development in the virtual summer school. The highest level of satisfaction is with communication competencies (6,5), intercultural competencies (6,4) and competencies for participation in international teams (6,2).

Table 4: Satisfaction with the tools to support communication on a 1-7 scale (7 being the highest score); 3-year comparison

Communication tool	2013/14	2014/15	2015/16
Blackboard communication board (forum, chat...)	6,0	5,8	5,9
One Drive	/	5,9	6,2
Skype	5,2	5,5	6,0
Wiki	4,5	4,3	3,9
Yammer	/	/	6,1
BB Collaborate (webinar)	6,1	6,3	6,5
Twitter, Facebook	5,9	5,8	5,5

The students use different communication tools in the course. Some of the tools are mandatory, such as the Forum in the course or Blackboard Collaborate (for following webinars, team presentations or oral exams). There are also several different tools available for communication within the team or between the students. The students can choose the communication tool that suits them best. The monitoring of team dynamics has shown that students prefer One Drive (6,2/7 in the study year 2015/16) and Yammer (6,1/7 in the study year 2015/16),

which have replaced Wiki, a tool widely used in the past years.

After each course in the virtual summer school, student satisfaction with different tools is monitored, while we also suggest the most popular and widely used tools in light of previous experience and use. We also noted a higher satisfaction level with Skype ever since the students have been offered the possibility of using Skype for Business, which is offered within the framework of Microsoft 365 services. Students therefore no longer have to share their personal email address with other participants, which used to be the main problem in past years.

The highest satisfaction levels have been recorded for Blackboard Collaborate (6,5/7) which offers audio and video communication and application sharing. Moreover, collaboration is enhanced with real-time annotations and text, whiteboard text editing allows content to be added and edited. Teachers have personal rooms accessible across all their courses, ideal for virtual office hours or ad hoc meetings. Blackboard Collaborate is most frequently used synchronous tools by the teachers. It is also an alternative to Skype for Business and approximately one third of students use it for communication between team members.

In the last 2 years teachers also have been using Blackboard Analytics which helps them identify and overcome barriers to student success and keep learners on track. It also provides the insights to help understand what is going on within a course from course activities to learner behaviours and is able to adapt the communication and course activities.

5.1. Challenges of online communication and collaboration in international groups of students

Although the online environment allows the shy, the hesitant, the slower and the less articulate students to have an equal say [2], the online collaboration can on the other hand cause stress by some students. Students may experience difficulties in building relationships with other students, participating in team decision making and reacting to team pressures and team dynamics. According to our experience, this is particularly true for African students who are more used to teacher-centred classroom and individual learning. In an online setting, where they don't "see" their classmates, they have difficulties understanding their circumstances, values and attitudes.

Experience has shown that students, who had previously been engaged only in the traditional study mode, needed four times more support than students, who were experienced in online learning.

Students in a virtual learning environment also have to interact with the technology. For technology novices, the interface may be a barrier to learning. One of the barriers for new technology users is that the student becomes more engaged with the technology and not with the content of interaction. As soon as students become more familiar and comfortable with the technology their communication is enhanced.

In our virtual mobility courses we encountered the following technology issues: lack of network access (especially African students), lack of basic technology skills, inability to navigate the virtual learning environment Blackboard. Video and written tutorials were prepared and sent to students (how to use different tool, how to navigate in Blackboard, etc.).

Moreover, students could contact DOBA's technical support via e-mail, Skype, phone or a special forum in Blackboard. The technical support was available throughout the course 7-days a week, most issues were solved in 24 hours.

In addition, a free online orientation course was designed in order to minimize all communication and technology issues and help students to prepare for virtual mobility. Students learn about the principles of online learning, intercultural communication and working in internationally mixed teams. A lot of focus is also given to netiquette (etiquette for the internet). In order to have good discussion online, students have to have some guidelines and boundaries for conducting the discussion so that the online conversation will be successful.

While only about 8% of international students explore the orientation course, the online orientation day, which is organized 2 days before the start of the virtual summer school, is attended by over 65% of international students. Online orientation day consists of short webinars on how to work and communicate in virtual summer school, how to navigate in Blackboard and use different tools.

While the orientation course is not moderated, orientation day is run by the programme manager, the course teacher and an IT specialist. In addition to introducing students to the work methods in the virtual summer school, the purpose of the orientation day is also to obtain information on the target group and correspondingly adapt the implementation of the course and student support.

At the end of the orientation day, the students fill in a questionnaire with questions on their previous experience with online learning, the familiarity with specific tools, their Internet connection, etc. Teachers are able to adapt the course activities and communication according to questionnaire results and the specifics of the target group.

6. CONCLUSION

Managing virtual mobility courses and international groups requires detailed planning and thorough selection of communication tools, especially as a number of students don't engage in course activities (lurkers), while the groups of students are also very diverse in terms of their cultural background and have different proficiency in the use of ICT. A close cooperation between the teacher and the tutor can influence students' performance. There is also a need for additional support for students participating in a virtual mobility course (technical support, orientation day, etc.).

With the implementation of a communication model in the virtual mobility courses, the satisfaction of students

after completing the course is high as well as the satisfaction with the developed competencies. The students state that the virtual mobility course provided them with many new experiences. Positive experiences which definitively stand out as important include; teamwork in a multicultural environment, project-based learning involving work with new media and quick feedback on their progress. The positive experience the students had with the virtual mobility course is also reflected in the high percentage of students who would recommend the course to a friend and would like to take part in another virtual mobility course in the future.

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TRANSITION PLANNING FOR HIGHER EDUCATION (HE) STUDENTS WITH DISABILITIES: THE OPINIONS OF EMPLOYERS IN SERBIA, BOSNIA AND HERZEGOVINA, AND MONTENEGRO

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Abstract: A survey within Erasmus+ Project Trans2Work was conducted in order to identify and analyze the needs of employers. The sample consisted of 426 employers from Serbia, Bosnia & Herzegovina, and Montenegro. Formal education of persons with disabilities was not prime consideration of employers. Although this varied by country, additional skills seemed to be the most important. Employers tended to employ persons with disabilities in order to fulfill social responsibility of the company - not for their professional skills. The main obstacle for employing persons with disabilities is time they need to fit in the working environment. Improvement of the soft skills of persons with disabilities has been pointed out as the most important task of HEIs in order to facilitate their employment. Disability targeted internship programs, financial incentives, assistive technology and disability awareness trainings are seen as the most important strategies in retaining jobs for persons with disabilities. Transition planning of students with disabilities to work life should take in the account these findings.

Keywords: Higher Education, Students with Disabilities, Employees with Disabilities, Inclusion, Transition.

1. INTRODUCTION

Due to the current economic crisis, the labor market in the Western Balkan region is characterized by the high rate of overall unemployment, a large share of long-term unemployed persons, as well as insufficient number of vacancies. As far as persons with disabilities are concerned, their position in the labor market is even more unfavorable, in view of all barriers they encounter in their private and professional life on daily basis. The position of this disadvantaged group in the labor market is influenced by personal qualities, complexity of their disability, degree of rehabilitation, motivation, educational level existing skills and potentials, and accessibility of their environment. However, in recent years there are highly educated persons with disabilities appearing at the labor market, who have difficulties to find a job regardless of their expertise. The fact is that the position of persons with disabilities in the labor market is unequal compared to other job seekers, what emphasize a need for a law to regulate the field of employment for the

persons with disabilities, and stipulate the commitment to recruit persons with disabilities under a quota-based principle.

Generally speaking, even though a significant progress has been made in the Western Balkan region regarding the adoption of laws that govern the employment of persons with disabilities [1-17], the progress is somewhat less visible in practice. The Law on Professional Rehabilitation and Employment of Persons with Disabilities is coordinated with all EU directives and is being constantly improved through the practice, while the relevant institutions show continuous readiness to improve this law and its enforcement in practice. This law regulates the manner and procedure of exercising the right to professional rehabilitation of persons with disabilities, measures and incentives for their employment, financing and other issues. However, despite significant subsidies, employers still prefer to pay special contributions to the Fund for Rehabilitation and Employment of Persons with Disabilities. The current economic situation negatively affects the level of employers' social responsibility and

their interest in issues that are not directly related to their economic benefit. Employers' prejudices towards persons with disabilities and the absence of adequate jobs (while the adaptation of workplaces is costly), are the main reasons why the situation on the ground changes rather slowly.

It is necessary to improve inter-institutional cooperation through involvement of all relevant factors in the mentioned areas. In this sense, the role of higher education institutions (HEIs) would be to facilitate and promote transition process by improving competences of students with disabilities, and educating employers on needs of persons with disabilities.

As a part of activities within ERASMUS+ Project „School-to-Work Transition for Higher education students with disabilities in Serbia, Bosnia & Herzegovina and Montenegro“, there has been conducted a survey of the employers from these three countries [18]. This particular survey aimed to identify and analyze the needs of employers in order to explore and create the methodologies for pioneering categorization and analysis of employers' needs. These findings could be used for further studies and/or to develop programs that would facilitate transition of students with disabilities to work life. This paper presents the most important results.

2. METHOD

The survey was conducted during March and April 2016. The process of distributing the questionnaire was the same in all three countries. Invitations to participate in the survey were sent by e-mail to the employers registered in the national employment agencies of Serbia, Bosnia and Herzegovina, and Montenegro. They were informed about the objectives of the Project and asked to complete the questionnaire which was available in two forms: 1) online (the web link was forwarded via email); 2) a hardcopy questionnaire. Employers willing to participate in the survey have signed the letter of consent (if the questionnaire was in hardcopy), or it was assumed to voluntarily approach the survey by following the link attached to the online questionnaire. Participants were informed that they are allowed to withdraw at any moment. The questionnaire was at their disposal for 2 months. The survey was completely anonymous.

The questionnaire consisted of 25 questions divided into five sections. The questions were of different types: 5-point-Likert-scale type, open-ended, binary, multiple choice and multiple response.

The survey was completed by 426 employers (341 of them from Republic of Serbia, 45 of them from Bosnia & Herzegovina, and 40 employers from Montenegro). The majority of participants were from private sector (71.06%), and rest were from public sector, non-government organizations (NGO), Civil Society Organizations (CSO) and non-profit organizations (NPO), and companies/organizations declared as "other" (Table 1). 52.37% of employers participated in the survey were male, and 47.63% of them were female. An average number of employees in organizations/companies included in this survey was $M=105.26$ with $S.D.=174.23$.

310 (72.77%) employers who took part in the survey had employees with disabilities.

Table 1: Participants by sector and country

Sector		RS	BiH	ME	TOTAL
private	f (%)	246 (72.14)	36 (80.00)	20 (50.00)	302 (71.06)
public	f (%)	71 (20.82)	4 (8.89)	13 (32.50)	88 (20.71)
NGO, CSO, NP	f (%)	12 (3.52)	5 (11.11)	4 (10.00)	21 (4.94)
other	f (%)	11 (3.52)	0 (0.00)	3 (7.50)	14 (3.29)
missing	f	1	0	0	1
total	f (%)	340 (80.00)	45 (10.59)	40 (9.41%)	425 (100.00)

Legend: RS – Republic of Serbia, BiH – Bosnia & Herzegovina, ME – Montenegro, TOT - total, NGO – non-government organizations, CSO – civil society organizations, NP – non-profit organizations, f – frequency, (%) - percentage

Disproportion between private (50%) and public sector (32.5%) of employers was the lowest in Montenegro. A percentage of employers who had employees with disabilities was the highest in Serbia (77.64%), and the lowest in Bosnia & Herzegovina (46.67%). Employers from the Republic of Serbia more often employed persons with disabilities than employers from other two countries. This difference was statistically significant ($\chi^2_{(2)}=21.764$, $p<.001$).

Table 2: Employers who had employees with disabilities by sector and country

sector		RS	BiH	ME	TOT/BS
private	f (%)	204 (77.30)	17 (80.00)	12 (48.00)	233 (77.15)
public	f (%)	45 (17.00)	2 (8.89)	8 (32.00)	55 (62.50)
NGO, CSO, NPO	f (%)	5 (1.90)	2 (11.11)	2 (8.00)	9 (42.86)
other	f (%)	9 (3.40)	N/A	3 (12.00)	12 (85.71)
missing	f	1	0	0	1
TOT/BC	f (%)	264 (77.64)	21 (46.67)	25 (62.50)	309 (72.70)

Legend: RS – Republic of Serbia, BiH – Bosnia & Herzegovina, ME – Montenegro, TOT/BS – total and percentage by sector, TOT/BC – total and percentage by country, NGO – non-

government organizations, CSO – civil society organizations, NPO – non-profit organizations, *f* – frequency, (%) – percentage

A percentage of organizations/companies which had employees with disabilities (Table 2) regardless of the country was largest in private sector (77.15%). Organizations/companies from the private sector employed persons with disabilities more often than employers from public sector and NGO/CSO/NPO. This difference was statistically significant ($\chi^2_{(3)}=18.250$, $p<.001$).

In fact, the highest percentage of companies/organizations which had employees with disabilities was in the sector designated as “other” (85.71, but it is our opinion that this finding should be taken with caution due to a small size and non-probabilistic nature of the sample).

3. RESULTS

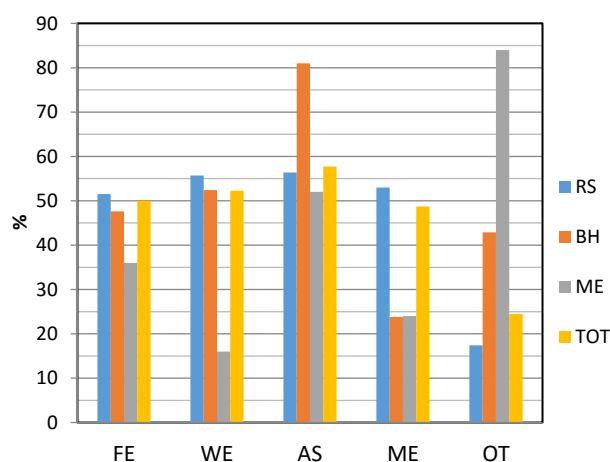
As far as employees with disabilities are concerned, according to data provided by the employers, majority of employees with disabilities have some kind of physical impairment (between 56 and 76.2% depending on the country), then visual impairment to much lesser extent (between 4.8 and 22.7%), hearing impairment (between 9.5 and 26.9%), or other types of impairments. Organizations/companies employ persons with disabilities mostly at administrative positions (between 33 and 57.1%), and much less at middle (between 6.4 and 14.35%) and high management positions (up to 12%). Employers have stated to a large extent that they have employees with disabilities at positions classified as “other” (from 36 to 70.1%). This category may contain positions that cannot be categorized in any of previous categories, or may be a container for positions that employers do not know how to classify.

Considering the strategies which the employers use to recruit employees with disabilities, we could say that they do not have such strategy at all in most cases. The most utilized strategy is posting job announcements in the job service or workforce employment center (48.4%). Creating partnerships with the organizations of/for person with disabilities, posting job announcements in disability-related publications, and including persons with disabilities in diversity recruitment goals are strategies that are used by less than 20% of employers (each). 14.2% of the employers are not fully aware of recruitment processes they follow.

When employers were asked (multiple response question) what was their prime consideration when hiring a person with disabilities, *Additional skills* was the most frequent response (57.7%). The least frequent option (excluding option “other”), *Mandatory employment*, was prime consideration in 48.7%. The employers from the different countries exhibited different patterns of responses. For employers from Serbia, the first four options were almost equally important (Formal education 51.5%, Working experience 55.7%, Additional skills 56.4, Mandatory employment 53%, and “Other” 14.4%). The magnitude of differences between frequencies of these considerations was not large enough to allow us to say that additional skills were more important than formal education or work experience and mandatory employment. In Bosnia and

Herzegovina, clearly the most important consideration was *Additional skills* (81%). *Mandatory employment* was much less important than in Serbia. Likewise, in Montenegro, *Mandatory employment* was not as important as in Serbia (24%), *Additional skills* were also very important (52%), but the most frequent considerations were those designated as “Other” (84%). We must keep in mind that, although here we speak about high percentages, absolute numbers are indeed small due to rather small samples from Bosnia & Herzegovina and Montenegro (i.e., 84% from Montenegro is just 21 case).

Chart 1: Prime consideration when hiring persons with disabilities



Legend: FE – Formal education, WE – Working experience, AS – Additional skills, ME – Mandatory employment, OT – Other

In line with this result there were the answers of the employers on 5-point Likert-scale-type question regarding the most important reasons for employing persons with disabilities. 11 reasons were offered. Majority of reasons were related to work ethics and competencies of persons with disabilities. Employers seemed to agree that the most important reasons for employment of persons with disabilities were to *fulfil social responsibility of organization/company* (means between 4.15 and 4.32 depending on the country) and *positive image that employees with disabilities give to the organization/company* (means 3.92-4.24). On the other hand, *qualifications for the job* of persons with disabilities were seen as the least important reason to hire them (means 3.47-3.52). Means of the employers responses followed approximately the same pattern in all three countries. There was one exception. Employers from Montenegro stated that they employed persons with disabilities primarily *for their competencies*, more often than the employers from the other two countries ($M_{ME}=4.20$, $M_{RS}=3.47$, $M_{BH}=3.67$).

When employers were asked the opposite question, *What are the main reasons for not employing persons with disabilities* (again 5-point Likert-scale-type question), they did not agree with most of the offered reasons. None of the means of the responses was higher than 2.43. Montenegrin employers consistently had the lowest means, but the differences were very small for all 6 offered reasons. The highest means were recorded for

long perceived time persons with disabilities need to fit in the working environment (means from 1.76 to 2.43 depending on the country). The second most important reason was the opinion that *persons with disabilities do not have the same rights in the working place as persons without disability* (means 1.61-2.33).

The employers tended to agree that a role of higher education institutions (HEIs) in order to *facilitate the transition* to employment of students with disabilities was very important. Means of the employers responses to 5 offered statements were between 3.61 and 4.52 with $M=4.16$ (Likert-scale-type question). *Raising awareness and sensitivity of employers towards employees with disabilities* (means between 4.13 and 4.52) and *educating employers on the needs of persons with disabilities* (means 4.08-4.22) were pointed out as HEIs most important tasks.

When the employers were asked a similar question, *What universities should focus on to promote transition of students with disabilities from higher education to work life*, they agreed that pretty much everything was important (median of means was 4.10). Skills of *presenting and writing clearly and effectively* (means 4.08-4.16 depending on the country), *Using appropriate technology to enhance and manage communication* (4.06-4.20) and *Obtaining and critically evaluating information from different sources* (3.78-4.08) emerged as the most important items. Although these three items had highest means, the differences from the means on other 8 items were rather small. The employers from three countries exhibited similar mean responses pattern to items, with two exceptions. The employers from Bosnia and Herzegovina had significantly lower scores than the employers from the other two countries on items concerning *Demonstrating leadership* and *Interpretation and communicating of numerical data*.

The employers tended to agree that improvement of the employability of persons with disabilities was duty of organizations/companies as well. All three offered options had high mean scores (from 3.93 to 4.44 depending on country). The highest median of means scores for three countries had *Providing accessible environment* ($Me=4.12$), then *Supporting the role of the mentor* ($Me=4.06$) and *Targeted trainings for improving knowledge and skills of persons with disabilities* ($Me=4.05$). The employers who did not have employees with disabilities considered duties of organizations/companies as more important, but all differences between mean responses were too small to say they were significant.

Among the thirteen offered strategies for retaining jobs of persons with disabilities, employers most often agreed with three. Strategies with which employers agreed the most were *Use of assistive technology* (means 3.70-4.39 depending on country), *Tax credits and incentives* (3.80-4.28) and *Disability targeted internship programs* (3.78-4.26). Next to these three strategies, there was *Disability awareness training*, with somewhat lower means (3.57-4.18).

4. DISCUSSION

Based on the results of the survey data we can conclude that, although a large percent of organizations/companies employ persons with disabilities, their number could and should be higher, especially at higher level positions.

In the opinion of the employers from the Republic of Serbia, Bosnia & Herzegovina and Montenegro, this is responsibility of higher education institutions, organizations/companies and governments.

Although highly valued, formal education and qualifications for the job of persons with disabilities, often are not prime reasons for their employment. As well as for the persons without disabilities, additional skills are something that employers value the most. To improve employability of persons with disabilities, higher education institutions and associations of persons with disabilities should encourage them to constantly work on their self-improvement through acquirement of additional skills, such as clear and effective presentation and writing, obtaining and critically evaluating of information from different sources and using appropriate technology to enhance and manage communication. It is our opinion that persons with disabilities should also be informed that having additional skills is an important factor in finding a job in order to motivate them to work on their acquisition.

Employers who participated in this survey stated that they often did not hire persons with disabilities because of their competencies, but for expected positive effect on organizations/companies image, and/or to fulfil social responsibility of organization/company. This could mean two things: either stated reasons are really more important to employers, or they do not have high opinion of persons with disabilities' competencies. The former case is legitimate. If latter is the case, it is misconception which must be corrected. Higher education institutions should not lower criteria for students with disabilities, but create conditions which would help and ensure that students with disabilities acquire the same level of competences as students without disabilities.

In this survey, as the most important reason for not hiring persons with disabilities emerged their perceived long time to fit in the working environment. Programs aimed to facilitate transition of students with disabilities from higher education to work life should take that into account. Higher education institutions should take actions which would facilitate faster adaptation of students with disabilities to the working environment, such as disabilities targeted internship programs. This is also one of the solutions that employers recommend the most (along with the use of assistive technologies) in order to retain persons with disabilities' jobs.

This study did not address the role of governments in the promotion of employment of persons with disabilities. Still, one thing that government could influence emerged. The employers stated that tax credits and incentives were a good strategy for retaining persons with disabilities' jobs.

In order to create programs which will promote and facilitate employment of persons with disabilities we should have all this in mind. Such programs should also

help employers to devise sound recruitment strategies of persons with disabilities, because they often have none.

At the end we should point out shortcomings of this survey. In the first place, it is relatively small and perhaps biased sample, especially in the case of subsamples from Bosnia & Herzegovina and Montenegro. Also, the questionnaire could have been somewhat more detailed and specific. Nevertheless, we think that this survey significantly contribute to identification of employers' needs when it comes to employment of persons with disabilities in the three countries of Western Balkans.

ACKNOWLEDGMENTS

This study was part of the project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina (project no. 561847-2015) and was supported by the Erasmus+ Programme of the European Union.

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TRANSITION PLANNING FOR HIGHER EDUCATION (HE) STUDENTS WITH DISABILITIES: THE OPINIONS OF STUDENTS AND EMPLOYEES WITH DISABILITIES IN SERBIA, BOSNIA AND HERZEGOVINA AND MONTENEGRO

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Abstract: According to the opinions of students with disabilities (SwD) and employees with disabilities (EwD), the employment is harder available for them than for the rest of the population. The transition from academic education to the inclusion in the work force is very complex and demanding process that has profound impacts primarily on SwD and subsequently at universities and organizations that offer jobs. Universities need to expand the area of operation and its role in the formation of SwD who will become successful employees and to actively participate in the process of transition itself. If it is examined widely, it will have a great opportunity to be involved in the curriculum mechanisms that will enable SwD to get the best possible education and a positive experience with the process of transition to work. Finally, the continuous support during studies and work should be provided by the local educational institutions and society.

Keywords: Higher Education (HE), Students with Disabilities (SwD), Employees with Disabilities (EwD), Inclusion, Transition.

1. INTRODUCTION

It is generally accepted in the Balkan region the fact that the employment is hardly available for employees with disabilities (EwD) as well as for the students with disabilities (SwD) than for the rest of the population, and consequently EwD and SwD are more exposed and treated of long-term unemployment. The initiation of the research lies in the project evaluation that is based on the investigation of the school-to-work transition for higher education (HE) students with disabilities in Serbia, Bosnia and Herzegovina and Montenegro. The project aim relies on the fact to facilitate the acquisition of professional experience in higher education, to give a better chance for employment especially to the employees and students with disabilities.

This paper focuses on the investigation the opinions of SwD and EwD regarding their transition from HE to work. However, we report on various mechanisms that can overcome the possible problems. The main objective should be encouraging dialogue and activation of all participants in the transition. On one hand local

stakeholders and communities have to be ready to support the process of employment of the EwD, while on the other, Universities need to expand the area of operation and its role in the formation of SwD who will become successful employees. After that, it is necessary to continue to actively participate in the process of transition itself [1-17].

The organization of the paper is as following. Section 2 deals with the legislative regarding the position of EwD and SwD in the reported regions. In Section 3 we provide a comprehensive analysis on obtained results for professional status of EwD and year of study of SwD. Results of the analysis with the discussion are presented in Section 4. Final section gives concluding remarks.

2. LEGISLATIVE

Based on the comparative analysis of the legislation, similarities and differences between the laws, policies and legislation relating to the transition of EwD and SwD from HE to work, we summarized the data and conclusions of the laws of partner countries namely Serbia (RS), Bosnia and Herzegovina (BiH) and

Montenegro (MNE) in relation to European Union (EU) law. Therefore, in Chart 1 we present the results of benchmarking scores regarding six themes: policy domain, evolution, targeting strategy, implementation strategy, outcomes and impacts and good practice and learning [1-20]. The benchmark scores are related to the following:

- Benchmarking score (-) signifies that partner country laws are at the moment below the ‘norm’ for the EU as a whole
- Benchmarking score (=) signifies that partner country laws are at the moment broadly at the same level as the ‘norm’ for the EU as a whole

- Benchmarking score (+) signifies that partner country laws are at the moment broadly above the ‘norm’ for the EU as a whole.

It is well known that benchmarking transition and employment policy should offer assessment of the initiatives in regional, national and international level that could be adopted in partner countries in order to facilitate the transition of EwD and SwD from HE into the labour market. It is clear that most of the legislation that is needed to be adopted in mentioned countries is in line with EU policies.

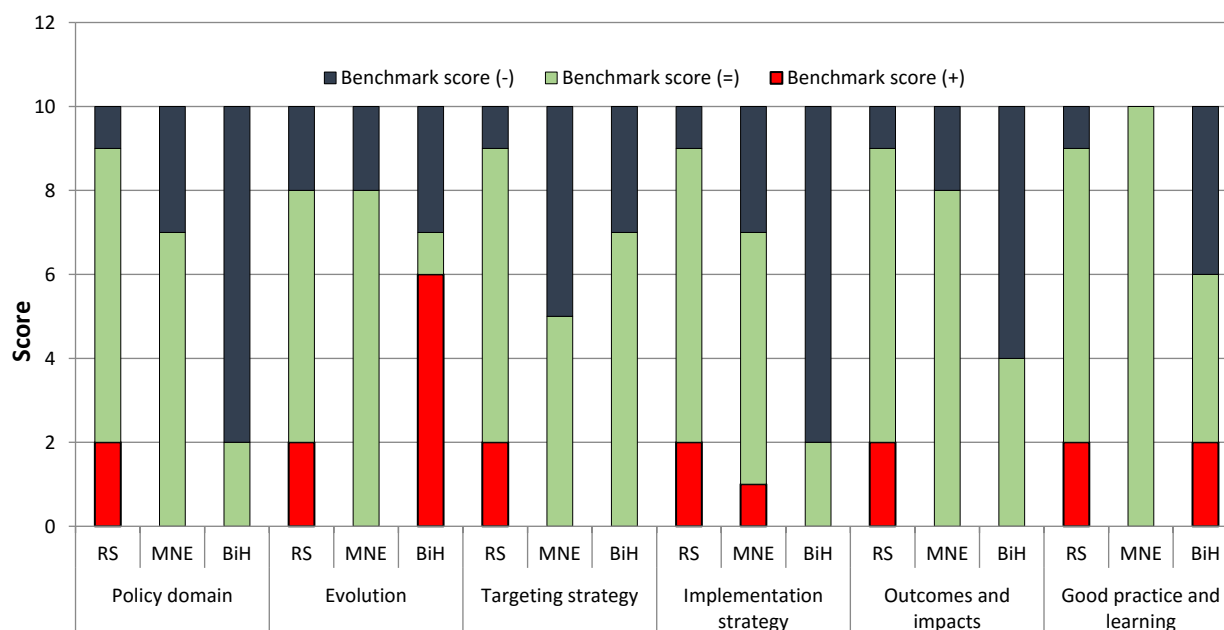


Chart 1: Distribution of benchmarking scores

Current legislative should be improved, especially the part that refers to mechanisms that are made to ensure implementation of those laws. There should also be a concrete encouragement by the government for the employers who hire persons with disabilities. This encouragement should not only be in terms of some tax benefits but also as a help with practical problems they can face when hiring EwD or SwD (like need for special equipment that can enable them to perform better on the job etc).

Despite the existence of legal framework and society in the labour market cannot always provide support for EwD and SwD. Many of them still have architectural barriers that are very slowly eliminated. Regardless of the numerous shortcomings that exist in higher education to all students, should be given continuous support during their studies. Beside the positive results already achieved by applying the existing legislation, for successful implementation of the principle of non-discrimination and improvement of the position of disabled persons, it is necessary to further develop, elaborate and harmonize legislation referring to the rights of the disabled with

regard to education and employment. The previous experience and practice show that it is necessary to improve inter-institutional cooperation (education, health care, employment, social protection) through involvement of all relevant actors in the mentioned areas (line ministries, institutions, faculties, associations, organizations, NGOs).

3. DESCRIPTION OF THE SAMPLE

Since in our analysis we divided two categories of examinees, we collected the data of 77 EwD and 170 SwD in all three countries. The distribution of categories is show in Table 1 [18-20].

Table 1:Categories’ data [19]

Category	RS	BiH	MNE
No. of examined EwD	39 (50.65%)	3 (3.90%)	35 (45.45%)
No. of examined SwD	65 (28.24%)	57 (33.53%)	48 (28.24%)

This was collected by the questionnaires provided in hard copy and electronic form. With respect to the first category, 29 participants were male (37.66%) and 48 participants were female (62.34%). Concerning participants type of disability that better describes their condition, 5 (6.49%) identified themselves as having a visual impairment, 3 (3.9%) as having a hearing impairment, 1 (1.3%) as having a visual and hearing impairment, 6 (7.79%) as having a visual and physical impairment, 2 (2.6%) as having a visual and hearing and physical impairment, 50 (64.94%) as having a physical impairment, 1 (1.3%) as having a learning impairment and a visual and physical and learning impairment, respectively, 2 (2.6%) as having other impairments and 7 (9.09%) are not reported answers [19]. Also, the results for professional status of EwD that were examined are shown in Chart 2.

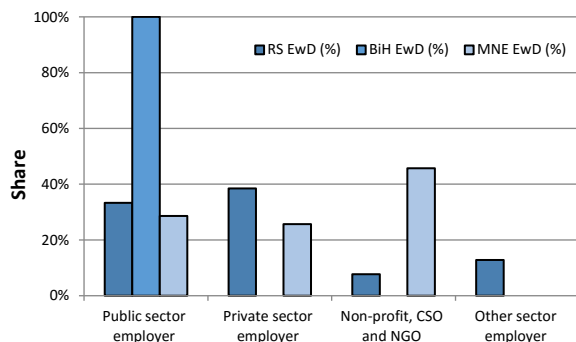


Chart2: Results for current professional status of EwD

As far as concerning second category, 76 participants were male (44.71%) and 93 participants were female (54.71%). In relation to participants' year of study, 26 (15.29%) were in 1st year, 18 (10.59%) were in 2nd year, 39 (22.94%) were in 3rd year, 28 (16.47%) were in 4th year, 17 (1%) were in 5th year and 42 (24.71%) were graduated (see Chart 3) [19]. Regarding the year of study of interviewed SwD, the results are shown in Image 3. Even 40% of examinees graduated in Serbia, 26.3% in Bosnia and Herzegovina and only 2.1% in Montenegro. The difference is also evident for the third year of study where Montenegro has the biggest share of 39.6% while only 15.4% and 17.5% is noted in Serbia and Bosnia and Herzegovina, respectively [19].

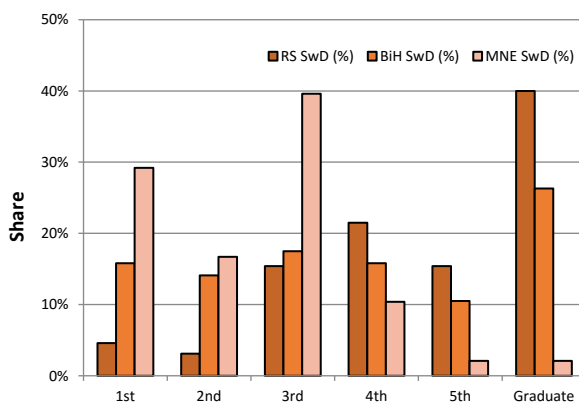


Chart3: Results of year of study of SwD

4. RESULTS

In this Section, we provide the results from the questionnaires on the following questions:

- What are the most important things that employer could do to facilitate a SwD/EwD to do the job?
- What Universities need to do in order to facilitate the transition to employment of SwD?
- What companies can do in order to improve the employment of SwD/EwD?
- Where Universities should focus on in order to better promote SwD transition from HE to work life?

First two issues implied the outputs from Serbia and Bosnia and Herzegovina, while the last two are indicated for Montenegro. Regarding Serbia, concerning participants' views on the most important things an employer could do to facilitate a SwD/EwD to do his/her job best, the top ranked thing was to make certain facilities accessible. After that, making their work schedule more flexible is of utmost importance. Then, the next requests were elaborated: purchase or change equipment, to reassign them to a vacant position, to leave them to do their job and provide supervision, to change a company policy and finally to assign part of their job duties to a co-worker. The opinion of Serbian SwD with regards to the activities of Universities in order to facilitate the transition to employment of them, the most important thing is to raise the awareness and sensitivity of the employers. The second top ranked was to educate employers on issues concerning accessibility, assistive technologies and individualized support. It is followed by informing employers on the provided support services that person with disabilities might need during their employment. In addition, according to the answers, the attention should be paid on education of employers on issues concerning the obstacles a person with disabilities may encounter during their employment, support the position of mentor during their first period at work and improve the knowledge and skills of persons with disabilities through additional training and education [19].

Similarly like in Serbia, the answers from Bosnia and Herzegovina shown that the most important issue was related to make certain facilities accessible for SwD/EwD, followed by the necessity to purchase or change equipment. Also, for them, it is very important to provide supervision, make their work more flexible, to change a company policy, to reassign them to a vacant position and to assign part of their job duties to a co-worker. With reference to Universities, we obtained the following answers: first ranked was to educate employers on issues concerning the obstacles a person with disabilities may encounter during their employment, then, we have the support services that should be provided, raising the awareness and sensitivity of the employers and consequently educate them on issues concerning accessibility, assistive technologies, individualized support. Finally, we have support the position of mentor during their first period at work and improve the knowledge and skills of persons with disabilities through additional training and education [19].

In Montenegro, the results of the questionnaires showed that providing an accessible environment/work place to attract employees with disabilities has the greatest result which is followed by the support the position of a mentor during the first period at work and finally, to take targeted training/educational actions for improving working skills and knowledge of persons with disabilities, so they are better prepared for employment ranked the lowest result. Regarding the answers of Universities that should focus on in order to better promote SwD transition from HE to work life, it was found that statement use appropriate technology to enhance and manage communication knowledge has the highest result, followed by integrate, experience, disciplinary and interdisciplinary knowledge and communicate this effectively has the best score. Apart from few other answers, the lowest rank were related to the issues of being engaged within the community to make a difference in a civic life and interpret, use and communicate numerical data and quantitative evidence [19].

5. CONCLUSION

The transition from academic education to the inclusion in the work force is very complex and demanding process that has profound impacts primarily on EwD and SwD and subsequently at organizations and universities that offer jobs. If the society and the labor market have not been positioned in front of university requirements to modernize curricula and study programs from the point of transition, the organizations and universities themselves need to take the necessary steps in this direction. Closing the gap between the educational institutions and employers, universities are not only helping the SwD, labor market and the society, but also have the opportunity to further strengthen its influence on employers and portray itself as a trusted service to the vulnerable part of the population.

It seems that the mutual cooperation between the universities and partner organizations would be useful. Seminars, conferences and the meetings aimed at the issue of transition of SwD, where it would participate both academic staff and managers of firms and companies and could form the knowledge that greatly help the successfully start, duration and finish the transition of SwD and the rest of the population. The main objective of these activities should be encouraging dialogue and activation of all participants in the transition. Universities need to expand the area of operation and its role in the formation of SwD who will become successful employees. After that, it is necessary to continue to actively participate in the process of transition itself. However, the space for further investigation is enormous, so any analysis or research can be directed to provide a better understanding of position of SwD and EwD and their transition from HE to work.

ACKNOWLEDGMENTS

This study was part of the project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina (project no. 561847-2015) and was

supported by the Erasmus+ Programme of the European Union.

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TRANSITION PLANNING FOR HIGHER EDUCATION STUDENTS WITH DISABILITIES: A COMPARATIVE ANALYSIS OF THE OPINIONS OF EMPLOYERS IN SERBIA, BOSNIA AND HERZEGOVINA AND MONTENEGRO

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Abstract:

In this paper we presented research as just one part of a comprehensive study of Erasmus + Trans2work project, aimed on supporting SwD from HEI to labour market and help HEI, employers and SwD to successfully complete this transition. The data analysis, where total of 426 employers from RS (341, 80.05 %), BiH (45, 10.56 %) and MNE (40, 9.39 %) participated in the project, included statistical indicators of descriptive statistics, Levene's Test for Equality of Variances and ANOVA with Scheffe post hoc tests. Acquired results formulate strategies and activities that can be adopted at national and regional level in order to facilitate the transition of SwD from HE into the labor market.

Keywords: Higher Education (HE), Students with Disabilities (SwD), Employers, Benchmarking, Transition.

1. INTRODUCTION

This paper focuses on one goal set by members of the consortium of Trans2work project in the Republic of Serbia (RS), Bosnia and Herzegovina (B&H) and Montenegro (MNE). This goal is to improve the quality and relevance of support for the transition of SwD from HE to work, in Serbia, BiH and Montenegro. In line with this overall goal, the main objective is to map the conditions and standards that will support the transition of SwD, in accordance with EU practices and policies. Therefore, first steps have descriptive purpose – mapping the ‘landscape’ of policies and practices to support the transition of SwD from HE to work in the EU; an analytical purpose – identifying commonalities and differences in policies and practices between EU as well as between three partner countries (similarities and differences in the legislation and their practical application in three partner countries: Serbia, BiH and Montenegro); and a ‘benchmarking’ purpose – comparing current state of the art in Serbia, BiH and Montenegro with that of the EU and identifying areas for improvement. Descriptive role, in addition, should review

the relevant legislative, regulations and rules in the sphere of inclusion of the highly educated students from education point to the employment. Benchmarking role needs to answer the question “Where is our position compared to other countries in the EU from the transition standpoint of SwD”, i.e. to compare the current situation in the three partner countries with the situation in EU and to propose a sphere in which there is a space for improvement.

Assessment of the initiatives in regional, national and international level that could be adopted in partner countries is necessary in order to facilitate the transition of SwD from HE into the labour market. In addition, the results obtained from the research analysis conducted so far need to formulate strategies and activities designed to achieve the overall objectives of the project:

- upgrade and prepare HEs services to support SwD to their transition from HE to Work following the EU policies;
- link Higher Education to “disability friendly work environments, assimilate transition opportunities and skills with EU practices and policies;

- to prepare employers on understanding the needs of employees with disabilities in order to offer new jobs.

2. METHODOLOGY

Benchmarking is a modern technique based on comparisons with other companies that provides the opportunity of learning and changing the behaviour. The process of benchmarking includes: defining the problem and data collection, data analysis, making decision on the best solution, implementing the solution etc. Benchmarking is used as an instrument to identify and assess their competitive position and also provides a continuous process of comparing the organization with others to find and run the best business practices to ensure long- term competitive advantages. In business practice benchmarking organization is an instrument that continuously compares the extent of their business compared to other organizations and consequently learns from the most successful and applies the acquired knowledge in order to increase performance and efficiency of the business. It can compare the products and services, business processes, technical solutions, strategy, etc., with the aim of understanding their own shortcomings, limitations and possibilities of their removal or improvement. Benchmarking is a continuous process of identifying, understanding and adapting products, services, equipment and procedures of companies with the best practices to improve their own business. This landscape identifies the standards and good practices that can then be used to develop and apply a benchmarking framework to enable the situation in Serbia, BiH and Montenegro to be compared with the EU situation, and key areas for future development identified. The overall approach proposed to benchmarking is taken from the BENVIC approach developed in collaboration with a number of organisations under the Socrates programme (Benchmarking for higher education campuses). The methodology is based primarily on 'Best Practice' benchmarking but reflects elements of two other approaches – process benchmarking and strategic benchmarking. 'Best Practice' benchmarking describes the comparison of performance data that has been obtained from studying similar processes or activities and identifying, adapting, and implementing the practices that produced the best performance results. Process of benchmarking starts where the initiating organisation focuses its observation and investigation of business processes with a goal of identifying and observing the best practices from one or more benchmark organisations. Strategic benchmarking involves observing how others compete. Benchmarking methodologies typically encompass the following methods and actions:

- Identify the subject or 'problem' area – i.e. the business/organisational processes to be assessed;
- Identify other industries that have similar processes;
- Identify organizations that are leaders in these areas;
- Identify data sources for comparison;
- Collect data (e.g. Survey companies for measures and practices; visit the "best practice" organisations to identify leading edge practices);
- Identify gaps between actual and desired state;
- Establish future changes and targets;
- Implement new and improved business practices.

3. PARTICIPANTS

A total of 426 employers from RS (341, 80.05 %), BiH (45, 10.56 %) and MNE (40, 9.39 %) participated in this study. As concerns participants' distribution based on the employment of PwD, 310 (72.77 %) participants had EwD and 116 (27.23 %) did not have EwD when data collection was undertaken.

4. COMPARISON AMONG EMPLOYERS OF SERBIA, BIH AND MONTENEGRO

Concerning the most important reasons for employing persons with disabilities the highest mean value scored the statement "Their employment helps the company fulfill its social responsibility to the community" ($M=4.29$, $SD=0.756$), followed by they "Tend to be reliable to be on time and to turn up" ($M=4.02$, $SD=0.754$), "Tend to be loyal employees" ($M=3.96$, $SD=0.748$), "Give a positive image for the organization/company" ($M=3.96$, $SD=0.840$), "Have a strong motivation to work" ($M=3.95$, $SD=0.851$), "Tend to be punctual and stay focused on one job for a long time, so they can be good employees" ($M=3.91$, $SD=0.740$), "Help all employees get on well socially" ($M=3.85$, $SD=0.850$), "Do good quality work" ($M=3.80$, $SD=0.749$), "Are open for new knowledge and training" ($M=3.74$, $SD=0.809$), "Because of their competence, not for any other reason" ($M=3.56$, $SD=1.016$), while smallest mean value had option that "They are well qualified to do the job" ($M=3.52$, $SD=0.849$). Levene's Test for Equality of Variances indicates unequal variances in the case of questions "They are well qualified to do the job" ($p=.002$), "They give a positive image for the organization/company" ($p=.005$), "They help all employees get on well socially" ($p=.005$), "They tend to be punctual and stay focused on one job for a long time, so they can be good employees" ($p=.007$) and "They are open for new knowledge and training" ($p=.008$). The Scheffe post hoc tests indicated that Serbian and BiH answers on question "They give a positive image for the organization/company" ($p=.013$) are significantly different. Also, Montenegrin answers on question "They are open for new knowledge and training" ($p=.003$, $p=.033$) and "We employee persons with disability because of their competence, not for any other reason" ($p=.000$, $p=.036$) are significantly different from answers in Serbia and BiH.

- Employers were asked additional about the reasons for not employing PwD in companies. Answers on this question, sorted in descending order of mean values are: "They take a lot of time to fit in a working environment" ($M=2.10$, $SD=0.931$),
- "A person with disability does not have the same rights in the working place as a person without disability" ($M=1.86$, $SD=1.023$),
- "It is better for them to work at home" ($M=1.78$, $SD=0.857$),
- "Other employees will feel uncomfortable and unhappy if they have to work together with a person with disability" ($M=1.76$, $SD=0.859$),

- “A person with disability should learn and do their job in a separate, protected environment” (M=1.71, SD= 0.851),
- “A person with disability has a lot of behavior problems, so it is best for them to work in private” (M=1.69, SD= 0.795).

Levene's Test for Equality of Variances indicates unequal variances in the case of questions “Other employees will feel uncomfortable and unhappy if they have to work together with a person with disability” ($p=.011$) and “A person with disability should learn and do their job in a separate, protected environment” ($p=.031$). The Scheffe post hoc tests indicated that Serbian and Montenegrin answers on questions “Other employees will feel uncomfortable and unhappy if they have to work together with a person with disability” ($p=.010$) and “A person with disability has a lot of behavior problems, so it is best for them to work in private” ($p=.015$) are significantly different. Also, Montenegrin answers on question “A person with disability should learn and do their job in a separate, protected environment” ($p=.007$, $p=.024$) are significantly different from answers in Serbia and BiH.

Concerning the questions about employers' views on what the universities should do in order to facilitate the transition to employment of SwD based on the results, the most important is “Raise awareness and sensitivity of employers towards employees who may have a disability/impairment” marked with M=4.21 (SD= 0.698), followed by “Inform employers on the provided support service that PwD might need during their employment” (M=4.16, SD=0.677), “Educate employers on issue concerning the needs of PwD” (M=4.13, SD=0.728), “Educate employers on the potential obstacles a PwD might encounter during their job” (M= 4.11, SD= 0.732), “Support the position of a mentor during their first time at work” (M=4.10, SD=0.751), and the least important is “Improve the knowledge and scales of PwD through additional training and education” (M=3.97, SD=0.840). Variances are not significantly different (all p values are greater than 0.05).

Employers were asked to answer concerning where universities should focus on in order to better promote SwD transition from HE to work life. It was found that “Work together with team members in a respectful and collaborative manner to complete tasks”, is the most reliable task (M=4.22, SD=0.618), followed by “Use appropriate technology to enhance and manage communication knowledge” (M=4.16, SD=0.593), “Present and write information clearly and effectively” (M=4.14, SD=0.624), “Be engaged within the community to make a difference in a civic life” (M=4.13, SD=0.647), “Integrate, experience, disciplinary and interdisciplinary knowledge and communicate this effectively” (M=4.11, SD=0.642), “Exhibit personal organization, accountability and time management” (M=4.09, SD=0.604), “Gain intercultural knowledge so as to interact effectively in various cultural contexts” (M=4.08, SD=0.646), “Obtain, critically evaluate and use information effectively from a variety of resources and formats” (M=4.05, SD=0.642), “Identify and solve problems, including evaluating alternatives and articulating reasoning” (M=4.04, SD=0.652), “Demonstrate leadership, including giving

direction and guidance, as well as strategic visioning” (M=4.01, SD=0.671) and “Interpret, use and communicate numerical data and quantitative evidence” (M=3.94, SD=0.697). Variances are not significantly different (all p values are greater than 0.05). There was a statistically significant difference between groups as determined by one-way ANOVA in questions:

- “Work together with team members in a respectful and collaborative manner to complete tasks” { $F(2.413) = 3.479$, $p=.032$ }.
- “Demonstrate leadership, including giving direction and guidance, as well as strategic visioning” { $F(2.411) = 6.739$, $p=.001$ }.
- “Interpret, use and communicate numerical data and quantitative evidence” { $F(2.410) = 4.984$, $p=.007$ }.

The Scheffe post hoc tests indicated that Serbian answers on question “Work together with team members in a respectful and collaborative manner to complete tasks” ($p=.039$) differ significantly from answers in BiH. Examinee in BiH gave significantly different answers on questions “Demonstrate leadership, including giving direction and guidance, as well as strategic visioning” ($p=.002$, $p=.017$) and “Interpret, use and communicate numerical data and quantitative evidence” ($p=.036$, $p=.009$) that examinee in other two countries.

Employers were asked to evaluate the helpfulness of specific strategies in retaining PwD's job within their organization/company. According to employers' answers the most helpful strategy is considered “Employer tax credits and incentives” (M= 4.11, SD=0.972), followed by “Disability targeted internship program” (M=3.87, SD=0.914), “Assistive technology” (M=3.83, SD=0.975), “Disability awareness training” (M=3.69, SD= 1.0313), “Flexible work schedule” (M=3.60, SD=1.007), “Mentoring” (M=3.55, SD=1.003), “Visible top management commitment” (M=3.54, SD=1.028), “On-site consultation or technical assistance” (M=3.49, SD=0.974), “Training existing staff” (M= 3.46, SD= 1.011), “Reassignment” (M=3.34, SD= 0.983), “Other strategies” (M=3.08, SD=1.207), “Short-term “on the job” assistance with an outside job coach” (M=3.01, SD= 1.074), and “Centralized accommodations fund” (M=2.96, SD= 1.037). Levene's Test for Equality of Variances indicates unequal variances in the case of question “Reassignment” ($p=.001$). There was a statistically significant difference between groups as determined by one-way ANOVA in questions :

- Short-term “on the job” assistance with an outside job coach { $F(2.410) = 3.501$, $p=.031$ }
- Mentoring { $F(2.412) = 6.433$, $p=.002$ }
- Visible top management commitment { $F(2.409) = 3.925$, $p=.020$ }
- Disability awareness training { $F(2.412) = 3.660$, $p=.027$ }
- Disability targeted internship program { $F(2.415) = 3.349$, $p=.036$ }
- Assistive technology { $F(2.413) = 5.512$, $p=.004$ }

- Reassignment { $F(2.408) = 7.643, p=.001$ }
- Employer tax credits and incentives { $F(2.414) = 3.427, p=.033$ }

The Scheffe post hoc tests showed that there are significantly different answers between Serbia and Montenegro on question “Short-term “on the job” assistance with an outside job coach” ($p=.040$) Serbia and Montenegro on question “Mentoring” ($p=.002$) Serbia and Bosnia and Herzegovina on question “Visible top management commitment” ($p=0.26$) Serbia and Bosnia and Herzegovina on question “Assistive technology” ($p=0.033$) Serbia and Bosnia and Herzegovina on question “Reassignment” ($p=0.001$) Serbia and Bosnia and Herzegovina on question “Employer tax credits and incentives” ($p=0.035$).

4. CONCLUSIONS

Obtained results clearly indicate that good quality services within the process of supporting students at universities are needed. First of all, it means enabling equalization of opportunities while studying (elimination of architectural barriers, providing access to the latest technologies, equal opportunities during exams, etc.). Afterwards, a long-term program has to be built and improved as well as the competence of students with disabilities needed during the study and in the labour market, for example time management, planning activities, the ways to cope with stress, computer skills, etc. Again, in common with a number of EU member states, implementation of policy and legislation has been uneven and fragmented, and significant work is still required to achieve the objectives of the disability action plan and the new ‘disability policy’ on transition from HE to work. Benchmarking transition and employment policy should offer assessment of the initiatives in regional, national and international level that could be adopted in partner countries in order to facilitate the transition of PwD from HE into the labour market. Current legislative should be improved [1] [2] [3] [4], especially the part that refers to mechanisms that are made to ensure implementation of those laws. There should also be a concrete encouragement by the government for the employers who hire PwD. On the other hand, SWOT analysis [11] as well as recommendations from this conclusion also point out that all of them have a greater significance because through research and benchmarking does not explicitly recognize such a number of indicators and that SWOT analysis and conclusion correlate with the real situation in the field of higher education and employment of persons with disabilities in all three countries. The specific areas where Serbian, Bosnian and Montenegrin HEIs could benefit from ‘transferable learning’ using examples of good practices from the EU should focus on: more extensive public awareness-raising programmes; improving methodologies to accurately assess target populations and their profiles and needs; improving accessibility in the built environment; promoting better integration between the different education sectors to support the educational needs of young people with disabilities; building more effective ‘transition pathways’ for young people between school, tertiary education and work; better training for professional staff in HEIs; improved ‘systematic support’

for disabled students – at all stages of the HEI ‘life cycle’ (including pre-entry, whilst studying, and post-qualification). Summarizing this paper, we need to focus on some points that are crucial for the transition from HE to work life [12] [13]:

- HE services: career counseling and guidance, internship/employability training, mentoring etc.
- Employment services: raising awareness on employers, mentoring, networking, ongoing support etc.
- Career preparation: self awareness, career awareness, work experience, mentoring, etc.
- Daily living skills: self advocacy, self determination, time management skills, safety and health etc.

Finally, other steps that could be done to upgrade and prepare HEs services to support SwD to their transition from HE to work following the EU policies include seminars, conferences and the meetings that are aimed at the issue of transition of SwD. Both academic staff and managers of firms and companies should take part in these in order to form the knowledge that can greatly initiate the successfully start, duration and completion of their transition [5] [6]. The main problem that could be solved is to encourage labour market to be positioned in front of university requirements to modernize curricula and study programs from the point of transition, and the universities need to take the necessary steps to create practices for SwD.

ACKNOWLEDGMENTS

This study was part of the project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina (project no. 561847-2015) and was supported by the Erasmus+ Programme of the European Union.

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TRANSITION PLANNING FOR HIGHER EDUCATION (HE) STUDENTS WITH DISABILITIES: A COMPARATIVE ANALYSIS OF THE OPINIONS OF STUDENTS AND EMPLOYEES WITH DISABILITIES IN SERBIA, BOSNIA AND HERZEGOVINA AND MONTENEGRO

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Abstract: Comparison between students with disability (SwD) and employees with disability (EwD) in RS, BiH and MNE was completed as a part of the study for further implementation of Erasmus+ Trans2work project. In this study the sample consisted of SwD studying at the university in the three countries and EwD. There was in total 170 SwD RS (65; 28.24 %), BiH (57; 33.53 %) and MNE (48; 28.24 %), and 77 EwD RS (39; 50.65 %), BiH (3; 3.90 %) and MNE (35; 45.45 %). To test differences between answers in the three countries Chi square and ANOVA analysis was conducted. Overall conclusion is that SwD and EwD in all three countries have similar view when it comes to their position at the labor market. They equally perceive themselves as capable to participate in labor market provided that they receive support at the work place from their employers and adequate preparation by their universities for the challenges of work life.

Keywords: Higher Education (HE), Students with Disabilities (SwD), Employees with Disabilities (EwD), Transition.

1. INTRODUCTION

Research presented in this paper is a part of comprehensive baseline study done by members of consortium of Trans2work project in Republic of Serbia (RS), Bosnia and Herzegovina (B&H) and Montenegro (MNE). Project aims are to highlight importance of support for SwD from HEI to labour market and help HEI, employers and SwD to make that transition.

First phase of the project was needs analysis of SwD and EwD. This was an essential first step in order to plan further project implementation.

Rights of persons with disabilities (PwD) are supported in a number of legal documents in all three countries. PwD have a right to equal access in all levels of education and on labour market [1] [2] [3] [4] [5] [6]. When we look at the situation in all three countries when it comes to HE all three countries are in a process of

implementation of Bologna reform and one of its aims is a compatibility of education and labour market. In order to do so, HE has to understand the needs of employers when it comes to the skills that future employees have to have.

Also, situation on labour market in all three countries is complex since all three countries have high unemployment rate so there is a lot of competition between people who finish HE and enter labour market.

The position of PwD is vulnerable and complex. They are often faced with prejudices about their possibilities, especially on work place. PwD have a bigger risk for life in poverty since their household income is considerably smaller than income of the households with non-disabled persons [7].

One of the reasons for this is difficulties in finding a job, job that provides possibility of advancement, promotion and long term employment.

2. SAMPLE

A total of 170 SwD from RS (65; 28.24 %), BiH (57; 33.53 %) and MNE (48; 28.24 %) participated in the project. Within the entire sample, 76 participants were male (44.71 %) and 93 participants were female (54.71 %). As concerns participants' age it was ranged from 18 to 42 ($M = 25.74$, $SD = 4.287$). In relation to participants' year of study, 26 (15.29 %) were in 1st year, 18 (10.59 %) were in 2nd year, 39 (22.94 %) were in 3rd year, 28 (16.47 %) were in 4th year, 17 (1 %) were in 5th year and 42 (24.71 %) were graduated. Concerning participants type of disability that better describes their condition 40 (23.53 %) identified themselves as having a visual impairment, 10 (5.88 %) as having a hearing impairment, 1 (0.6 %) as having a visual & learning impairment, 1 (0.6 %) as having a visual & physical impairment, 1 (0.6 %) as having a hearing & physical impairment, 1 (0.6 %) as having a visual & learning & physical impairment, 99 (58.24 %) as having a physical impairment, 3 (1.76 %) as having a learning impairment, 1 (0.6 %) as having a physical & learning impairment, 6 (3.53 %) as having other impairments and 7 (4.12 %) are not reported answers.

4. INSTRUMENTS

A tailor-made research tool consisted of 21 questions was used in order to collect data for identifying and analyzing the needs of SwD. Aimed at gaining a holistic and in depth view of SwD needs, the questionnaire was addressed to i) former SwD -currently employees- and ii) current or graduate SwD. In this context, questionnaire was organized to three sections. Section A (7 questions) addressed to EwD, tapping their basic demographic characteristics. Section B (11 questions) addressed to current or graduate SwD. The first 7 questions of Section B aimed at collecting data concerning current and graduate SwD basic demographics. The remaining 4 questions of Section B were more targeted to SwD needs. Specifically, these 4 questions aimed at providing detailed data concerning students' with disability a) views on (i) whether and how their faculty had enabled/facilitated them to acquire knowledge and skills helpful for finding a job, (ii) whether and how their studies increase their skills to find a job and become competitive on the labor market (iii) any additional training needs they have for finding a job and b) level of awareness concerning several amenities they may have once they find a job and have assessed level of disability. The last section of the questionnaire (Section C) addressed to all the participants and covered the main research questions (5 questions). The questionnaire consisted of different types of questions (open ended, close ended, Likert type etc.) in order to better achieve a rich amount of data concerning participants' different needs. All partners participated in the project used the questionnaire with no modification to its structure or content with the only

exception of the needed translation/linguistic adaptation to partners' national language.

3. PROCEDURE

All partners of the project participated in research tool's design and development. During the development phase, several former versions of the questionnaire were exposed to few changes for better complying with the specifics of the area as well as to the specific requirements of all three partner countries where data collection would be conducted. The questionnaire has been modified mainly to provide the collection of all necessary data related to the specific problem of SwD transition from schooling to employment and to detect as many as possible needs of SwD in the transition process. Following the aims of the project and trying to achieve a sufficient number of participants from all the target populations that is EwD, current SwD and graduate SwD, public and private Universities as well as several Associations and Organizations related to SwD and EwD, located in each partner country, were contacted to serve as sources of participants of our project. Participants were informed about the objectives of the project, the voluntary and anonymous character of their participation and their right to give up their participation at any time.

Two forms of the questionnaire were available to target populations:

- An online form
- A hardcopy form.

For those participants selected to fill-in a hardcopy version of the questionnaire, assistance were provided in case it was needed.

5. RESULTS

On the question "*Has your faculty enabled/facilitated you to acquire knowledge and do practical work or other activities that may help you find a job?*", 64.62% respondents from Serbia, 62.50% respondents from BiH and 55.32% respondents from MNE answered with "Yes" and 35.38% respondents from Serbia, 37.50% respondents from BiH and 44.68% respondents from MNE while answered with "No" Pearson Chi-Square didn't show any significant differences between answers on questions from three partner countries ($p > .05$).

On the question "*Do you think that your studies will increase your skills to find a job and become competitive on the labour market?*" 30.77% respondents from Serbia answered with "No" and 69.23% with "Yes", 26.79% respondents from BiH answered "No" while 73.21% said "Yes", and in Montenegro 19.15% examinee gave "No" and 80.85% "Yes" as an answer. Pearson Chi-Square didn't show any significant differences between answers on questions from three partner countries ($p > .05$).

On the question “Do you know that if you have assessed level of disability and you find a job your salary is subverted from the Fund for professional rehabilitations and employment for people with disabilities?” 49.23% respondents from Serbia answered with “Yes” and 50.77% with “No”, 53.57% respondents from BiH answered “Yes” while 46.43% said “No”, and in Montenegro 76.60% examinee gave “Yes” and 23.40% “No” as an answer.

We observed a strong association between the Yes/No answer on question “Do you know that if you have assessed level of disability and you find a job your salary is subverted from the Fund for professional rehabilitations and employment for people with disabilities” and the country, $\chi^2=9.188, p=.010$.

On the question “Do you know that if you have assessed level of disability and you find a job costs for assistive equipment and technical and technological adaptation of working place are covered?” 50.77% respondents from Serbia answered with “Yes” and 49.23% with “No”, 35.71% respondents from BiH answered “Yes” while 64.29% said “No”, and in Montenegro 54.55% examinee gave “Yes” and 45.45% “No” as an answer. Pearson Chi-Square didn’t show any significant differences between answers on questions from three partner countries ($p>.05$).

On the question “Do you know that if you have assessed level of disability and you find a job earnings to your assistant are covered in case you have 80% or more disability rating?” 27.69% respondents from Serbia answered with “Yes” and 72.31% with “No”, 16.07% respondents from BiH answered “Yes” while 83.93% said “No”, and in Montenegro 58.14% examinee gave “Yes” and 41.86% “No” as an answer.

We observed a strong association between the Yes/No answer on question “Do you know that if you have assessed level of disability and you find a job earnings to your assistant are covered in case you have 80% or more disability rating?” and the country, $\chi^2= 20.681, p=.000$.

Table 1: In your experience, how strongly do you agree (or disagree) with the following statements regarding the most important things an employer could do to facilitate you to do your job best? [8]

		Mean	SD
I. Assign part of the my job duties to a coworker	Serbia (RS)	2.24	1.027
	Bosnia and Herzegovina (BiH)	2.11	1.145
	Montenegro (MNE)	3.19	1.214
	Total	2.46	1.208
II. Make certain facilities accessible.	Serbia (RS)	4.65	.786
	Bosnia and Herzegovina (BiH)	4.35	.935
	Montenegro (MNE)	4.40	1.026
	Total	4.48	.915
III. Purchase or change equipment	Serbia (RS)	3.84	.954
	Bosnia and Herzegovina (BiH)	3.67	1.058
	Montenegro (MNE)	4.08	1.088
	Total	3.85	1.036
IV. Reassign me to a vacant position	Serbia (RS)	3.40	1.185
	Bosnia and Herzegovina (BiH)	3.30	1.253
	Montenegro (MNE)	3.33	1.342
	Total	3.35	1.248
V. Make my work schedule more flexible	Serbia (RS)	3.75	1.135
	Bosnia and Herzegovina (BiH)	3.98	1.126
	Montenegro (MNE)	3.00	1.111
	Total	3.61	1.188
VI. Change a company policy	Serbia (RS)	3.02	1.120
	Bosnia and Herzegovina (BiH)	2.95	1.329
	Montenegro (MNE)	2.46	1.237
	Total	2.83	1.243
VII. Leave me to do my job and provide supervision	Serbia (RS)	3.30	1.136
	Bosnia and Herzegovina (BiH)	4.19	1.060
	Montenegro (MNE)	3.44	1.398
	Total	3.64	1.251

In Table 1 are presented the findings from the main research questions of the entire sample of three partner countries. Concerning participants’ views on the most important things an employer could do to facilitate a PwD to do his/her job best the top ranked thing was to make certain facilities accessible ($M= 4.48, SD= 0.915$), to purchase or change equipment ($M= 3.85, SD= 1.036$), to leave them to do their job and provide supervision ($M= 3.64, SD= 1.251$), to make their work schedule more flexible ($M= 3.61, SD= 1.188$), to reassign them to a vacant position ($M= 3.35, SD= 1.248$), to change a company policy ($M= 2.83, SD= 1.243$), to assign part of the their job duties to a co-worker ($M= 2.46, SD= 1.208$)

There was a statistically significant difference between groups as determined by one-way ANOVA in questions :

- Assign part of my job duties to a coworker { $F(2,165) = 14.143, p = .000$ }
- Make my work schedule more flexible { $F(2,165) = 10.635, p = .000$ }
- Change a company policy { $F(2,166) = 3.196, p = .043$ }
- Leave me to do my job and provide supervision { $F(2,166) = 9.470, p = .000$ }

The Scheffe post hoc tests indicated that Montenegrin answers on question “Assign part of my job duties to a coworker” ($p=.000$) and “Make my work schedule more flexible” ($p=.0030$) differ significantly from answers in Serbia and BiH. Also, BiH answers on question “Leave me to do my job and provide supervision” ($p=.006$) differ significantly from answers in Serbia and Montenegro.

Table 2:What should universities need to do in order to facilitate the transition to employment of students with disabilities?[8]

		Mean	SD
I. Improve the knowledge and skills of persons with disabilities through additional training and education	Serbia (RS)	4,17	,925
	Bosnia and Herzegovina (BiH)	4,26	1,027
	Montenegro (MNE)	4,06	1,392
	Total	4,17	1,038
II. Raise the awareness and sensitivity of the employers towards employees who may have a disability/impairment	Serbia (RS)	4,56	,639
	Bosnia and Herzegovina (BiH)	4,63	,587
	Montenegro (MNE)	4,29	1,166
	Total	4,51	,817
III. Support the position of mentor during their first period at work	Serbia (RS)	4,23	,792
	Bosnia and Herzegovina (BiH)	4,26	,768
	Montenegro (MNE)	3,85	1,130
	Total	4,14	,906
III. Educate employers on issues concerning accessibility, assistive technologies, individualized support	Serbia (RS)	4,55	,665
	Bosnia and Herzegovina (BiH)	4,63	,487
	Montenegro (MNE)	4,27	1,086
	Total	4,50	,772
V. Inform employers on the provided support services that person with disabilities might need during their employment.	Serbia (RS)	4,37	,829
	Bosnia and Herzegovina (BiH)	4,56	,627
	Montenegro (MNE)	4,29	1,071
	Total	4,41	,850
VI. Educate employers on issues concerning the obstacles a person with disabilities may encounter during their employment	Serbia (RS)	4,27	,827
	Bosnia and Herzegovina (BiH)	4,58	,565
	Montenegro (MNE)	4,31	1,035
	Total	4,39	,826

In relation to the question, that is participants' views concerning what the universities should do in order to facilitate the transition to employment of SwD based on the results statement „Raise the awareness and sensitivity of the employers towards employees who may have a disability/impairment“ has the highest value (M= 4.51, SD= 0.817), followed by „Educate employers on issues concerning accessibility, assistive technologies, individualized support (trainings, working assistance, flexible working time and workplace“ (M= 4.50, SD= 0.772), „Inform employers on the provided support services that person with disabilities might need during their employment“ (M=4.41, SD= 0.850), „Educate employers on issues concerning the obstacles a person with disabilities may encounter during their employment“ (M= 4.39, SD= 0.826), „Improve the knowledge and skills of persons with disabilities through additional training and education“ (M= 4.17, SD= 1.038) and „Support the position of mentor during their first period at work“ (M= 4.14, SD= 0.906) (see Table 2). All mean values are very high (above 4.00) showing that overall opinion is that universities have important role in facilitating the transition to employment of SwD.

There was a statistically significant difference between groups as determined by one-way ANOVA in questions:

- Support the position of mentor during their first period at work {F(2,166) = 3,353, $p = .037$ }
- Educate employers on issues concerning accessibility, assistive technologies, individualized support {F(2,166) = 3,133, $p = .046$ }

However, as it can be seen from next table Scheffe post hoc test didn't show some significant differences in provided answers between partner countries.

Even one-way ANOVA results regarding questions III and IV showed some significant differences between groups, Scheffe's post hoc test did not support these findings, because all p values are greater than 0.05

In relation to the question, that is participants' views concerning what companies can do in order to improve the employment of PwD it was found that statement to provide an accessible environment/work place to attract employees with disabilities has the greatest result (M= 4.51, SD= 0.825), take targeted training/educational actions for improving working skills and knowledge of persons with disabilities, so they are better prepared for employment (M= 4.22, SD= 0.912) and to support the position of a mentor during the first period at work has the smallest result (M= 4.21, SD= 0.877) .

There was a statistically significant difference between groups as determined by one-way ANOVA in a question:

- Take targeted training/educational actions for improving working skills and knowledge of persons with disabilities, so they are better prepared for employment {F(2,165) = 3,406, $p = .036$ }.

The Scheffe post hoc tests indicated that Montenegrin and Serbian answers on question „Take targeted training/educational actions for improving working skills and knowledge of persons with disabilities, so they are better prepared for employment“ ($p = .049$) are significantly different.

Table 3:Where should universities need to focus in order to promote the transition from Higher Education to Work life of the students with disabilities? [8]

		Mean	SD
I. Work together with team members in a respectful and collaborative manner to complete tasks.	Serbia (RS)	4.33	.691
	Bosnia and Herzegovina (BiH)	4.39	.648
	Montenegro (MNE)	3.96	1.071
	Total	4.24	.820
II. Demonstrate leadership, including giving direction and guidance, as well as strategic visioning	Serbia (RS)	4.24	.665
	Bosnia and Herzegovina (BiH)	4.32	.711
	Montenegro (MNE)	3.88	1.044
	Total	4.16	.821
III. Exhibit personal organization, accountability and time management.	Serbia (RS)	4.16	.787
	Bosnia and Herzegovina (BiH)	4.30	.626
	Montenegro (MNE)	4.08	1.048
	Total	4.18	.824
IV. Identify and solve problems, including evaluating alternatives and articulating reasoning.	Serbia (RS)	4.22	.750
	Bosnia and Herzegovina (BiH)	4.40	.563
	Montenegro (MNE)	4.04	1.071
	Total	4.23	.811
V. Obtain, critically evaluate and use information effectively from a variety of resources and formats.	Serbia (RS)	4.27	.696
	Bosnia and Herzegovina (BiH)	4.28	.750
	Montenegro (MNE)	4.04	1.031
	Total	4.21	.823
VI. Interpret, use and communicate numerical data and quantitative evidence.	Serbia (RS)	3.83	.908
	Bosnia and Herzegovina (BiH)	4.12	.867
	Montenegro (MNE)	3.85	1.148
	Total	3.93	.974
VII. Use appropriate technology to enhance and manage communication knowledge.	Serbia (RS)	4.33	.757
	Bosnia and Herzegovina (BiH)	4.49	.571
	Montenegro (MNE)	4.27	1.086
	Total	4.37	.814
VIII. Gain intercultural knowledge so as to interact effectively in various cultural contexts.	Serbia (RS)	4.19	.895
	Bosnia and Herzegovina (BiH)	4.44	.627
	Montenegro (MNE)	4.04	1.129
	Total	4.23	.902
IX. Be engaged within the community to make a difference in a civic life.	Serbia (RS)	4.27	.821
	Bosnia and Herzegovina (BiH)	4.47	.630
	Montenegro (MNE)	3.92	1.217
	Total	4.24	.921
X. Present and write information clearly and effectively.	Serbia (RS)	4.24	.797
	Bosnia and Herzegovina (BiH)	4.47	.538
	Montenegro (MNE)	4.23	1.016
	Total	4.32	.798
XI. Integrate, experience, disciplinary and interdisciplinary knowledge and communicate this effectively.	Serbia (RS)	4.37	.679
	Bosnia and Herzegovina (BiH)	4.49	.601
	Montenegro (MNE)	4.15	1.072
	Total	4.35	.797

Participants were asked to answer *where universities should focus on in order to better promote SwD transition from HE to work life*. It was found that statement use appropriate technology to enhance and manage communication knowledge (M= 4.37, SD= 0.814), integrate, experience, disciplinary and interdisciplinary knowledge and communicate this effectively has the best score (M= 4.35, SD= 0.797), present and write information clearly and effectively (M= 4.32, SD= 0.798), work together with team members in a respectful and collaborative manner to complete tasks (M=4.24, SD= 0.820), be engaged within the community to make a difference in a civic life (M= 4.24, SD= 0.921), identify and solve problems, including evaluating alternatives and articulating reasoning (M= 4.23, SD= 0.811), gain intercultural knowledge so as to interact effectively in various cultural contexts (M= 4.23, SD= 0.902), obtain, critically evaluate and use information effectively from a variety of resources and formats (M= 4.21, SD= 0.823), exhibit personal organization, accountability and time management (M= 4.18, SD= 0.824), demonstrate leadership, including giving direction and guidance, as well as strategic visioning (M= 4.16, SD= 0.821), interpret, use and communicate numerical data and quantitative evidence (M= 3.93, SD= 0.974) as the lowest result.

There was a statistically significant difference between groups as determined by one-way ANOVA in questions :

- Work together with team members in a respectful and collaborative manner to complete tasks { $F(2,166) = 4,259, p=.016$ }
- Demonstrate leadership, including giving direction and guidance, as well as strategic visioning { $F(2,165) = 4,369, p=.014$ }
- Be engaged within the community to make a difference in a civic life { $F(2,166) = 5,048, p=.007$ }

The Scheffe post hoc tests indicated that Montenegrin answers on question “Work together with team members in a respectful and collaborative manner to complete tasks” ($p = .027$), “Demonstrate leadership, including giving direction and guidance, as well as strategic visioning” ($p = .022$) and “Be engaged within the community to make a difference in a civic life” ($p = .008$) differs significantly from answers in BiH.

6. CONCLUSION

As it can be seen from results above SwD and EwD are aware of a difficult position they have when it comes to their chances to find and keep a work position. Differences found between countries are minimal and do not indicate big differences in perception and status of SwD. Importance of HEIs in facilitating of transition to labour market is marked as important in sample from all three countries.

SwD and EwD perceive their position on labour market as more vulnerable and the need for support at the work place is highlighted as essential for integration.

ACKNOWLEDGMENTS

This study was part of the project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina (project no. 561847-2015) and was supported by the Erasmus+ Programme of the European Union.

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E-LEARNING APPROACHES FOR SUPPORTING HIGHER EDUCATION (HE) STUDENTS WITH DISABILITIES ON TRANSITION PLANNING

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Abstract: The results of the survey that was conducted in the framework of the Trans2Work project will be the basis (a) for six e learning seminars that will be organized during the project life time in order to reach as many stakeholders as possible and (b) for the training of the teaching staff, mentors, employers, students with disabilities and mentors. The most crucial part will be the synchronous and asynchronous training that will be offered in the local language to as many stakeholders as possible and will need to respect accessibility rules. HEIs cannot avoid the responsibility towards all students or trainees on providing accessible material. This paper presents basic issues related to accessibility focusing on deaf and hard of hearing persons and for blind and low vision persons that will be taken into account during the design and implementation of the e learning seminars as well as the training.

Keywords: e-learning, accessibility, higher education, students with disabilities

1. INTRODUCTION

Due to rapid development of information-communication technology (ICT), we are witnesses of significant differences in all areas of life. In particular, these have been especially obvious in the field of education and inclusion of persons with disabilities (PwD). Consequently, in modern technologically-oriented society, PwD gained possibilities for equal inclusion in social, societal and economic environment. In this way, quality computer-based education that would be suitable for all, disregarding their abilities and motives, has become an important question in all environments, especially in developing countries. Necessities for continuous renewal of skills caused that education and content have not only been adjusted to young generations, but also PwD, who have their own needs and requirements. This leads to the need that the ways of knowledge transfer and educational content should be adjusted to the needs and requirements of PwD as well.

Current situation on the labour market, e.g. high competitiveness regarding the workforce, shows the urgency that PwD should be involved in educational environment specifically tailored for them, so that they are able to reach their professional and personal goals.

The output of merging both technology and education is e-learning as a field which allows distance learning and learning with techniques tailored to users. Concurrently, electronic media and devices are used for facilitating access to learning material [1].

The importance of ICT use in education for PwD is strongly emphasized on national and international level, so there is an increasing need for development of accessible e-learning and its inclusion into public administration and private corporations as well. However, the above-mentioned action is not sufficient, but what is needed is rather additional public awareness raising in teachers and personnel working with PwD. This is especially crucial at the moment, when UN Convention on Rights of Persons with Disabilities is ratified by most of the European countries. Hence, Higher Education Institution (HEI) staff needs to understand how the use of equipment can make their life as well as life of their disabled students, easier.

However, there are still too many open questions at HEIs about how to develop accessible e-learning material and teaching process. It is essential to be aware that it is important how the e-learning material is developed for persons with different types of disabilities, such as d/Deaf

and hard of hearing (D/HH), blind and weak-sighted and persons with other types of disabilities. The familiarity with specific needs and requirements of all relevant types of disabilities is crucial and accordingly the system should be adapted.

One of the reasons for paying attention to accessibility lies in statistics, as well. According to World Health Organisation [2], about 15% of the world's population lives with some form of disability. Out of these, 2-4% experience significant difficulties in functioning. When studying at HEIs is concerned, 18% of all Europeans go to university, while only 9% of Europeans with disabilities do so [3]. To the best of our knowledge, there is still a lack of reports on how many SwD actually study on HEIs. In 2016, there was a study conducted within the EU project Trans2Work (<http://trans2work.eu/>). A total of 170 SwD from Serbia, Montenegro and Bosnia & Herzegovina participated in this study. Out of these, 23.53% had visual impairment, 5.88% had hearing impairment, and 58.24% had physical disability or orthopaedic impairment.

Accessibility provides a specific form of social cohesion, since independence is best for users and the most efficient support for our social systems. Accessibility also makes independent and reduces social costs in care, rehabilitation, inclusive education, employment and all daily activities. Currently, there are technical and organisational regulations in use, and tools for implementing accessibility, such as the WCAG 2. Also, ITU, IEC and ISO encourage "the development of standards that take account of the widest range of characteristics and abilities of persons, including in particular those of older persons, children and PwDs" [4].

The aim of this paper is to present the essential issues which should be followed when purchasing accessible equipment, emphasizing the needs and requirements of D/HH, blind and weak sighted persons. Moreover, concrete advice for adequate purchase of equipment is provided, while recommendation for certain existing adaptive solutions for D/HH, blind and weak sighted are provided as well. These are of significant importance due to its relevance in the EU Erasmus + project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina. In the project, training e-learning and on-site programme will be developed and implemented for teaching staff, employers and SwDs in Serbia, Montenegro and Bosnia & Herzegovina.

2. GOALS FOR USING ACCESSIBLE EQUIPMENT

The first step towards development and implementation of new systems accessible to all is familiarity with accessible equipment. It is possible to define several goals for use of accessible equipment in education, such as:

1. Technology significantly increases independence of PwDs.

D/HH persons can receive the e-learning material not only in written language, but also in sign language which can be considered as a mother tongue to many of them. Blind

persons can now read the books, using software recognizing print or buying e-books and using screen reading software.

2. Equipment allows PwDs to have the same chances during exams and in the same time it supports teachers in preparation of the exams.

D/HH persons can more easily understand the content by providing sign language interpreter video. Accordingly, if the teacher poses a question, D/HH person may understand it to a greater extent when the question is displayed in sign language as well. Moreover, additional time should be ensured, so that the D/HH may not be under time pressure. As far as blind and weak-sighted persons are concerned, technology provides a number of opportunities to reduce barriers when passing written exam. For instance, usually, blind person needs magnifying glasses for reading and it may take him/her more time than for average student. Similarly, it takes more time for teachers to read the student's answers. However, when technology is used during the exam, electronic version of exams may replace the paper-based version which may simplify the process of reading and answering.

3. Technology increases chances for good communication.

Many disabilities influence the communication between disabled student and his professor in a negative way. It implies to d/Deaf persons and people with hands disabilities not being able to write in normal way. Also, blind persons may face difficulties in written communication. Hence, use of accessible technology may reduce such barriers.

4. Technology supports people not being able to read regular books.

Deaf student should be provided by the content in language adequate for them, e.g. sign language, and in a form adjusted to their capabilities, e.g. reading capabilities. Unfortunately, not all the deaf, whose primary language is sign language, are able to capture written information in the same way as hearing people do, so it would be suggested to provide easier-to-read written learning material. When learning material is provided in sign language by using sign language interpreter video, captions should be used concurrently since results of the previous study [5] show that the comprehension of the content presented in sign language video increased by 24% among deaf viewers and 42% among hard of hearing viewers.

Likewise, for blind students is simply impossible to read printed books and for low vision is often difficult, so the technology adapter allows them to read the electronic books.

5. Accessible technology supports academic teachers to work with disabled students in their groups.

Having a d/Deaf or blind student, teacher can send all messages to him/her by e-mail or by video message. Student can prepare their homework and other assignments on his/her computer and in this way allow the teacher to read the electronic material prepared by

them. Thus, it is necessary to raise awareness of academic staff on the role of accessibility and its use during the classes. In some cases when material does not meet standards of accessibility, even the most advanced technological solutions will not be effective enough to guarantee the independent access to such material. On the other hand, producing accessible materials does not cost in comparison to adapting not accessible materials.

6. Equipment allows PwDs prepare for work.

In many cases, the use of assistive technologies enables PwDs to perform the work, and can importantly increase its effectiveness.

3. ADVICE FOR ADEQUATE PURCHASE OF EQUIPMENT

Before purchasing of the equipment is conducted, it is important to be aware of the rapid changes on the market and different way of transmitting information. Stand-alone computers were popular until recently. Currently, the use of mobile devices, such as smartphones and tablets, is at the forefront. Likewise, these devices are personalized and adapted to the user needs to a greater extent.

As a result, we face the situation where students with disabilities (SwD) are less likely to use traditional stand-alone computer devices, but rather they prefer to use personal, portable and mobile devices. On the other hand, the accessible equipment can be in most cases more expensive than standard, mostly non-accessible devices.

Another issue is the assumption that the devices are purchased only for already existing SwD. In other words – many HEIs present the attitude that purchasing of adaptive solutions in advance has no sense. However, for many SwD the information about available accessible e-learning and equipment is crucial when selecting the HEI they want to study at.

Taking these factors into consideration, during the purchase of equipment the following criteria should be respected:

1. Choose first the solutions accessible to persons with different types of disabilities, or being possible to connect with many different accessible tools.
2. Do not purchase many pieces of the same type of disability, but rather be prepared for many different situations and types of disabilities.
3. If possible, choose rather portable equipment, which can be used both as the classroom equipment as well as personal equipment.
4. Prepare clear procedures of obtaining this equipment, i.e. whether it is possible to rent it, for what period of time, in which classroom situations it can be used by students, etc.

5. ADAPTIVE SOLUTIONS FOR D/HH STUDENTS

When advising on equipment purchase for d/Deaf students, it is essential to consider two issues:

- providing written information in sign language video as an online video (e.g. video conference) or offline video (e.g. webinar);
- considering the findings of the previous study [6], we should take into account the fact that natural videos are currently more accepted by the end users than signing avatars and synthetic gestures. In line with that, lately, researchers more focused on development of e-learning materials and systems which use videos and sound amplifiers.

As far as equipment for hard of hearing students, who use hearing aids or cochlear implants, is concerned, firstly, Personal frequency modulation (FM) systems are quite popular. They function as miniature radio stations, operating on specific frequencies, and consist of transmitter microphone used by the speaker (such as the teacher in the classroom, or the speaker at a lecture) and receiver used by the listener with hearing aid.

Secondly, another useful system for hearing aids, which have a chance for using T-Coil, is "induction loop" system. It magnetically transmits sound to hearing aids and cochlear implants with telecoils (T-coils).

Thirdly, for live following the lectures by D/HH students it is advised to use a system for live subtitling, where the sound from the talking person is transmitted to the typist situated in the same room or at the distance (see Image 1).



Image 1: Live subtitling (from VerbaVoice)

Moreover, another important system is a multipoint videoconference system which enables collaborative work, telepresence, desktop video conferencing, and multipoint connections to users.

For webinars, popular systems are systems like Adobe Connect or Webex, since they allow using video, document sharing and text chatting during the live sessions.

Furthermore, an example of good practice when using the video for D/HH is the Sign language Interpreter Video Player (SLI module) for web sites, which allows multimodal composition of HTML5 video, audio and subtitles on the web page, so that video on demand is displayed over the existing web-page [7]. Accordingly, there is no need for additional implementation of static video clips which usually take much space on the website. Video is activated on demand by end-users and implementation is unobtrusive into existing websites. The ability of the system is also important in terms of including cross-browser and cross-mobile video player, and that the subtitles are displayed over the existing video

- Poslanstvo in vizija
- Strategija in vrednote**
- Organizacijski in drugi
- Vodstvo fakultete
- instituti
- Obvladovanje kakovosti
- Dokumentno središče
- Zgodovina
- Bančnična hiša
- Lokacija
- jezika naročila
- Zaporedni
- Alumni

Strategija in vrednote

Strategije usmeritve

- uporaba inovativnih metod poučevanja in sodobnih orodij, ter vzpostavitve pogojev za učenje, esenotsedstveno na študenta.



Čeprav učimo, ne razumemo in ne sprejmemo, kar učimo

Kakovostni študijski uspehi vključujejo vse to in še več:

- krepitev kompetenc za obvladovanje kakovosti: UMI FER v smerni večje prepoznavnosti, vključevanje in aktiviranje vlog...

At the University of Maribor, Slovenia, the e-learning portal based on a custom-modified version of Moodle has been already implemented as an e-learning system,. The system comprises three parts: contextual, communicative and collaborative. The whole content is accessible in both, written and sign language. Sign language interpreter videos with translation of the written text are fixed and are positioned on the left side of a screen window. The text in written form is on the right (see Image 3).The glossary of potentially unknown words is provided with a transparent SLI module, where the words are explained in sign language and supported with captions. The video is displayed when activated by the user on the website.

6. ADAPTIVE SOLUTIONS FOR BLIND AND WEAK SIGHTED STUDENTS

1. Allow for independent reading.
2. Allow for independent writing in the way which can be read by sighted persons.

- It is necessary to remember that blind persons do not need special tools to write on computers. They memorize regular keyboard and use it without extra adjustments. However, these persons who know Braille, can take advantage of it, using note takers with Braille keyboards, which consist only 7 keys and are much smaller. Using Braille keyboard in electronic devices does not change the standard of files, so they still can be read in regular computers.

- Reading with speech.
- Reading with Braille displays.

In order to use Braille displays which will allow the use of a PC or tablet, it is still necessary to bear in mind the software connecting such device with computer. It is usually done by screen reading software, which is also used to allow for access to the computer with voice.

Taking these conditions into consideration, HEIs will definitely need the following equipment:

- Ad a.** You should remember that on one hand the computers or tablets can be just standard ones. On the other hand, speech solution will always take some part of computer's capacities, so it is recommended to buy medium or higher speed computers.

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persons, but in the periods when there are not such students, it can be also used for other purposes.

Ad b. It is not necessary now to purchase expensive Screen reading software. There are two options mentioned already above:

- use NVDA free software, which is very efficient and good enough for most University tasks; It is dedicated to computers with Windows systems. Window-Eyes for MS Office User (ver. 10 and up) is also free;
- use Apple products which have screen readers implemented in their operational systems.

Recommendation is to make at least two standard Windows base sets. They will include laptop with screen reader (free software is usually enough); additionally you can add local language speech synthesizer. Depending on number of students with disabilities, you need to keep at least one for University use (organizing tests, exams etc.), and at least one or more which will be given to students for their personal use.

Two tablets or iPads for portable use. They can be used as personal devices allowing students to read electronic materials, to record lectures, use mail, Facebook etc.

They also have the advantage of being used for persons with different disabilities – i.e. for low vision students; if we talk about tablets, we definitely recommend iPads – at least for the group of totally blind students. iPads have also many functions supporting partially sighted students.

It is necessary to remember that for writing purposes tablets without standard keyboard are not as useful as regular laptops. However in case of totally blind students you can connect tablet (iPad) with Braille display and in this way you provide students with tools allowing for reading (in this way student can read during class, being able for example to have speech).

Ad. c. Braille display is one of the most expensive tools, but it is necessary for really independent studies and doing more requiring task such as programming, note-taking with simultaneous possibility of checking/reading them, giving speeches/lectures/presentations.

Currently there are two types of such devices available:

- Braille displays working exclusively as output devices to standard computers or tablets. They need software to be installed on such computer to be a manager for such display. Since they have its own Braille keyboard, they give much more flexibility when working with tablets or iPhones. Unfortunately, they are useless as independent pieces of equipment.
- Second type are Braille display with note takers built-in. They have all functions described above, but when disconnected from laptop or tablet, they can work as independent note taker allowing also for reading files saved in the memory of the display. For that reason we recommend this solution.

Ad. d. To allow students to read written materials you need one set made of a computer (laptop or regular PC), scanner and OCR software.

Currently, the quality and speed of scanners is so good that we do not recommend any particular model. In the field of OCR still the best option is Abby Finer Reader.

Having such a set of equipment available, for example, in the library, not only students but also teachers can easily convert written materials to electronic version.

7. IMPLEMENTATION OF E-LEARNING APPROACHES IN THE TRAIN-THE-TRAINERS PROGRAMME

Based on abovementioned solutions, we will develop the training programme within the Erasmus + project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina. The aims of the project are (<http://trans2work.eu/>):

“(a) Upgrade and prepare HEIs services to support SwD to their transition from HE to Work following the EU policies,

(b) Link Higher Education to “disability friendly” work environments,

(c) Assimilate transition opportunities and skills with EU practices and policies and

(d) To prepare employers on understanding the needs of employees with disabilities in order to offer new job.”

Accordingly, there are recognised two crucial moments within the project:

1. for six e learning seminars that will be organized during the project life time in order to reach as many stakeholders (teaching staff, employers and SwDs) as possible, and
2. for the training of the trainers and mentors that will take place in EU countries.

In order to assure sustainability and exploitation results in the region, six e-Learning seminars will be organized, students with disabilities, environment, university teachers, staff, and university established services, career centers, employers and potential networks. The e-Learning sessions will be open to everyone and class invitations will be sent to all identified from indexed organizations related, announcements for the e-sessions will be included in newsletters and uploaded to websites. The e-Learning informational sessions are aiming to raise awareness of respective groups inside partner countries within region and will present the accessible data base and its use as well as the web based tool that will help (a) employers to identify suitable people to fill specific positions and it will be designed to account for special requirements needed by employers and (b) SwD to identify their interests and educational needs.

An important milestone of the project activities is the training that aims at providing high quality training at Partner University and public associations working on education and support of students with disability. All stakeholders will be acquainted with necessary knowledge for improving the quality of transition from School to

Work of students with disabilities. The content of the training will be based on the guidelines and transition curriculum that will be developed in previous WPs taking into account the results from the basic research. Training material will be available in the project website and in the data base and of course it will be used for the e learning seminars.

8. CONCLUSION

In this paper, we provided a technical overview of adaptive technical solutions for D/HH, blind and weak sighted persons along with lessons learned from several existing systems.

The discussed systems present a combination of multimodal information, including video, audio and captions, and offer the option of prioritizing the sign language on the Web for D/HH users. The interaction is mainly managed with transparent and movable videos of a sign language interpreter. For instance, the videoforum for deaf people presents an asynchronous communication tool for the exchange of ideas among students and tutors in two languages: sign language and written text. The tools presented could have a stimulating effect for the D/HH since they can choose their own preferred communication method.

We believe that the systems presented will thoroughly change the method of information transmission for the D/HH on the Web. These systems have already been accepted at a large scale national level in Slovenia and tend to be positively accepted in countries where sign language is recognized as an official language for the D/HH. In Slovenia, official websites are meanwhile supported with sign language translations. Moreover, a majority of television programmes and movies are captioned. Amongst the weaknesses, one cause of indignation for the deaf is the absence of captions in live television programmes and in sign language interpreter videos on the Web. Thus, our future research will be aimed at proving that the captions integrated into sign language interpreter videos are required.

With the expansion of the discussed technologies, we could contribute to literacy improvement, rising education levels and improvement of competitiveness in labour market. This will also enable them to get better opportunities for easier social integration and, at the same time, it will preserve their identity and self-esteem.

While designing and implementing the e learning seminars and the training during the Trans2Work project some recommendations from Wegner's theory will be taken into account [8]. The e learning seminars will help HEIs to make links with the employment sector and the wider community. Thus, HEIs will finally be able to identify their needs and the needs of other communities so that HEIs can improve the focus and the nature of the theory and practice related to e-learning. Combining the e learning seminars with the training hopefully at the end the project can shift the focus from the "product of accessibility towards the process of accessibility [8].

ACKNOWLEDGEMENT

This study was part of the project Trans2Work – School-to-Work Transition for Higher education students with disabilities in Serbia, Montenegro and Bosnia & Herzegovina (project no. 561847-2015) and was supported by the Erasmus+ Programme of the European Union.

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USE OF SEQUENTIAL BLENDED LEARNING FOR THE IMPARTING OF CAD ACQUIREMENTS ON THE FACULTY OF MECHANICAL ENGI- NEERING

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Abstract: As part of the course “Technical Drawing”, a sequential blended learning course has been offered by the department of machine elements at TU Dortmund University. Students are able to acquire the whole knowledge that is required to handle the CAD program “AutoCAD” by Autodesk. In order to increase learning effects, this course offers a combination of e-learning and in-class lecture. Further the students are asked for a responsible participation to get part of the course. Thanks to intensive transfer of knowledge a significant improvement of the results of the exam could be identified. Therefore the using of the named method, additional to scripts, videos with teaching contents, tests, exercises and tutorials, which are supervised by teachers, are valuable tools, which increase the motivation of students.

Keywords: e-learning, distance learning, online, Mechanical Engineering, technical drawing, CAD

1. INITIAL SITUATION

At the department of machine elements at TU Dortmund University many teaching contents are taught in terms of blended learning, also integrated learning, [1], for more than eight years. Blended learning combines the advantages of traditional courses with new ways of teaching by the omnipresence of the internet. The required media are available at home as well as mobile at any time. This allows the students to work on the educational content at an individual pace according to the personal needs, as well as to rework missed lectures. A learning platform, including the accompanying material of lectures, video files in the form of annotated PowerPoint presentations for lectures and exercises, as well as materials for controlling knowledge, is provided. All e-learning videos have been recorded outside of the classroom, without listeners, and hence without noise. Still, the students have the opportunity to interact with each other in forums.

This form of blended learning, which is also called parallel blended learning [2], has been very well proven in several subjects.

But for the course “Technical Drawing and CAD”, which is offered in the first semester, no appropriate blended learning course for the CAD part was available so far. In the technical drawing part students can change individually between e-learning and presence lesson.

The content of teaching of the CAD part was introduced by a script for self-study as well as weekly offered consultation hours.

The knowledge of technical drawing is examined as follows:

Part 1: Classic paper exam (90 minutes) with the following contents: creating and dimensioning of technical drawings, hands-free on paper: development of one of the three views front view, side view, top view, creating a drawing in isometric or dimetric projection, complete dimensioning and tolerancing of a shaft.

Part 2: Online exam on the PC:

- theoretical knowledge examination: 15 multiple choice tasks about the course of “Technical Drawing” (estimated processing time: 20 minutes)
- AutoCAD test: drawing of a shaft with complete dimensioning by means of the program AutoCAD by Autodesk (estimated processing time: 60 minutes)

In the first part the knowledge of the practical application and the capabilities of freehand drawing are examined. This exam performance is independent of the online exam.

In the second part the theoretical knowledge, for example, the correct representation of machine elements (such as screw connections, shafts, axles) and components is examined by the multiple-choice method on the PC. The tasks are taken from an item pool, so that all students receive the equivalent, in terms of content, but different tasks. This examination performance arrives with 60% in the overall score. Image 1 shows an example.

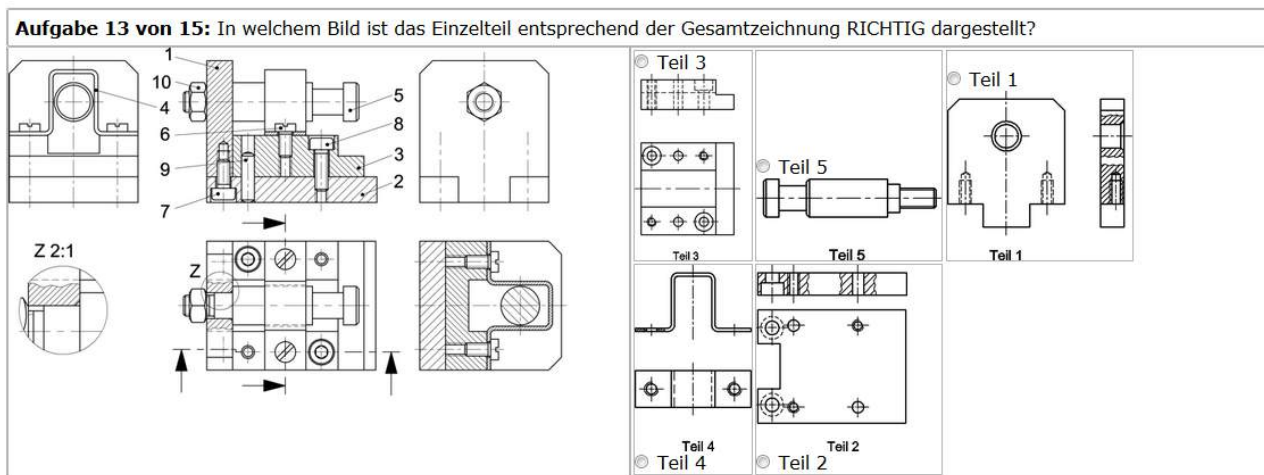


Image 1: Example of task out of the multiple-choice-test with images in question and answer

The knowledge and skills of working with the CAD system are tested in the CAD part. This part accounts for 40% of the overall score.

The mark of the entire online exam consists of the results of the two online parts. In the exam two PCs are available for each student. Therefore, it is possible to switch freely between the tasks of multiple choice test and the CAD part. The processing time is a total of 80 minutes. This time can be distributed individually by the students on both parts of the exam.

In the past, the number of students who have not passed the exam was relatively high and thus not satisfying. To remedy this situation, the causes were investigated first. In the winter semester 13/14 283 students were examined. 34 students (12.01%) reached 0% in the CAD examination and 3 students (1.06%) achieved 0% in the online exam.

Table 1: Results of the students in the winter semester 13/14

283 students	online	CAD	result total
CAD exam, best result	75%	94%	mark 2.0; position 4
online exam, best result	100%	0%	mark 3.3; position 54
best result of all students	90%	80%	mark 1.7; position 1

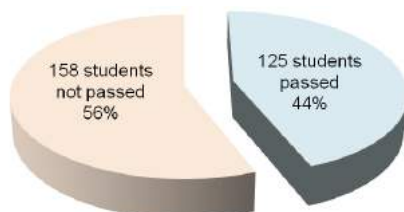


Image 2: Exam results online exam (multiple-choice questions and CAD), total, in the winter semester 13/14

The investigation of the causes for the high failure rate shows that on the one hand only the multiple choice test has been elaborated and on the other hand only the CAD part. In exclusive evaluation of the multiple choice test, the score improves for 196 students (69.26%). In exclu-

sive evaluation of the CAD part only 87 students (30.74%) would improve their score. Image 3 shows these results.

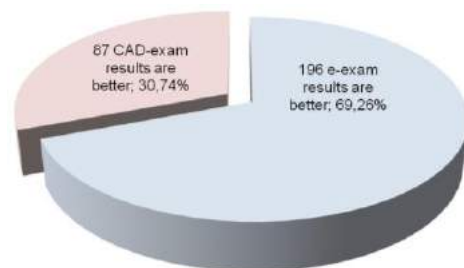


Image 3: Improving the results by exclusive evaluation of both parts of the exam

This result shows that the biggest difficulties exist in working with AutoCAD. Obviously, the few courses, as well as the offered consultation hours, were not enough to convey the contents sufficiently. Especially the consultation hours were used rarely, so the supervisors got the wrong signal, that the students needed seemingly no help in dealing with the CAD system.

The problem had to be taken into account in the development of remedial action, that participation had to be enabled on the one hand for about 300 students, on the other hand, the number of existing workstations and the support capacity for the required number of groups does not exist.

As a solution, a blended-learning course for the CAD part was developed and offered.

2. WAY OF SOLUTION

Because of capacity reasons, only two three-hour maximum presence lessons can be offered, it is essential to work there effectively. The use of a sequential blended learning course was chosen as an appropriate course of action.

In opposite to parallel blended learning or flipped classroom, the parallel blended learning or inverted classroom [3] not only content will be made available, that can be obtained by students at any time. Rather dependencies and conditions between the part of e-learning and the presence lessons are created, so that it is guaranteed that

at defined points in time, some progress is achieved and certain knowledge must be present. In addition, there may be communication between students and teachers at any time via the learning platform moodle. Weekly consultation hours are offered for further support. Better planning of capacities and resources for the presence lectures (62 workstations) a registration for an appointment and for the presence lesson via the learning platform moodle is required. An improved and more efficient use of both class lectures should be achieved that the students must provide inputs for this purpose. These represent the conditions to participate in the presence lectures.

For this purpose teaching materials in the form of a script have been created, which contains numerous examples of exercises to be worked with by the students. As another tool, video tutorials were developed and made available to the students about the structure of the program and the application of its commands.

The content of the exercises is already known by the students because it is similar to the course "Technical Drawing", so that now the implementation by the CAD technology is in the foreground. These exercises are structured in that way the students get comprehensive knowledge in dealing with the most important commands of the CAD system, which are also relevant in the exam.

Next task was to check whether the students have indeed sufficient basic knowledge and whether the exercises required as prerequisite have actually been processed before the presence lecture.

First, an online knowledge control was introduced as a solution to the problem. Once students had completed the knowledge check properly, they could sign up for the first presence lesson. For the control of knowledge, students had as many attempts as they needed.

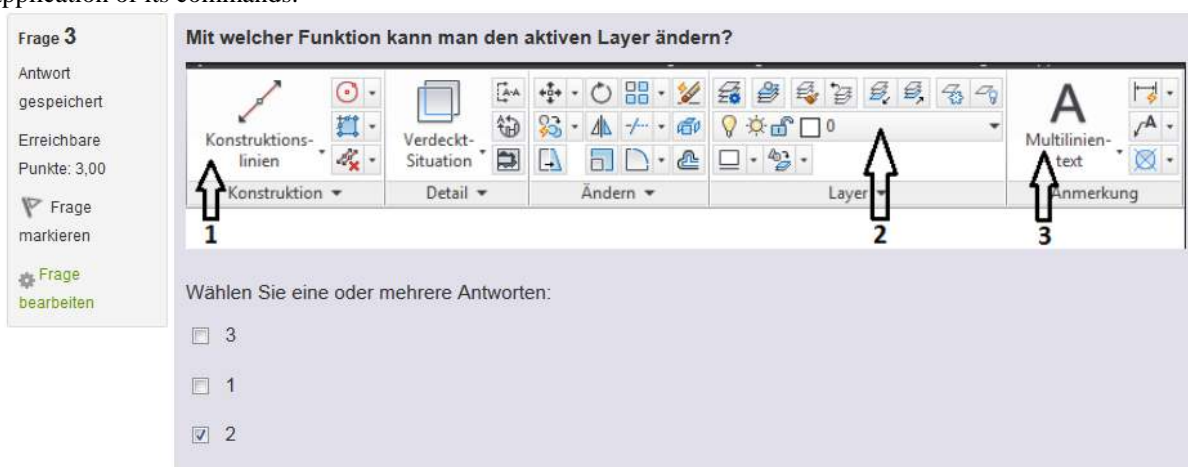


Image 4: An example of a question of the online knowledge control

In the presence lecture two simple drawings using AutoCAD were drawn and dimensioned. The necessary steps have been presented previously by teachers.

At the department of machine elements, the particularly positive situation exists that four apprentices to the technical product designer are involved. Because the contents of training largely coincide with the content of the course "Technical Drawing", there are excellent synergy effects, which can be used for the benefit of all stakeholders. In consulting of the students the apprentices also have opportunities for stand-alone presentation of content and to advice the students in solving their tasks.

The examination regulations of the training of apprentices to the technical product designer stipulates that an operational order is executed and then presented to a committee in the final exam. A good preparation for obtaining

thenecessary safety and skills is therefore presenting to groups. Because the presence lessons in the course of CAD, which is a subject in the first semester with limited number of participants in one group and in a field in which the apprentices very well know, this is a very good opportunity to practice the presentation. For any problems an experienced supervisor is available at any time.

After the first presence lecture tutorial videos are uploaded for the students, who were not able to take part in the presence lecture or still have difficulty with the solution of the handled tasks. In these the explanations of AutoCAD drawings, created in the first presence lesson, are drawn and dimensioned. In addition, click-instructions were created, which explain step by step the most important commands, shown in image 5.



Schritt	Button/Aktivität	Kommentar
3	Mit dem Mauszeiger über den Befehlsbutton fahren 	Ein Rechteck lässt sich mit Hilfe des Rechteck-Befehls auch schneller Zeichnen
4	Befehlsbutton anklicken 	Wie auch beim Linien-Befehl wird der Rechteck-Befehl durch Linksklicken auf den Button aktiviert

Image 5: Part of the click-instructions

3. EXPERIENCE WITH PREREQUISITE

As a prerequisite to the first presence lecture, the successful completion of a knowledge check was required in a first step. Hereby, however no good experience could be gained. Despite successful participation in knowledge checks, some students have extremely low previous knowledge and could hardly follow in the presence lecture. Here is the surmise that these students have not completely independently performed the knowledge checks.

Students self study should specialise in dealing with AutoCAD on the basis of exercises for the second presence lecture. This was the simplified drawing of a shaft. To prevent a possible sign-off from others, different drawings regarding geometry and dimensions had to be created by all students. This drawing had then to be uploaded to an online system (moodle).

In the next step, these drawings were assessed by responsible persons of the department of machine elements. Based on the result of the respective students their registrations for the second presence lesson were unlocked and associated with a group of beginners or intermediate.

Two differently designed courses were offered to meet the different knowledge levels of the students. The basics were treated more comprehensively in a longer event for beginners. In an event for students with larger basic knowledge in CAD was the opportunity to meet the advanced features in more detail. In addition, the temporal scope of this event was low.

For the correction of the uploaded drawings numerous expenditure on staff was necessary. In this respect, this solution was still much in need of improvement.

The second problem was in the assignment of the students to the class lectures for beginners or advanced. Here, some students complained about the requirement of deep skills, while others criticised a too slow pace of work.

Thus a new approach was followed in the next year: knowledge checks were used for the first presence lecture in the winter semester 15/16 just as a voluntary element. This tool should serve the students to assess their own abilities. Based on this, they could allocate for the first presence lecture by themselves to a group of novice or to an advanced course. A side effect was that they could complain about the assignment to a group no longer.

As prerequisite to participate in the second presence lesson, students had to draw all the same shaft, where at first a dimension was not required. This drawing had to be uploaded by the students. The correction was considerably simplified due to the uniformity of the task. Incorrect drawings had to be corrected by the students and uploaded again. This achieved a better learning effect.

The motivation of the students could be increased significantly by this: the own drawing was processed in the second presence lecture under the guidance of the supervisor to a full production drawing with dimensioning and tolerancing. Because the drawing was already finished and uploaded into moodle before the presence lecture, the topic

of dimensioning could be treated significantly more intensively.

The edited item represents a standard problem in the field of machine design. It resembles also the task, which is to edit in the examination. It includes all commands that are required for processing the exam task.

After the second presence lecture, a solution video was created for the preparation for the exam, and more exercises in the online platform were being provided for the students. In addition, consultation hours were offered once a week, where students could ask any questions about technical drawing and the CAD system.

4. EVALUATION OF THE RESULTS

Based on the results of the exam the following conclusions have been found: in contrast to the previous examination, all students (274) in the CAD examination achieved a positive result. Nobody reached 0%. Only one student (0.36%) achieved 0% in the online exam. Table 2 shows the main results.

Table 2: Results of the students in the winter semester 14/15

274 students	online	CAD	result total
CAD exam, best result	0%	100%	mark 3.3; position 91
online exam, best result	91.5%	74.5%	mark 1.7; position 3
best result of all students	82.9%	92.5%	mark 1.3; position 1

The failure rate, which previously stood at 56%, improved significantly and now stands at around 39%, shown in image 6.

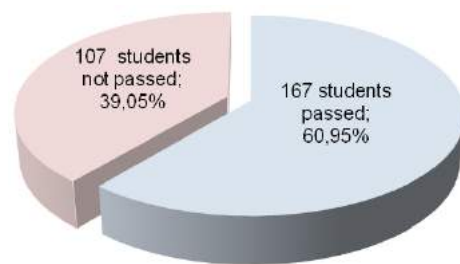


Image 6: Exam results online exam (multiple-choice questions and CAD), total, winter semester 14/15

For further review it was investigated again how the results change when on the one hand only the CAD results as a valuation basis are used and on the other hand only the results of the multiple choice tests. It showed that with 60.22% of the students the mark would improve, if only the CAD part would be assessed. Thus succeeded, to come to a part of exam performance with consistently good results by this part with previously rather weak results, shown in image 7.

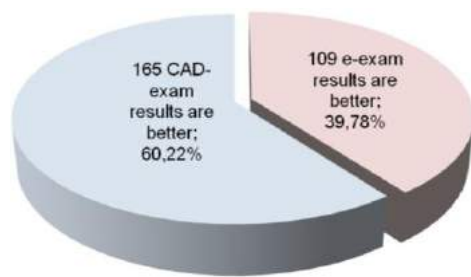


Image 7: Improvement of the results depending on the scoring of the exam

As further review exam scores of those students (231 of total 274, 84.3%) were evaluated, who have not taken part in the presence lectures, but have used only the blended-learning material. Although these students have not fully exploited all possibilities for exam preparation, 63.20% of them have passed the exam, shown in image 8. This is to recognize that the developed teaching / learning materials are suitable for a self-study.

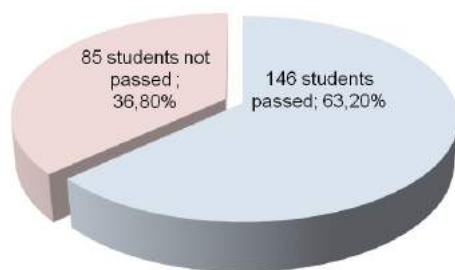


Image 8: Exam scores of those students in the winter semester 14/15, which have not taken part in the presence lectures

In the winter semester 15/16 a similar result was reached. 158 of 248 students (63.7%) have passed the examination, 90 (36.3%) have not passed the exam.

Table 3: Results of the students in the winter semester 15/16

248 students	online	CAD	result total
CAD exam, best result	48.7%	100%	mark 2.2; position 12
online exam, best result	82.9%	74.5%	mark 1.7; position 3
best result of all students	74.3%	96.5%	mark 1.3; position 1

In the winter semester 15/16 87 of 248 students (35.1%) have not participated in the presence lessons. 54 of them (62.1%) have passed the exam, 33 (37.9%) have not. Thus, similar results were achieved as in the previous year.

5. CONCLUSION

With the blended learning course exam results could be improved significantly. So this is a very well suitable tool to improve the learning experience.

As a result the motivation of students increased significantly, that now as input to the second presence lecture a basic drawing had to be created. They had to be corrected

before the lessons as far as they could be finished in the lesson.

As a result that the prerequisite are used as milestones, students are required to comply with a defined scheduling. It was also possible to use only the blended-learning materials in the self-study to acquire knowledge in the handling of the program, without having to use the presence lessons. By the dates specified by means of the presence lessons, students have a guideline until when, what skills must be present.

By the fact that the students were divided in beginner or advanced groups by themselves based on the level checks, a significantly greater satisfaction with the grouping was achieved.

Due to the consistently positive experiences a similar integrated course will be created in future along the lines of the AutoCAD course, is conveyed in the dealing with the 3D CAD software Autodesk INVENTOR.

It has been proven that the developed concept is suitable to be able to take care of relatively large numbers of students with a small number of presence lessons. The presence lessons can be used considerably more efficiently by combining with blended learning courses.

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OVERVIEW OF ONLINE TEACHING RESOURCES FOR LOGIC PROGRAMMING

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Abstract: *Computer science studies offer a number of programming courses. Previous research, mostly concentrated on object-oriented programming, has shown that students face various obstacles in learning programming languages, which resulted in suggestions for improving teaching process in this field. Logic programming, belonging to a different, declarative programming paradigm, has been researched to a smaller extent, although it raises even bigger challenges for both students and teachers. Students are recommended to first acquire knowledge in formal logic, and then to learn how to apply that knowledge in logic programming. This paper addresses teaching formal logic and especially logic programming. As a first step in initiative for its improvement, an overview of existing logic programming teaching resources is made, with the emphasis on freely available online courses, materials and tools.*

Keywords: *logic programming, formal logic, teaching resources, online*

1. INTRODUCTION

In a number of programming courses in computer science studies students have opportunity to learn various programming languages belonging to different programming paradigms. Most of those languages belong to object-oriented programming (OOP) paradigm or support multiple paradigms, one of them often being OOP. Logic programming languages that belong to declarative programming paradigm are also an essential part of computer science studies, especially those oriented towards artificial intelligence or databases.

Problems connected both to teaching and learning programming in general and especially for OOP or multiple paradigm languages have been researched extensively for decades, which resulted in various teaching and learning proposals and freely available online resources. Logic programming (LP) courses are not that numerous and hence problems in teaching and learning this paradigm have not been researched to such an extent. Therefore, the goal of this paper is to present an overview of currently available free online resources that will show possibilities for improvements in the process of teaching and learning LP.

This paper is organized as follows. Chapter 2 explains the importance of formal logic in everyday life and gives an example of teaching formal logic and logical reasoning based in virtual environment. In Chapter 3 we discuss problems and available resources for programming education in general and LP and in Chapter 4 we give an overview of availability of various online resources for LP divided into four groups: specialized educational websites, course resources at educational institutions, logic programming tools and other resources. We conclude the paper in Chapter 5.

2. TEACHING FORMAL LOGIC

We don't claim that knowledge of formal logic is necessary to successfully solve problems within the context of the logic programming paradigm, nor do we claim that such knowledge is sufficient - but we do claim that it is, without doubt, desirable. Independent of us being conscious of this, our cognitive abilities after a certain age contain not only elements of reasoning in first order theories, with first order logic as a basic system of logic, but elements of higher order logic as well, which includes reasoning about knowledge, reasoning about reasoning about knowledge... These aspects of logical reasoning are the subject of the theory of multi-agent systems, very well and very comprehensively presented in [1].

An example of everyday behaviour in which the participants, if even unconsciously (implicitly), reason in the logic of the second and higher orders, is street crossing behaviour related to traffic lights. In short, the situation looks like this: The driver and the pedestrian know the meaning of the traffic lights, but that in itself doesn't suffice to guarantee safe traffic. When e.g. the pedestrian wouldn't know that the driver is aware of the meaning of the traffic lights, he possibly wouldn't dare to cross the street crossing when the green light tells him it is safe to do so. Or, when the driver would know that the pedestrian doesn't know that he knows the meaning of traffic lights, he would try to signalize this in a way, which could be interpreted by the pedestrian in an intended or in an unintended way, which would again have further consequences for the behaviour of the participants.

Teaching exact sciences such as mathematics is often done using "examples". These "examples" are in their

essence models of abstract theories in which variables of different types are substituted with their “values” (to be more precise, their interpretations or models). As these “examples”, in difference to the theories themselves, have “content” that is conceptually closer to students' understanding, “examples” can (and the practice shows they very often do) considerably facilitate conceptual acquiring of corresponding theories.

When we are talking about teaching formal logic, then, if we were to apply principles we presented above, it would be logical to pursue it with some of the formal logic system models as its object domain (considering the fact that formal logic systems have very well developed model theory). Here we will mention the Tarski's World environment, named by the famous Polish mathematician and logician Alfred Tarski.

The problem environment consists of a “chessboard” onto which regularly ¹shaped geometrical objects are placed (Image 1). The meaning of the predicates used to build formulas is obvious from their names [2], as is seen in Image 2, and they are applied in the same manner in logic programming.

Teaching formal logic is done through interaction with computer during which the initial assumption of the player (student) is verified in relation to the truthfulness of the formulas presenting statements (claims) about a given model. Under the assumption that the initial claim contained in the formula put by the player was false, her opponent (the computer) will unmistakably show it to be so. The player will then learn to reason better, based on the experience of her mistakes. If the opposite is the case, the computer will try to “deflect” the player from logically valid reasoning and again point out to the errors.

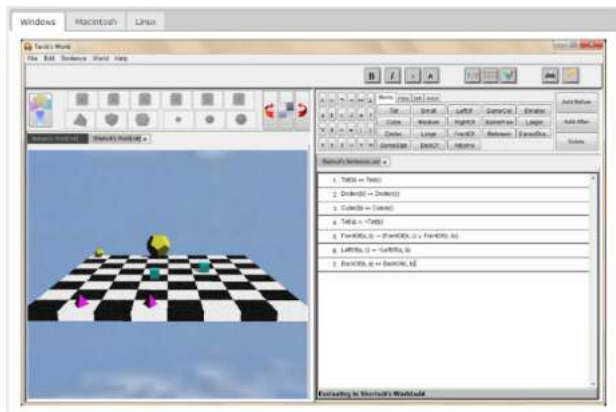


Image 1: The graphical interface of the Tarski's World²

A new advance in the same paradigm of teaching formal logic is apparent in the implementation of theories of logical reasoning on temporal-spatial structures, developed in the work of G. Ligozat [3], P. Cabalar i P. E. Santos [4] and other authors. A developed formal frame (a theory) for reasoning on temporal-spatial structures and

relations enables the formalization and solving of logical puzzles.

TABLE 2 Blocks language predicates.

Atomic Sentence	Interpretation
Tet(a)	a is a tetrahedron
Cube(a)	a is a cube
Dodec(a)	a is a dodecahedron
Small(a)	a is small
Medium(a)	a is medium
Large(a)	a is large
SameSize(a, b)	a is the same size as b
SameShape(a, b)	a is the same shape as b
Larger(a, b)	a is larger than b
Smaller(a, b)	a is smaller than b
SameCol(a, b)	a is in the same column as b
SameRow(a, b)	a is in the same row as b
Adjoins(a, b)	a and b are located on adjacent (but not diagonally) squares
LeftOf(a, b)	a is located nearer to the left edge of the grid than b
RightOf(a, b)	a is located nearer to the right edge of the grid than b
FrontOf(a, b)	a is located nearer to the front of the grid than b
BackOf(a, b)	a is located nearer to the back of the grid than b
Between(a, b, c)	a, b and c are in the same row, column, or diagonal, and a is between b and c

Image2: Predicates of the Tarski's World environment³

3. PROGRAMMING EDUCATION

Since programming is a very popular and promising field of study, there has been a lot of research regarding its teaching and learning with various proposals of support to this process. Here we shall give just a short overview of this research regarding problems as well as improvement proposals for teaching and learning programming in general and logic programming specifically.

Programming education in general

As in other fields of study, students face various obstacles when learning programming languages. There has been a substantial research regarding those obstacles both for teaching and learning. Three decades ago, difficulties in this process were emphasized in [5] with an overview of new ideas to overcome them. New research shows that those difficulties still haven't been solved [6]. Large research with over 500 students and teachers regarding course contents and course materials has shown that most difficulties refer to the practical parts of courses [7] and other research confirmed the importance of problem solving knowledge [8], examples and practical work [9]. OOP and procedural programming [10] or only OOP [11] were for the most the focus of the research. A number of authors propose visualisation [9][10][11] as a possible method for improving of teaching and learning process in programming education. A short overview of types of auxiliary tools can be found in [12] and an extensive review of research on the subject in [13].

¹<https://ggweb.gradgrinder.net/tarskisworld>

²Source:

<https://ggweb.gradgrinder.net/tarskisworld/features.jsessionid=47CE24A1A8A866CA388A51BE814CB798>

³Source: D. Barker-Plummer, J. Barwise and J. Etchemendy, “Tarski's World: Revised and Expanded”, Stanford: Center for the Study of Language and Inf, 2007, pp. 92.

Considering online resources for programming, there are various websites with mostly interactive programming lessons, some freely available and some with monthly subscription, for example Codecademy⁴, Treehouse⁵, Coursera⁶, edX⁷ or MIT OpenCourseWare⁸. All of them offer lessons for several or more programming languages mostly aimed at web or database development or supporting multiple programming paradigms. Of course, many universities have openly available materials for their courses online. Hence both tool and online support for programming education in general is substantial.

Logic programming education

According to our experience in teaching logic programming, students in those courses face even bigger obstacles, because methods of solving problems are different than in other programming paradigms that they usually learn earlier, although early research also shows the problem in understanding how such system operates when LP is chosen as introductory course in high school [14]. Difficulties with examples used and reasoning in learning logic programming have been identified with Prolog programming language as the example [15] as well as issues with problem solving [16].

Research has shown that various approaches to teaching LP are used [17]. There has also been a number of suggestions how to improve teaching and learning of logic programming, for example (historically):

- to clearly address misconceptions caused by prior experience with different programming paradigms [18]
- to create a competitive environment [19]
- to put in focus algorithm development [16]
- to use drawing an analogy between LP and natural language argumentation texts within linguistics studies [20]

Tools developed for teaching purposes include competition framework based on Ataxx game [19], MeLoISE platform that uses specific scenario tasks in a collaborative visual interface [21] and online development environment specifically for Answer Set Programming [22].

Online resources are also less available than for programming in general. For example, none of above mentioned websites doesn't offer lessons for logic programming. Situation is somewhat better with freely available online materials for university courses. In general, LP has been researched to a lesser extent and much less tool and online support for teaching and learning process is available.

4. ONLINE TEACHING RESOURCES FOR LOGIC PROGRAMMING

⁴<https://www.codecademy.com/>

⁵<https://teamtreehouse.com/>

⁶<https://www.coursera.org/>

⁷<https://www.edx.org/>

⁸<http://ocw.mit.edu/index.htm>

Overview of online teaching resources for logic programming represents initial research about available online materials for introductory and general courses and it includes specialized educational websites, course resources at educational institutions, logic programming tools and other resources. The goal was to find where and to what extent online resources for LP can be found.

Specialized educational websites

There are many educational websites today that offer courses on one or more various subjects. For logic programming subject we examined well known general providers of Massive Open Online Courses (MOOCs) and websites offering programming education specifically.

MOOC providers offer courses and specializations for various subjects from different universities and organizations for free or for a fee. Most known and popular MOOC providers are Coursera, edX, Udacity⁹, FutureLearn¹⁰, OpenClassrooms¹¹, OpenLearning¹², Open2Study¹³ and KhanAcademy¹⁴. We examined them with keywords: "logic programming", "logic" (in case logic programming didn't offer any results) and "Prolog" as a representative programming language. Although analysis shows that programming in general is a subject that has more courses than any other¹⁵, there were no courses as a result for the searched keywords, with the exception of just one course offered by Coursera titled "Introduction to Logic".

Websites that offer only programming education include: Codecademy, Treehouse, Code Avengers¹⁶, Code School¹⁷, CodeHS¹⁸, freeCodeCamp¹⁹, Landofcode²⁰, and PVT²¹. They offer no courses connected to LP, logic or Prolog, which can also be seen in the comparison of several online resources for learning programming²².

Course materials at educational institutions

Various educational institutions offer logic programming courses. Some of them have options for free or payed access to online courses or their materials (with or without certificates and credits) and others just publish online materials for regular courses.

Several well-known universities offer online courses or their materials. MIT is the most known for publishing their course materials online and making them freely available on MIT OpenCourseWare website. A search showed that LP is just one of topics in available course

⁹<https://www.udacity.com/>

¹⁰<https://www.futurelearn.com/>

¹¹<https://openclassrooms.com/>

¹²<https://www.openlearning.com/>

¹³<https://www.open2study.com/>

¹⁴<https://www.khanacademy.org/>

¹⁵<http://www.onlinecoursereport.com/state-of-the-mooc-2016-a-year-of-massive-landscape-change-for-massive-open-online-courses/>

¹⁶<https://www.codeavengers.com/>

¹⁷<https://www.codeschool.com/>

¹⁸<https://codehs.com/>

¹⁹<https://www.freecodecamp.com/>

²⁰<http://landofcode.com/>

²¹<http://pvtuts.com/>

²²<http://www.hongkiat.com/blog/sites-to-learn-coding-online/>

about programming languages and that also some information about it can be found among formerly used materials for other course. Also, there are three courses about logic and none about Prolog. Materials are available as lecture notes, video or audio lectures, assignments, projects, exams and tools, depending on the course. Stanford²³ offers online courses in the same manner as MOOCs, in our field of interest just two about logic, one of which is also offered at Coursera. Berkley²⁴ offers course materials up to Spring 2015 (new courses are on edX), but no courses on logic programming. Harvard²⁵ offers several free online courses and others for a fee, but also none for LP. Yale²⁶ and UCLA²⁷ also don't offer any online courses and Carnegie Mellon offers one course on logic²⁸. Open University²⁹, although specialized for distance learning, also doesn't offer any such courses.

Even though there are no online courses for logic programming, many universities offer such courses in their study programs with materials available online. Image 3 shows one of those course pages. Several examples with notes on freely available online materials are:

- The University of Edinburgh³⁰ - lecture slides, several lecture videos from previous years, programming coursework, tutorials with solutions, old exams, literature and software information and link to online book
- University of Kent³¹ - only course description, possibly due to the start of the course this Fall
- York University³² - only course description, possibly due to the start of the course this Fall, 4-year old lecture slides, assignments, literature and software information³³
- KTH Royal Institute of Technology^{34,35} - two courses (basic and advanced), only course description, links to course pages with no information, possibly due to the start of the courses this Fall
- RWTH Aachen³⁶ - extensive course script, lecture notes and slides, exercises with solutions, old exams with solutions, literature and software information
- University of Bonn³⁷ - lecture slides, assignments with solutions, literature and software information

- Technical University of Dresden³⁸ - lecture slides, tutorials, literature information
- The University of Texas at Dallas³⁹ - literature and software information



Image 3: LP course page from University of Bonn

Logic Programming Tools

For many courses the main language for teaching logic programming is Prolog, a language that is also specified with two ISO standards: ISO/IEC 13211-1:1995 (general core) and ISO/IEC 13211-2:2000 (modules). There are various tools developed for programming with Prolog that are freely available and open source with extensive tutorials and online community. Mostly used are: SWI-Prolog⁴⁰, Visual Prolog⁴¹, Ciao⁴², GNU Prolog⁴³ and XSB⁴⁴. Strawberry Prolog⁴⁵ offers a light version for free, and SICStus⁴⁶ offers evaluation version.

Other Resources

Various other resources for LP can be found on the Internet, including private web pages and blogs. They vary from simple introduction information^{47,48} to web tutorials^{49,50} and wiki pages with a large amount

²³<http://online.stanford.edu/courses>

²⁴<http://webcast.berkeley.edu/>

²⁵<http://www.extension.harvard.edu/academics/online-campus-courses>

²⁶<http://oyc.yale.edu/>

²⁷<https://www.uclaextension.edu/>

²⁸<http://oli.cmu.edu/learn-with-oli/see-our-free-open-courses/>

²⁹<http://www.open.edu/openlearn/free-courses>

³⁰<http://www.inf.ed.ac.uk/teaching/courses/lp/>

³¹<https://www.kent.ac.uk/courses/modules/module/CO884>

³²<http://lassonde.yorku.ca/course-directory/eecs-3401-300>

³³http://www.eecs.yorku.ca/course_archive/2012-13/F/3401/

³⁴<http://www.kth.se/student/kurser/kurs/ID1213?l=en>

³⁵<http://www.kth.se/student/kurser/kurs/ID2213?l=en>

³⁶<http://verify.rwth-aachen.de/lp15/>

³⁷<https://sewiki.iai.uni-bonn.de/teaching/lectures/alp/2016/start>

³⁸[https://iccl.inf.tu-dresden.de/web/Foundations_of_Logic_Programming_\(WS2015\)](https://iccl.inf.tu-dresden.de/web/Foundations_of_Logic_Programming_(WS2015))

³⁹<http://www.utdallas.edu/~gupta/courses/lp/>

⁴⁰<http://www.swi-prolog.org/>

⁴¹<http://www.visual-prolog.com/>

⁴²<http://ciao-lang.org/>

⁴³<http://www.gprolog.org/>

⁴⁴<http://xsb.sourceforge.net/>

⁴⁵<http://www.dobrev.com/>

⁴⁶<https://sicstus.sics.se/>

⁴⁷<https://bernardopires.com/2013/10/try-logic-programming-a-gentle-introduction-to-prolog/>

⁴⁸<http://users.isy.liu.se/johanl/yalmip/pmwiki.php?n=Category.LogicProgramming>

⁴⁹https://www.cpp.edu/~jrfisher/www/prolog_tutorial/contents.html

⁵⁰<http://kti.mff.cuni.cz/~bartak/prolog/>

of information and links, such as Formal Methods Wiki⁵¹. Variety of materials can also be found on pages of special interest groups and laboratories, such as Association for Logic Programming⁵² and The Computational logic, Languages, Implementation, and Parallelism Laboratory⁵³.

Most of those information pages and tutorials are mainly oriented towards Prolog. Also, links to various online materials for learning Prolog can be found, among other programming languages, on a GitHub⁵⁴ page. One of popular resources is the introductory course Learn Prolog Now!⁵⁵ that offers an online book, lecture slides and links to Prolog tools, manuals and several other resources.

5. CONCLUSION

Research for freely available online materials for logic programming has shown that the situation is unfavourable when compared to OOP and programming languages belonging to multiple paradigms. Within in the scope of our research, we can conclude the following:

- A short overview of programming resources in general showed that they mostly refer to OOP and multiple paradigm languages and that LP is covered to a smaller extent.
- There are no online courses in logic programming, logic and Prolog on examined MOOCs with the exception of one course on logic, although there are many courses for other programming paradigms.
- There are no available online courses or course materials in LP, logic and Prolog at examined educational institutions, with small exceptions.
- Various educational institutions that offer logic programming courses have course materials freely available online, but they vary greatly from just course descriptions or literature and software information to lecture slides, tutorials and exercises.
- There are many Prolog tools with extensive support available online, considering that it is the main language used in LP education.
- There are various other online resources made available from special groups and laboratories, personal websites and blogs, but mostly oriented towards Prolog.

Therefore, looking at the overall picture, it seems that most of freely available online resources are oriented towards Prolog and accessible from tool websites, unofficial private websites or special group websites. Course materials at educational institutions vary greatly and depend on a lecturer. There are virtually no online logic programming courses either from MOOCs or educational institutions.

According to these results, more effort should be put into development of online courses for LP, as well as into the improvement of resources at websites of educational institutions. Further research will be more oriented towards problems of teaching and learning logic programming with the aim of developing better online resources.

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⁵¹http://formalmethods.wikia.com/wiki/Logic_programming

⁵²<http://www.cs.nmsu.edu/ALP/>

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⁵⁴<https://github.com/vhf/free-programming-books/blob/master/free-programming-books.md#prolog>

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KNOWLEDGE ASSESSMENT USING CAUSE-EFFECT GRAPHING METHODS

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Abstract: *This paper presents a test of the learning process that aims to check students' knowledge. Through additional activities in the learning process it's possible to check knowledge of the student, and in this paper are used activity questions and answers and multiple choice activities. It has been created a learning process that consists of a series of questions with possible answers true and false and multiple choice questions that support marking multiple correct answers. Testing will be performed with cause-effect method and the result will be shown by Cause-effect graph with defining test cases based on the obtained results.*

Keywords: *E-Learning, Distance learning, Personalized learning, Cause-effect graphing, testing software*

1. INTRODUCTION

Personalized learning allows customization of teaching material to the needs of students, participants in the learning process, depending of the shown knowledge. Applying the personalization, students are getting interactive learning process with additional activities that enables the check of student in accordance with the level of knowledge after specified domain. [4]. Student can independently check their knowledge through the activities in the learning process and on the basis of the obtained results determinate own level of knowledge. If necessary, it is possible to go through the process of re-learning and re-examination until the student is not satisfied with the results that obtained. Learning processes with additional activities affect the final outcome of learning (student's level of knowledge) and as such they must be reliable and consequently tested. In this work, the learning process with additional activities (questions and answers, multiple choices) will be tested by the method Cause-effect [3]. It will be shown well-known inputs (causes) and the expected outputs (effect, in this case the number of points of a student) from the learning process. After analyzing the obtained result will be shown corresponding Cause-effect graph with defining of test cases for different types of inputs and expected outputs of the learning process.

2. PERSONALIZED LEARNING

Learning materials used in personalized learning processes must be in the form of learning objects (small clear content) containing characteristic metadata. Tendency towards dividing teaching materials as small learning objects makes available its reuse in various learning processes. Defining characteristic metadata for each object allows the further search of objects within the

system. Professor, author of the course, when creating personalized learning process searches for learning objects where search is based on metadata (usually the level of knowledge) and puts them in the learning process.

During the learning process within the system is necessary to conduct: filtering, personalization and evaluation. Filtering involves defining the level of knowledge of the student and determining the further course of the learning process. The „Cause-Effect” technique in testing e-learning application is applied, because it is suitable for automation, as well as the fact that the test cases are extracted from the software specifications given in natural language. [2]

2.1 SYSTEMS FOR THE PERSONALIZATION OF THE LEARNING PROCESS

Students differ in their abilities, needs and profiles. The stated deviations should be taken into account when designing an intelligent learning process. In addition to the eventual evaluation given by the professor (the author of the course) it is necessary to review in detail the information available to the student after passing through the learning process. In the analysis of the student in the learning process it is also involved the context. Context represents any information obtained by the system, which characterizes the state of the entity. An entity represents a student, a place in the process of learning, object or any activity that may be relevant and as such can provide a description of the interaction between the user and the system. The information that can assist in the personalization of learning are related to the devices from which students approach to learning systems, the time required to interact with the system (number of clicks during the learning process) and the habits of students (at which time accesses to the system and goes through the

learning process). During the learning process within the system is necessary to conduct: filtering, personalization and evaluation. Filtering implies defining level of knowledge of student and defining of further course through learning process. In part of personalization specific teaching materials through the system of interface are being displayed to the student based on the level of knowledge. The last part, evaluation, implies the evaluation of students through a clearly defined task or test adjusted to the level of learning in which the student is and also to the shown knowledge. [1]

The concept of filters (filtering) is used as a modifier that can be applied to the space in which is developed a personalized learning process. In addition to defining the level of knowledge of the student it is possible to determine in which way is necessary to set up and to organize the learning process and to adapt it to the needs of the student. The concept of space represents a complete learning process. In any personalized learning process is possible to set nodes. The term nodes in a personalized learning is the formulation of the theme of the learning process, different aspects, groups of aspects and levels of abstraction. Every aspect of the context node is a sub-theme of personalized learning process. With the introduction of aspects it is enabled the formulation of themes and sub-themes within a personalized learning process with support for different characteristics of students, the manner and style of learning. [5]

Level of aspect is the importance of one aspect of the learning process. By using the level aspect it is made available the setting up of various student workload in certain parts of the learning process. In this way, by using of levels, it is possible to make the learning process so that one part is the theory of teaching theme, while the second part is based on exercises and tasks according to the theory. [6]

The system through the analysis of information about students (student model), the time spent on performing tasks, can define a group to which it shall assign the aspect with exercises and tasks. In that way, if the system evaluates that a group of students devote more time for performing of the tasks of teaching themes with the analysis, the accuracy of performed tasks, to this group of students will be assigned an aspect that will include exercises and tasks for independent work.

Interactive process. Starting from the predefined hierarchy of the course through the LMS system it is possible to create an interactive process in which students will participate (users). Interactive process enables the system to maintain student activities through the teaching process (answers to questions, most frequently opened teaching material, time spent on teaching materials) and consequently determine the manner of student learning and its activity in the teaching process. If the student spends most of his time doing tasks on the system, the system and the author of the course will have the information that it is necessary in continuation of the process to enable as many practical examples. Student has

a profile in which data on the teaching process are stored, the process activities that student accesses etc.[7]

The user interface system adapted for personalized learning process communicates with the student and takes the characteristics of students (time interaction with the learning process, general information about the student, a device used for learning), and the connection between the student and the adaptive part of the system that deals with personalization.

The core of the system for support to personalized learning process deals with the creation of personalized learning process on the basis of information obtained by the students stored in a single student model. The core of the system combines teaching material and creates a learning process according to information obtained from the student model. Also, in addition to the original definition of personalized learning process based on knowledge, the core of the system continues the evaluation of the student's knowledge and the learning process that is assigned. If the system assesses that students spend too much time on the resulting learning process it shall be repeated the analysis of model student and it shall be redistributed the teaching materials and the re-creation of the learning process. In personalized learning processes the most commonly are found activities for testing of knowledge (questions and answers, tests, assignments for independent work) in order the system can assess at what level of knowledge the student is. By regular tests in the learning process is conducted an assessment of performance of learning of student within a certain theme. Automatic updating of the model student enables gathering information in the system on student activity within the learning process. Updating the student model after each access to the learning process is obliged in order of holding the right information in the system. If the student demonstrates a higher level of knowledge of the learning process in which there is a necessary to redistribute system of teaching materials and to be displayed to a student a different learning process according to the present level of knowledge.

3.CASE STUDIED - EVALUATION OF STUDENTS IN THE FRAMEWORK OF PERSONALIZED E-LEARNING SYSTEM

Students are offered with several questions in different forms. In order to adapt next learning activities on the e-learning system, each student is offered a series of questions of different types, such as: question with two response options (True / False), questions with multiple choice answers that are scored as a result of student performance are offered additional questions that allow him to earn extra (bonus) points, and the combination of interdependent questions to avoid cases of accidental correct response.

Ensuring the correctness of this complex combined system of questions and answers require very detailed and intelligent testing. As an effective way of testing it's suggested a combination of two techniques of functional

software testing - "Cause-Effect" analysis and combinatorial testing known as orthogonal vector robust testing (OART - Orthogonal Array Robust Testing) on a concrete case of complex scenarios of questions and answers. In this paper, due to limited space, it will be described only application techniques "Cause-Effect" analysis [2,3].

Before we go deeper into the very testing techniques that will be applied, we must first carry out an analysis of software for student assessment, so that we know precisely what is tested.

3.1 TESTING METHOD "CAUSE-EFFECT" graphs

Cause-Effect (C-E) graph is essentially a technique that is used to test hardware, and is adapted to software testing, and then such as is developed[3]. This is the technique of testing method of "black box", therefore, it observes at the functional behavior of the system, without the need to analyze the internal structure of the system design. Also, it is the only technique black box test design, which takes into regard a combination of causes of system behavior that is applicable in both the analysis and development of design specifications.

When C-E analysis should first identified in the specification and readily available, the initial documentation of software:

- Causes
- Side effects
- Limitations

Then, construct the "Cause-Effect" graph, as well as combinatorial logic network whose nodes are the elements, which are called "causes" and "effects", and if necessary intermediate node, representing the Boolean operations: AND, OR, NOT. Finally, search the graph builds the table of decision-making that will be converted directly into specific cases of using the software, and then the test cases.

Cause-Effect graphs also describe the functional model depending on certain components and software used in the design software. C-E analysis focuses on showing relationship of dependency between inputs (causes) and output (result) of the software. These links are presented visually using C-E graph. Graf is a visual representation of the logical relationships between inputs and outputs that can be represented Boolean algebra. C-E graph allows you to select various combinations of input values to be made a test. The explosion of the number of test cases is avoided by applying heuristics and logical rules during the time graph.

The cause is any condition set out in the claims which could affect the result of the work program. The result is a reaction to the program given combination of inputs.

Here we describe a generic procedure for test generation using C-E graph through the following activities:

- Identify the causes and consequences of re-reading required
- Every cause and effect to assign a unique identifier
- Show the relationship of cause and effect by using the "Cause-Effect" graph
- Transform C-E graph in limited decision-making table
- Generate test cases from the decision-making table

In evaluating the student performance progression through the lessons path, a series of questions are asked which are causes, in our case, that we will mark with the C1, C2, ... C8. The effect is the result of the response that is expressed in points designated as E.

3.2 DESCRIPTION OF PERFORMANCE ASSESSMENT solving by combining several types of questions

As part of the lesson, which deals with the application design patterns of software the questions are:

C1 - true / false question is: Sample State separates behavior that depends on the state of the object of the original object.

Correct answer: True. Any processing of questions and answers, in the application is observed as a transformation, so that the question C1 (the cause of) student earns an appropriate amount of points (E1) on the basis of this transformation we will mark it with a t1 (Figure 1).

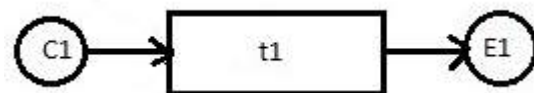


Figure 1: Relation t1, which is the result of responses to the question C1

C2 - true / false question: Software patterns that have as a purpose the description of behavior solving the problems which occur in the allocation of responsibilities classes and designing algorithms.

Correct answer: True.

C3 - true / false question: Software patterns to describe the behavior can be that when the behavior of a class should be transferred to the subclasses, use the structure of inheritance.

Correct answer: True.

Questions C2 and C3 both brings a student certain number of points E11 (t23 transformation within the application) if both correct answers (C2 and C3 are in the Boolean AND route i.e. Transformation of t23 is the AND operation that is shown in Figure 2).

Thus, C2 and C3 in the transformation result t23 give E11.

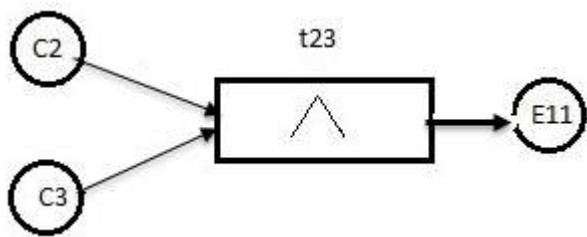


Figure 2: Relations t23 is Bull AND operation between C2 and C3

C4 - true / false question: Behavioral patterns do not suggest a static relationship between objects or classes but it describes the way objects communicate.

Correct answer: True.

The questions C3 and C4 together brings the student a number of points, i.e. E12. If answers are true to any of question points are added (C3 and C4 are in Bull OR operation).

Thus, C2 and C3 provide the result in the transformation of E11.

C5 - true / false question: The software pattern state does not belong to describe patterns of behavior.

Correct answer: false. If the answer on question C5 (cause) is correct (determined false), student earns a corresponding amount of points (E1) on the basis of this transformation we marked with t2.

C6 - multiple choice question: Pattern state is used when:

- behavior of the object depends on its condition - O6-1;
- behavior of the object does not depend on his condition. O6-2;
- behavior of the program changes the behavior of the object - O6-3;
- behavior change at the time of performance depending on the state - O6-4;

O - is a possible answer to the condition: signed or not signed (1 point or 0 points, respectively), incorrect marked offered answer is penalized -1 point.

Correct answer:

-> Behavior of the object depends on its condition, i.e. O6-1

-> Behavior change at the time of performance depending on the state, i.e. O6-4.

Transformation t3 - Results of the marked responses to C6 question

Students answer to the question number 6 is the effect of E6 (earned points) as a transformation t3 i.e. $E6 = \sum O6-i$ (true) $-\sum O6-i$ (false), $O6-i = 1, 2, 3, 4$ E6 may be a value of 0 (if the result of the transformation is negative Is set to

0) to 2 (the maximum possible number of correct marked response i.e. 100%).

C7 - multiple choice question: Pattern State:

- separates behavior that depends on the state of the object of the Original object - O7-1;
- behavior assigns a series of other objects - O7-2;
- assign a one object for each condition - O7-3;

O - is a possible answer with the condition: signed or not signed (1 point or 0 points, respectively), and incorrectly mark offered answer is penalized -1 point.

Correct answer:

- separates behavior that depends on the condition of the object of the Original object i.e. O7-1;
- behavior assigns a series of other facilities i.e. O7-2;
- assign one object for each state i.e. O7-3;

Transformation t4 - Results marked responses to C7 question

Students answers to the question number 7 is the effect of E7 (earned points) as a transformation t4 i.e. $E7 = \sum O7-i$ (correctly) $-\sum O7-i$ (false), $i = 1, 2, 3$ E7 may be a value of 0 (if the result of the transformation is negative Is set to 0) to 3 (maximum possible number of correct marked response i.e. 100%).

Furthermore:

C8 - multiple choice question: Role models are used:

- when we want a dynamic alteration functionality of the program - O8-1;
- when it is necessary to achieve the flexibility of Class - O8-2;
- when is need to reduce the complexity of Sistema - O8-3;

O - is a possible answer to the state: signed or not signed (1 point or 0 points, respectively), and incorrectly mark offered answer is penalized -1 point.

Correct answer:

-> When you want a dynamic alteration functionality of the program i.e. O8-1;

-> When it is necessary to achieve the flexibility of classes, i.e. O8-2;

-> When it is necessary to reduce the complexity of the system i.e. O8-3;

Transformation T5- result of marked answers to the question C8

Students answers to the question C8 is the effect E8 (points earned) as a transformation that is t5. $E8 = \sum O8-i$ (correctly) $-\sum O8-i$ (false), $i = 1, 2, 3$ E8 can be a value of 0 (if the result of the transformation is negative is set to 0) to 3 (maximum possible number of correct marked responses, 100%).

To summarize:

C1 is the first type of question where the correct answer (true) student passes and receives a score of E1.

C2 is the second true / false type of question where with the combination of question C3 which is also true / false and correct answer receives a score E11.

C3 is a true / false type of questions and in the combination with C4 (fourth true / false questions) shows student scores E12.

C5 is a true / false type questions, which in transformation with a correct answer gives students a result of E1.

C6 is a multiple choice type questions, where 100% (if the E6 = 2 has a true state in all other cases, the answer is false marking) in combination with C7 100% (if the E7 = 3 status is true in all other cases mark the answer is false) and in combination with 8 additional sub-question multiple choice (if E8 = 3 status is true in all other cases mark the answer is false) guides student to additional points for commitment (additional 50%) and obtaining the results of E13 with additional knowledge test.

Through multiple choice student may incorrectly answer the question 6 (in Figure 3 marked the symbol of negation ~) or that score can fix in the question C7, which comes after questions C6. Additional points of commitment can be achieved on the queswtion C8, which in the total score and result of E13 brings the points. In that way, the student has the opportunity to correct his mistake in the process of learning offered through an additional set of questions. The final-Cause Effect graph is shown in Figure 3.

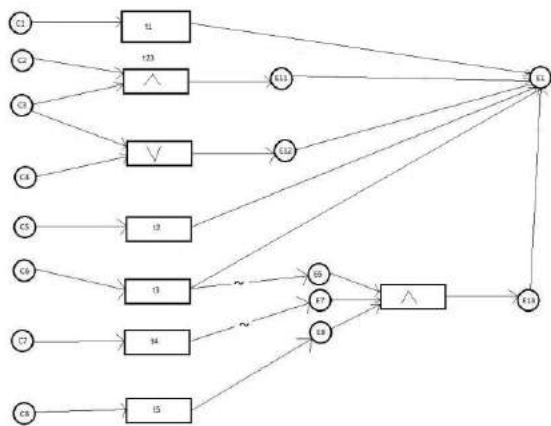


Figure 3: Final Cause-Effect graph for the described scenario of testing personalized learning process

3.3 TESTS FOR CHECKING implementation in e-learning applications - TEST CASE DESIGN

The easiest way to test is to create one test case for each combination of input parameters C which is obtained by the formula $2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 = 2^8 = 256$ test cases. This testing is obtained for n causes 2^n test cases. However, in the papers [2, 3] it is shown that the more efficient method is passing back through the graph (Backward graph traversal) that we used.

Passing back through the graph is a technique that can optimize the selection of tests [2].

The method consists of the following:

- We consider the graph as a set of trees, through the branches of leaves to the roots, where every tree begins a consequence of (root), and ends with the causes (leaves)
- Following each of these trees the leaves (causes) in every possible way
- When you get to the leaves, those causes that we could not achieve in this passage we set the value of the unavailable (NO) or status is irrelevant to the cause, and one that we have put the check value (YES).

In our case, this procedure provides a set of six (6) test cases. Cause-Effect graph of our example would be the process of passage given back the next decision table:

We will create 6 test cases (table 1), define each C and E with the values true or false, and create a table. Note that the student answers questions one after the other C1 then C2 etc. It is necessary to determine the condition at each transition from the roots to the leaves i.e. that value (True or False) give proper effect to this path for which there is value YES. For example, in the case of TS1 to the question C1 be that the student answered correctly i.e. True, while the TS2 to the question C2 and C3 should respond correctly to both, and TS3 any correct answer to C3 or C4, or both leads to E12, and E1 as to the final result of passing back through the graph, and so on.

Table 1: Relevant test cases

	TS1	TS2	TS3	TS4	TS5	TS6
C1	YES	No	No	No	No	No
C2	No	YES	No	No	No	No
C3	No	YES	YES	No	No	No
C4	No	No	YES	No	No	No
C5	No	No	No	YES	No	No
C6	No	No	No	No	YES	YES
C7	No	No	No	No	No	YES
C8	No	No	No	No	No	YES
E1	YES	YES	YES	YES	YES	YES
E6	No	No	No	No	No	YES
E7	No	No	No	No	No	YES
E8	No	No	No	No	No	YES
E11	No	YES	No	No	No	No
E12	No	No	YES	No	No	No
E13	No	No	No	No	No	YES

4. CONCLUSION

Creating a learning process provides more interactivity with the students and improving of the quality of teaching

materials. Personalization of the learning process presents an opportunity that each student based on the level of knowledge obtained teaching materials and check the acquired knowledge. Through personalized learning processes benefit both students and authors of teaching materials. Obtaining feedbacks from the learning process, by the activity within which is checked students' knowledge, the authors of teaching materials have an insight into the possibilities of each student and therefore they can plan and develop other parts of the learning process.

The process of software testing can be very problematic due to imposed limitations in resources and time. Thoughtful planning of a testing strategy is crucial to the quality managing of the process development and software testing. It must be taken into consideration both economic and technical aspects, particularly the risks of non-disclosure of defects.

Benefits of "Cause-Effect" technique, which was used in testing e-learning applications, as its susceptibility to automate and the fact that the test cases are extracted from the software specifications given in natural language. On the other hand, the same technique is very problematic because a relatively small force in reducing the number of test cases. Therefore, in future studies it should be experimentd with more complex case scenarios of questions and answers, using combinatorial testing known as orthogonal vector robust testing (Oarta - Orthogonal Array Testing Robust).

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ENHANCING TRUST IN E-LEARNING THROUGH SECURITY MECHANISMS IMPROVEMENT

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Abstract: Trust is an important issue in establishment of any service. Researchers usually discussed trust in contexts of online banking, but other services are prone to trust problems too. We researched models of trust in e-learning and potential role of security in development of trust. Security was improved through usage of additional learning environment module that communicate with user. An adapted trust model was tested and the results are presented with appropriate conclusions and suggestions for future research.

Keywords: e-learning, trust, security

1. INTRODUCTION

Trust is a general term. According to the Webster's dictionary, it is "belief that someone or something is reliable, good, honest, effective, etc." [1]. Oxford dictionary offers similar explanation: "Firm belief in the reliability, truth, or ability of someone or something" [2]. Belief is a subjective category, so is the trust. Not having trust in someone or something -in some person, organization or web-service, might have strong influence on how we approach it, if we approach it at all. We could limit sharing confident information with the person or stop using a service qualified as non-trustworthy. Also, we may require additional check and measures of control, since there is not enough evidence of reliability to just close our eye and believe everything will be fine.

Trust is an important issue in online services operation. Its definition is more specific in this context: "a psychological state that allows a person to accept vulnerability based upon positive expectations of the intentions or behavior of others" [3]. It is even stated as key factor of online business success [4]. Further, information security is stated as one of factors influencing trust [5], with various classification of elements that compose the security itself. In [5] author defines three elements - access control, transparency of identity and surveillance, while other may have different taxonomy, as it will be stated in next section.

Matter of trust in online services is mostly researched in context of e-commerce and e-banking, which is reasonable, since these services bring risks that may put users (clients) in possibility of heavy loss. However, any online service, even a plain web site is accompanied with certain level of trust. Therefore it is justified to assume trust as important issue in e-learning.

The paper deals with relation of security and trust and how we may enhance the trust through improvement of security mechanisms. The problem tackled in this paper is how could we improve trust in e-learning that is facilitated in official education. Other approaches, dealing with open education options, that may require full anonymity are not discussed, but one may find interesting results in [6].

The rest of paper is structured as it follows: current research in area of trust in online services (including e-learning) is given, then the foundations of security architecture and model of research are presented and the results are discussed and conclusions are made.

2. BACKGROUND

Researchers tended to classify factors influencing trust in various ways. Wang defined trust framework with four complex factors: credibility, design, instructor socio-communicative style, privacy and security [7]. Similar approach was taken by Hsu [8], who analyzed e-commerce service trust. The security elements he defined are "perceived security" and "perceived privacy".

In [9] authors conveyed a wide-scale research in which they concluded that security is an important factor, but dealing with possible accident and ensuring users that it would be mitigated and fixed showed up to be more important than evident existence of security controls.

Wright et. al. argued that both privacy and trust were highly context-dependent issues and that policy makers were supposed to clarify statements regarding privacy and trust and to adapt them to new needs [10].

A comprehensive literature review is given in [11], in order to bring a model for web-site trust evaluation. Among other things, there is an interesting debate stated - about how users' technology proficiency affects their

trust. In short: it is still unclear whether higher proficiency leads to greater trust or it is the opposite. The final model is made consisting of many factors, which are not of same importance for different kind of web-service, i.e. for e-banking and e-commerce.

Trust model used in this paper is based on [7] and [11].

3. SECURITY MODULE

Model of enhanced security is based on usage of seLTSA architecture given in [12] (Image 1). The security module is developed as key part of LTSA (Learning Technology System Architecture) upgrade. It is an element that orchestrates security measures integrated in the learning environment. It presumes improvement of conventional security mechanisms built into learning environment, by using advanced monitoring and enhanced communication with users.

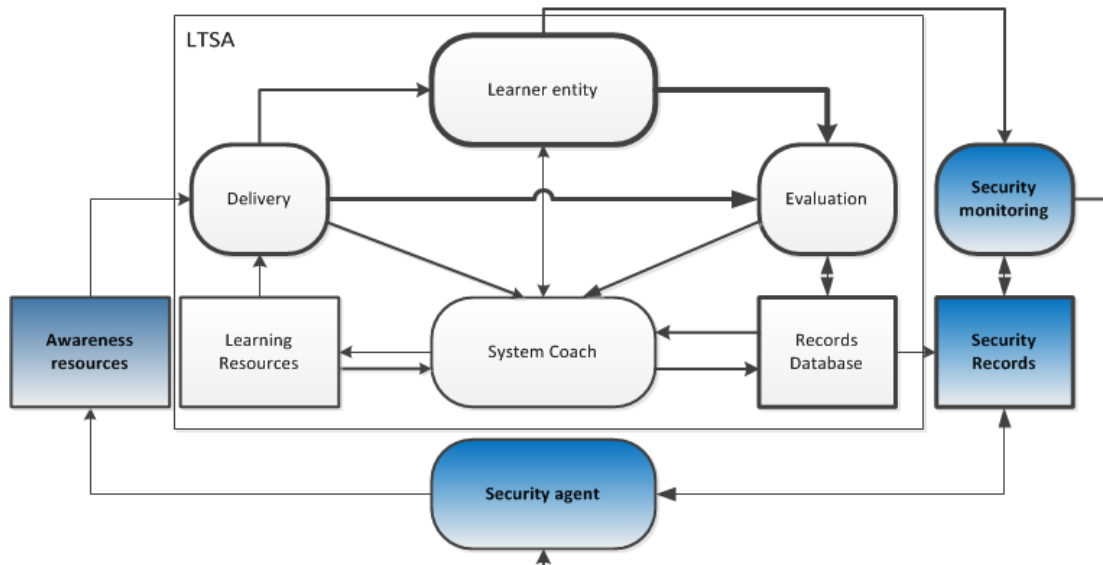


Image 1: seLTSA architecture (taken from [12])

Module's role in brief is to monitor events related to security, act proactively and correspond with users, disseminating security recommendations. Communication is "light": it is integrated in courses that users visit and users are not forced to interact, i.e. they are not forced to read some text or to take e-test related to security issues.

The module is implemented as a software agent - a plugin for the popular learning environment - Moodle [13]. Moodle is chosen mostly because it is open source and because students of the faculty where it was planned to assess the module, are already familiar with it.

Users (students) are exposed to the relatively small block of text taken from awareness resources (which are further derived from terms of system usage). The resources are dependent on user's profile and the profile is built upon user's behavior. The behavior includes password management, malicious file handling and security awareness test results. The test is not obligatory. Module also may send mails and private messages with required information.

4. RESEARCH

We established an online course, placed on Moodle platform with installed security module. A group of 35 students was enrolled for two months. No additional information regarding the module or the research was

disclosed, in order to get unbiased results.

After the course was over, we conducted a survey related to trust, based on model given in section "Background". Factors comprising trust were categorized in three groups: security, reputation and content. Security was articulated through module functions. The survey utilized Likert's scale (1-5) (Appendix). The results are presented on Image 2.

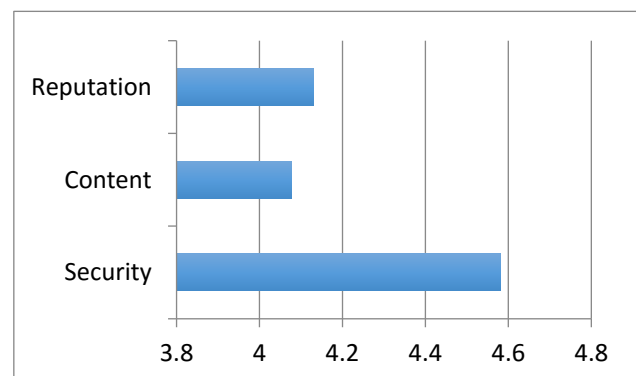


Image 2: Survey results

The results have unambiguously shown that security is important building block of trust. Module's functions turned out to be valuable, even more important than other trust "ingredients".

Although the results are somewhat satisfying in matter of hypothesis that security is important and that we may improve the trust in whole by enhancing the security features through module, we further analyzed how component of "security" factor correlate in order to check if there were some internal components interconnections. Therefore we used SPSS package to make automatic refactoring of the factors standing inside each category. We found strong relationship between reputation and security factors. Most factors belonging to "security" category were factored in same group as reputation. Therefore we concluded that security is tightly related to reputation and these two categories may even be merged into one.

5. CONCLUSION

Trust in e-learning is established through interaction of various factors. Security is one of them. By enhancing security, trust may be improved too. In order to boost trust, it is important that users get feeling that they are cared about and that they won't be let to themselves to solve problems. Security module developed as part of seLTSA architecture is user-oriented. Even it is not too proactive, users got they way of getting information and automatic support.

Research showed that factors related to security are important for trust, but also suggested seeking for new models of trust, since not just every kind of e-business got its own oddities, but even different scenarios and sub-scenarios of learning may bring some novel moments in model of trust, revealing factors affecting it. It is up to further research to enlighten these models.

APPENDIX - SURVEY ITEMS

Reputation

1. For trusting this system, it is important that the e-learning site is on university domain.
2. For trusting this system it is important if other colleagues are using it.

Course content and communication

3. Accuracy of e-learning content influence my trust in e-learning.
4. Site availability influences my trust.
5. Availability of technical support influences my trust.
6. Quality of teaching material affects the trust.
7. Communication with other users on course affects my trust.
8. System design (look, colors) influences my trust in e-learning system.
9. Feel of community affects my trust

Security

10. It is important for trust in e-learning to be well introduced with terms of usage.
11. It is important for trust to get assistance with login problems.
12. It is important for trust to have uploaded files checked.
13. It is important for trust to have potential attackers banned.
14. Preserving privacy of my data is important for trust.

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LEARNING STYLES METHODS FOR STUDENTS CLASSIFICATION

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Abstract: *In this paper we will discuss about learning styles methods student classification. The objective of this classification is to achieve a better adaptation of interfaces and classes in the order to create adaptive e-learning materials used by the Metropolitan University of Belgrade. Learning styles represent an individual's habitual way of organizing and processing information and habits of students for learning. Students can use this model to determine which learning style fits them personally. Implementing this mechanism can improve their experience in education by a wide margin, focusing on what benefits each individual student.*

Keywords: *e-learning, learning styles, student classification*

1. INTRODUCTION

Personalized learning is an imperative in the transformation of education. This form of learning can be explained as determination of student interests and possibility for offering opportunities for a progress of this interests. This form of learning is focused on the student and controlled by student himself.

In sum, to create a personal learning, it is required:

- *Get to know students very well.* If we want to personalize lesson for each student, it is necessary for us to know them well. To achieve this, teachers need to create bases which contain personal information about the students.
- *Adapt lessons.* The next step is to create personalised adaptive lessons.

The art of teaching is frequently defined as forming and couching of educational environment and experience of the person who teaches with the purpose of archiving and accomplish desirable result of learning. Thus, we can say that precondition for successful education is to familiarize process of learning and factors which facilitate or aggravate studying.

Each man is an individual. The fact is that people are not capable to accept new information in the same way, thus, there are tendencies to define styles of learning. That includes the description of attitude and behaviour which is

determined the way of studying which students have chosen. Technology plays an important role in personalized learning, but to create the technical base it is necessary to design mode of work. For purposes of BMU it is necessary to defined by classification of students based on the style of learning. The importance of the division of students according to style of work and studying is for achieving better adaptation of interface and lectures. The goal is to create high – quality and adaptive lessons.

There are controversies about the classification according to styles of learning. Pashler's research from 2008. [1] in which he had demonstrate that teaching whit applying appropriate style won't contribute for individual for better and easier acceptance of knowledge.

At site [2] as explanation about controversy of the learning styles we cite: "There is a very simple explanation why learning styles have no influence on effectiveness of learning. The most popular classification, according to learning styles, means individuals who prefer visual learning (V), the ones who prefer audio learning (A), the ones who learns by reading/writing (R) and the ones who prefer kinaesthetic learning (K – combination with previous styles). For example, learning to play guitar. Pupils can't learn to play guitar unless they take it in their hands and start to play (K), unless they listen how to play it in the proper way (A), unless they don't follow sheet music (R), and if they don't follow notes and watch photos which shows proper position of fingers during

playing. That means that the content which we learn is more complex than it looks like. Thus, any of this four styles of learning, is not enough for a good result. In much simpler examples, we can notice the same. Does priority for auditory style, the learning style by listening, means that person is not going to prepare properly for drivers license practice test, because they need visual identifying traffic signs? Information which are represent visually, must be adopt by visual way and after that, they must be identify than on the same way. According to this two examples, only, it is clear that to this idea about learning styles is missing basic validity. "

Studies of Coffield [3] and Pashler [2] unequivocally confirm not to resort using of styles of learning. Effectiveness of style of learning could be tested easily. In this purpose we can form two groups of students. Each of this group uses different style of studying (for example one group with visual study, the other kinaesthetic), and then each group should learn a new lesson, using style of learning from opposite group.

In spite of researches, many educational institutions, such as Barkly, Yale, UCLA and Harvard, classified their students based on this theory of students classification. According to research of this institutions, students had better and higher results if they studied by their own personalised style of learning. Also, there are many science papers which support classification of students by the style of learning and they will be shown in this paper.

In this paper, at the begging section of different styles of learning is going to be explained. After that, we are going to recommend style of learning which could be useful at BMU. The goal is to personalize and adapt our traditional and e-learning education. Afterwards, we are going to show the way of grouping students which is designed by the division and in the end the suggestion of adaptation of education program is going to be represented. The chosen way of studying is going to be applied on students volunteers in purpose of determining effectiveness of the style of learning. Effectiveness of style of learning is going to be tested in the following explanation: ten groups of students are going to be form for every faculty. Every group have two members. Every group is going to learn using different style of studying, and lecture is adapted for one of the group member. At the end we are going to match the results. For example: unless both of students from every groups are going to learn the same content with visual style, by the supposition that learning style are useful, and student which is dispoaset to visual style should achieve better results, and vice versa.

2. AN OVERVIEW OF LEARNING STYLES

While researching science works which consider learning styles, we realised that there are many divisions. Some classifications might not be suitable for purposes of BMU, some classifications are strictly oriented to certain sciences, others are general. Considering that different groups of students will be testing during research, it is neceserry that some general classification should be used.

Metropolitan University, except engineering Science at Faculty of Information, also has Economic Sciences at Faculty of Management, and Faculty of Digital Arts. Thus learning styles must be generalised. In this chapter well-known classifications of learning styles will be presented. Many classifications have similarities, to a certain extent.

The Myers-Briggs Type Indicator [4]

This model classifies students according to the theory of Psychological Types, created by Carl Jung [5].

- **extraverts** (trying out, focused on external world and other people) ili **introverts** (they think about problems solving, their focus is on internal world of ideas).
- **sensors** (practical, oriented on details, focused on facts and procedures) i **intuitors** (imaginative, oriented on concepts, focused on the possibilities and meanings).
- **thinkers** (skeptical, they making decisions based on logical rules) ili **feelers** (they prefere to make decisions based on personal and humanistic considerations)
- **judgers** (they follow agendas and terms, demand closure of projects with incomplete data) ili **perceivers** (adaptable to changing circumstances, postpone the closure of projects until they collect more data).

Classification itself gives 16 different learning styles. For example(extravert, sensor, thinker, perceiver), it could be ESTP or IIFJ(introvert, intuitor, feeler, judger).

Kolb's Learning Style Model [6]

This model classifies students according to:

- concrete experience or abstract conceptualization (how they take information in)
- active experimentation or reflective observation (how they internalize information),

There are four types of students in this classification:

- **Type 1** (concrete, reflective) Typical question for this type of students is „Why?“ Students in this group respond to how teaching material, in relation with their experience, their interests, can influenced their carrier. To be effective, their teacher should be acting as a motivator.
- **Type 2** (abstract, reflective) - Question that describes this group is „What?“ Students from type 2 reacting to given information which are logical and useful. They think about problem solving. To be effective, teacher should be acting as an expert.
- **Type 3** (abstract, active) - “How?“ is typical question which describes this type of students. (These students are fond of active work on good-defined tasks and they learn with trial-and-error method. Teacher should act as a coach, leading practice and providing information about success of students.

- **Type 4** (concrete, active) Question that describes this group is „What if?“ Students of this group like to solve real problems according to lectures. Teacher should give real problems with solutions in lectures, and to assign tasks of that type.

Herrmann Brain Dominance Instrument (HBDI) [7]

This method classifies students according to their ways of thinking with regard to brain function. Classification consists of:

- Quadrant A (left brain, cerebral). Logical, analytical, quantitative, factual, critical;
- Quadrant B (left brain, limbic). Sequential, organized, planned, detailed, structured;
- Quadrant C (right brain, limbic). Emotional, interpersonal, sensory, kinaesthetic, symbolic;
- Quadrant D (right brain, cerebral). Visual, holistic, innovative.

Most engineering instruction consequently focuses on left-brain Quadrant A analysis and Quadrant B methods and procedures associated with that analysis, neglecting important skills associated with quadrant C (teamwork, communications) and quadrant D (creative problem solving, systems thinking, synthesis, and design). This imbalance is a disservice to all students, but particularly to the 20-40% of entering engineering students with strong preferences for C and D quadrant thinking.

Felder and Silverman Model [8]

Firstly developed by Dr. Felder and dr. Lynda K. Silverman (educational psychologist), for students and teachers purposes in engineering and science, but today is widely used. Classification itself divides students in four groups, with the fact that each group additionally has two classifications.

Groups of students are:

- Active or reflective learners
- Sensing and intuitive learners
- Visual and verbal learners
- Sequential and global learners.

This model seemed appropriate, and it was using for student's questionnaire.

3. FELDER AND SILVERMAN LEARNING STYLES MODEL

Questionnaire and classification of students are based on Felder-Silverman model [8]. Precisely, after detailed studies of classifications, these authors presented this universal classification for students who are on different study programs. Other classifications can be applied only to certain groups, or applied incompletely. Regardless of intentions that classification should be universal because of testing students from a different colleges and universities, decision was that this model of testing should be used because it is suitable for purposes of BMU.

Active or reflective learners

Active learners have tendency to receive and keep info information during active work, discussion, or applying of knowledge. Reflective learners prefer to think about new information. Active learner's phrase is "Let's try it to see how it works", and Reflective learner's phrase is "Let's think about it". Going through lessons without any practical work is difficult for both learning types, especially for active learners. Each one of us is sometimes more active, sometimes more reflective. Therefore classifying is necessary. Balance between two types is most desirable. If you always go to action without thinking, you could find yourself in a problem, if you spend too much time thinking, perhaps you wouldn't do anything. If you are an active student in a class which allows little time for discussion or creating a strategy for solving problems, you could have problems during learning, because you try to guess a solution. Or you could forget some facts because you didn't have enough time to think about them. Anyway you will keep information more likely, if you try to do something with it. If you are reflective learner, you could help yourself if you don't waste too much time on it, anytime you gather new information. Goal is not only to read or to memorize information you don't have always to recall what have you read and which questions could emanate from new info. It is necessary to write notes with your own words. It will take more of your time, but at least you can keep new information for a long period of time.

Sensing and intuitive learners

Sensing learners favour facts, but intuitive learners prefer to discover relations and possibilities. Sensitive learners solve problems using well-known pattern, they avoid complications and surprises, while intuitive learners like innovations and do not like repetitions. More than intuitive learners, sensitive learners like to test material which is not presented at a class. They can be patient with details and laboratory work, they tend to be more practical; intuitive learners are better with innovations, they work faster and tend to be more innovative than sensitive learners. Everybody can sometime be more sensing or more intuitive. Effective learners and problem solvers are able to function both ways. If the information is connected to the real world, sensitive learners can easy remember and understand it. They may have difficulties if material is abstract and theoretical. They should ask their instructor for examples of concepts or try to find some in other references or during discussions with their classmates. Intuitive learners may have problems with memorization and repetition because they are impatient with details, therefore their instructors must always link theories and facts.

Visual and verbal learners

Most people are visual learners, they learn best through what they see, pictures, films, flow charts, practical demonstrations, etc. Verbal learners learn best while reading written and spoken explanations.

Everyone can learn more if information is presented both visually and verbally.

Visual learners should always find or make some diagrams, schematics, or any visual representation if material is predominantly verbal.

Verbal learners should write materials in their own words or to work in groups.

Sequential and global learners

Sequential learners learn in linear steps, through pattern in which each step emanate from the previous one in a logical way. Global learners absorb learning material randomly, without seeing connections, until they finally learn it. Sequential learners may not understand material completely, but they can almost always do something with it, because the pieces they have absorbed have logical connections. Global learners are able to solve complex problems quickly, but they may have difficulties to explain how they did it. Most of college courses are written in a sequential manner. Sequential learners could strengthen their global thinking skills if they relate new topics to the facts they already know. Global learners should realize that they need the big picture of a subject before they master details. New topics must be somehow related to familiar topics.

4. TESTING RESULTS

Students of BMU from Faculty of Information Technology and students University of Nis, Faculty of Medicine, took a part in this research. 40 students in total were included: 20 students from Faculty of Information technology from BMU (from Belgrade and Niš) and 20 students from University of Nis, Faculty of Medicine. To compare results, the same learning material will be given to students of similar educational profiles from Faculty of Medicine and from Faculty of Information technology.

Review of testing students from Faculty of Information Technology

To determinate his learning style, it is necessary that each student fulfill the questionnaire. This questionnaire is created by author of classification itself, and it can be found on website of NC State University. [9]

As we can see, questionnaire includes 44 questions. For each of the 44 questions below, they must select either "a" or "b" to indicate their answer. They must choose only one answer for each question. If both "a" and "b" seem to apply to them, they must choose the one that applies more frequently. Students answers should be gathered and scaled from 11 to 1 and from 1 to 11. If your result is between 1 and 3, you are well balanced on both dimensions of this if it is between 5 and 7, you have the advantage of one dimension of these scale, and you will easily learn in teaching environment which favored this dimension, if your result on scale is between 9 and 11, one dimension of the scale is favoured.. Overview of students scaling is presented in image 1.

Results are as follows:

- ACTIVE / REFLECTIVE - neutral,
- SENSING / INTUITIVE - weakly sensing,
- VISUAL / VEBAL - weakly visual,
- SEQUENTIAL / GLOBAL - weakly sequential

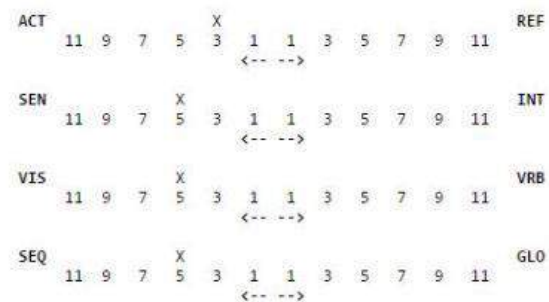


Image 1: Result - Scaling in the Felder-Silverman principle of classification

Put differently, student doesn't matter if he is working active or reflective, he adapts to it depending on situation. Results also prove that student is weakly sensing, which means that he prefer lectures with facts, clear methods, but if there are no facts, he will not have problem to check new possibilities for solving problems. Due to fact that student is weakly visual, it means that he can learn better by watching videos, diagrams, images. And he wouldn't have problem sometimes to learn without visual effects. In result where student is weakly sequential, we can say that he prefer learning in logical steps in which material in each step is more logic than in a previous one. This student can sometimes learn material "randomly". Presented student is a student of Software Engineering. Considering that goal is to adapt lectures connected to scientific areas represented on BMU, it is necessary to adapt lectures to student, according the result.

Lecture adapted to this student is:

- Lecture which can consist practical tasks inside of lesson, but doesn't have to
- Most part of lecture will be based on facts and presentations of possible solutions, and only one part will have types of tasks which solutions are not given in lecture. This is to force student to find solutions in similar situations (because he is weakly sensing).
- Lecture will comprise videos and diagrams because that is more appropriate to student
- Lecture will consist of linear steps and gradually learning (from intro to complex facts)

Subject chosen for lecture is from basis Ruby on Rails, because students on BMU haven't met this material yet. Student chosen to visit the same lecture is also Software Engineering student who has total opposite results on Felder-Silverman test:

- ACTIVE / REFLECTIVE - strongly reflective
- SENSING / INTUITIVE - weakly intuitive
- VISUAL / VEBAL - neutral,

- SEQUENTIAL / GLOBAL - weakly global

To create adaptive lessons, we used:

- Book - Learning Rails [10]
- Video - Ruby on Rails Tutorial [11]

Combination of book and video material, and tutorial for adoptive style learning, lectures were made with different content, which have for basis introduction in Ruby-programming. Time interval for this material was equal to 3 school-classes. After that, a test was given. The test given to students after lecture, can be seen on the following link [12]. Maximal result on test was 100 points. Student, after whom the lectures were adapted has result of 87 points, while student after whom lectures were not quite adapted has 74 points. According this principle, 10 groups were created, and each consist of a pair of students. None of chosen students has ever before met this lecturing material. This is related to students of Informational Technologies. It is important to say that all of chosen students has average marks over 8.5, which means that students of the same level were tested. They are all students on the 2nd and 3rd year basic studies Faculty of Information Technologies.

Students of Information Technology on BMU testing results

8 of 10 pairs that consist of a students to whom lectures were adapted, were with a better results.. Student I in each group is the student, at whose profile lectures is adapted. Results marked with star presents the deviation from expected - students with adapted lectures had poorly results, but students in group III have similar profiles so deviation is not unexpected.

This is the chart with abbreviations:

n-neutral, w - weakly, s - strongly, a - active, r - reflective, s - sensing, vi - visual, ve - verbal, s-sequential, g-global.

To get more representative results, it is desirable to create more groups and make another tests where, for example, groups will consist of more than two of students. . Because only 2 of 10 groups had unexpected results, conclusion is that student of Information Technologies to whom lectures are adapted, can make better results on control examinations.

Group	I	II	III	IV	V	VI	VII	VIII	IX	X
Student	I	II	III	IV	V	VI	VII	VIII	IX	X
1	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.
2	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.	ACT/REF SEN/INT W.S. VIS/VRB PW.VI SEQ/GLO W.S.
Result	87/74	77/70	73/79 (*)	88/75	79/76	90/77	85/89 (*)	77/72	77/73	86/74

Image 2: Table of results for tested BMU students

Testing presentation of Students of Medical College, University of Nis

During their education, Medical students have pre-clinical and clinical subjects. Teaching on Medical College consists of lectures, interactive seminars, and practical exercises. According to complexity and volume of lecturing material, creating of adaptive material is not applicable to all subjects. It is necessary to carefully choose a subject on which adaptation of lecturing unit will be made. Based on the content of lecturing subjects, we have concluded that is possible to apply adaptive learning on pre-clinical subjects, while in clinical subjects which demand interactive approach and contact with patients during practical work, it is feasible with limitations and deficiencies.

We chose for lecturing unit "Disorders in body fluids and hemodynamic" on College subject Pathology. Pathology is subject on 3rd year of Medical College, and volunteering group of students included in this research are students on 2nd year of Medical College This group of students shouldn't have problem with terminology during lessons, and also they have never before heard or read this lecturing unit. 20 volunteering students divided in 10 groups were tested. As BMU students, these students also have average marks over 8.5, which means that these two categories of students are similar. Time interval for this material was equal to 3 school-classes. After lecturing, students solved questions which related to topic.

Former students who had this subject during education on Medical College were included in realisation of lecturing and thereafter creating test-questions.

To create lectures and tests, the following material was used:

- 1.) Books: Pathology, 4th edition [13], General Pathology[14]
- 2.) Videos about oedema [15], dehydration, hyperthermia, Congestion, Deep Vein Thrombosis, Pulmonary embolism [16]...

Medical College students testing results

Testing results are presented in the same way as the testing results of BMU students. Unlike previous testing, 6 of 10 groups have expected results, as it were, students with adaptive lectures have better results. 4 groups have opposite results, and students with adapted lectures were better on testing. Results are presented on Image 3. Forasmuch that the Medical College student has different learning habits than student of Engineering Science, results are not unexpected.

Conclusion is that learning styles are not very helpful to Medical College students.

Group	I	II	III	IV	V	VI	VII	VIII	IX	X
Student										
1	ACT/REF FWA SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.F SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF W.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF N SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.F SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO
II	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.F SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF W.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF N SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.F SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO	ACT/REF S.B SEN/INT WJ VIS/VRB SEQ/GLO
Result	71/74 (*)	82/79	80/82 (*)	86/75	89/76	90/87	72/89 (*)	77/72	77/81 (*)	76/80 (*)

Image 3: Table of results for tested Medicine students

5. CONCLUSION

Some students tend to focus on fact, data and algorithms; others are more comfortable with theories and mathematical models. Some respond strongly to visual forms of information, like pictures, diagrams and schematics; others get more from verbal forms written and spoken explanations. Some prefer to learn actively and interactively, others functions more introspectively and individually. However, a prosperous student, scientist, or engineer, requires good resourcefulness in every learning style: they have to be methodological, thoughtful, innovative, curious and must be good interpreters. Also they have to develop visual and verbal skills. Information routinely comes in both forms, and much of it will be lost to someone who cannot function well in both of these modes.

If professors teach exclusively in a manner that favors their students' less preferred learning style modes, the students' discomfort level may be great enough to interfere with their learning. On the other hand, if professors teach exclusively in their students' preferred modes, the students may not develop the mental dexterity they need to reach their potential for achievement in school and as professionals.

In this paper it is shown that the success of using learning styles is primarily in the choosing of aim of research. Some fields of science are more suitable and easier for adaptation to learning style, and some of them are not. In this paper it is shown that at BMU, on Faculty of Informational technology, technology and classification can advance learning. Also, testing showed that learning styles are not adequate division for students of medicine, because there is no progress in learning. Except that, after testing students we got lower scores and lower connection successfulness of test with the adaptation by the style of learning. Of course, we suggest that it is necessary to test more students in purpose of getting exact results.

Our research has shown that it is only a question to what extent and on which university or school, this model of classification can be useful, because some field of science are not suitable for applying classification of students based on the styles of learning.

We can say that models that have been used effectively in engineering education.

ACKNOWLEDGMENT

This work was supported by Ministry of Education, Science and Technology (Project III44006).

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PERSPECTIVES AND CHALLENGES OF DISTRIBUTED VIRTUAL ENVIRONMENTS IN E-LEARNING

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Abstract *Developments in Information and Communication Technologies (ICT) have had great impact on higher education, particularly in new forms of distant learning. With ever increasing Internet connection speed and mobile broadband, multi-media content can be transmitted in real-time and with little delay. Consequently, E-learning systems have become more accessible for synchronous communication and collaboration. Nevertheless, problems continue to emerge, most notably in terms of user isolation. Strong potential in overcoming such problems can be seen in distributed virtual environments. Virtual reality (VR) systems and Virtual chat applications allow users to meet up in multi-user virtual environments and engage in real-time lectures or e-learning games. This paper presents our proposals for reconstruction and extension of the VR Social Environment “Tribes” for educational purposes, considering new interaction models from both technology and user-centered perspectives.*

Keywords: *virtual reality, usability, interactive learning environments, computer mediated communication*

1. INTRODUCTION

In this paper we will explore possible use of Virtual reality (VR) technology as a medium of human communication and how it could be used to support the existing e-learning platform of Belgrade Metropolitan University (BMU).

BMU has an e-learning system that supports chat, forums and Q&A, but nevertheless, online students still feel isolated as they don't have many options to meet each other. Most of the time they communicate with their lecturer via e-mail or schedule a Skype meeting one-on-one. Sometimes, they might meet their fellow colleagues on forums and discussion boards, but these forms are not encouraging them to build an online community. This is why we wanted to explore possibilities that offer commercial VR headsets and applications for smartphones. We wanted to see if they could be used in communication between students and lecturers and among themselves.

In cooperation with Belgrade based company *Digital Mind*, we have developed a use case scenario for the VR Social Environment, based on their VR mobile application named *Tribes* (working title). For the user interface (UI) model we used the existing sociable VR application *V-time*, property of *vTime Holdings Limited*.

The idea was to use a VR environment for group meetings in order to reduce feelings of isolation for distant learners, and also to engage them to build an online community and help lecturers use their time more efficiently.

2. VR TECHNOLOGY

3D VR Environments have existed for some time. Ivan Sutherland implemented the first VR system in 1968, using wire-frame graphics and a head-mounted display (HMD)[1]. Since then, various VR systems have been implemented and are widely used in military, engineering, trainings, flight simulations etc. Only recently have VR systems become commercially accessible.

In 2015, several companies announced mass production of affordable VR headsets (also called Head Mounted Displays – HMD), display devices, which are worn on the head with a display optic in front of the eyes. The most popular among them were the *HTC Vive* with optional hand controllers and *Oculus Rift*. These devices require support of computers with powerful processors and graphic cards in order to render immersive 3D graphics and 360 degree videos, while simultaneously tracking the motion of the user. During the same year, we were introduced to even more affordable mobile VR headsets - *Samsung Gear VR* and *Google Cardboard* viewer that can be combined with compatible smartphone devices. These two headsets are not compatible, and applications must be

developed separately. Google Cardboard is the most affordable simple VR viewer, and is made of cardboard with lenses that can be assembled from low-cost components using specifications published by Google. Alternatively, it can be purchased pre-manufactured.

3. KEY FEATURES OF VR ENVIRONMENTS

In terms of functionality, virtual reality can be defined as a simulation in which computer graphics are used to create a realistic-looking world that responds to the user's input in real-time, modifying the virtual world instantaneously [2]. This definition recognizes real-time interactivity as the key feature of VR environments.

In [3] were presented four key elements of VR: (1) physical and (2) mental immersion, (3) sensory feedback and (4) interactivity. The concept of *physical and mental immersion* can be also expressed through the term *sense of presence – the sensation of being in an environment*. *Sensory feedback* is based on the physical position of participants. Typical VR systems track the movement of the participant's head, along with an object held by hand. There are many VR technologies for tracking movement. The fourth element - *interactivity* - also appears in several forms: one of them is the ability to affect a computer-based world (for example in *Dungeon*, a classic text-based massive multiplayer online role playing game (MMORPG) worlds were rendered via text description typed by players, and computer graphics were not required). Another form of interactivity is the ability to change one's viewpoint and move physically within the virtual world.

Collaborative environment

The collaborative environment is an extension of the interactive element and refers to multiple users interacting in the same virtual space or simulation, and can be referred to as multi-presence or multi-participant [3]. One of the earliest online social networks, *Second Life* (launched by Linden Lab in 2003.) is a 3D virtual world where users interact via avatars (their virtual representations). They meet other residents, socialize, participate in individual and group activities, build, create, shop and trade virtual property and services with one another using virtual currency known as the Linden dollar (that can be exchanged for real currency). In [4] virtual worlds are defined as a combination of these elements: 1. synchrony: collaborative activities need synchronous communication, 2. persistence: a virtual world does not cease to function when users log off, 3. networked people: users interact with one another and/or with the environment, 4. avatar representation: any action taken by the user is actually presented as an action taken by the avatar, that is to say her/his digital representation, 5. networked computers: the required technical infrastructure.

Film Director Peter Greenaway gave a speech in *Second Life* on September 23, 2010, at the opening of the 48HFP Machinima film festival. He was represented by his 3D

avatar. At the end of his talk, there was room for some Q & A for the audience [5].

In *Second Life*, users see their avatars as a second person and they use a desktop interface. With VR headsets, users can have a camera point of view – a first person view, as if they were in the head of their avatar. Sometimes they can see their hands, if the motion tracking is provided by additional controllers or other tracking technology.



Image 1: Peter Greenaway's avatar gives a lecture in Second Life

4. SUPPORTING HUMAN COMMUNICATION

In Computer Mediated Communication (CMC) we distinguish synchronous and asynchronous communication, where synchronous is live and uninterrupted (audio, video chat, instant messaging, chat rooms), and in asynchronous, response time varies (e-mails, sms, weblogs). Some of the forms are more or less persistent since not all messages are logged, and we lose all the content when the dialog box is closed (for example, video chats are not logged in most applications).

A very important issue in CMC is the non-verbal part of human communication. Many CMC applications widely support the use of emoticons as a new means of online social communications. There are also technological challenges in CMC since the access to technology-based resources necessary for participating may be a challenge for some users. That is why it is necessary to prepare participants for CMC events via virtual tours and tutorials about technology and interfaces that will be used. They must be prepared for what they will experience in CMC. Misconceptions may result in participants falling behind and never recovering [6].

The main idea and the purpose of implementing the mobile VR application in the BMU online learning system is to facilitate group meetings (consultations) between online students and lecturers within VR environments on a weekly basis. Students would be able to present their work in a VR environment, ask questions and discuss certain topics with their lecturers and colleagues. These VR meetings would eventually reduce the number of one-on-one Skype meetings that students have with lecturers, and they would also reduce the number of e-mails that lecturers exchange with online students.

Conclusively, the goal of the VR app is to enhance communication between distant learners and to reduce their sense of isolation. This application is not aiming to introduce new forms of learning materials.

5. GATHERING REQUIREMENTS

There are several requirements we had to gather: requirements of the end users – students and lecturers and system requirements of the institution, BMU.

The application *Tribes* is meant to be an open social VR network, rendered using the VR Unity engine. Custom tailored solutions for business and education would also be available. In order to gather requirements for the implementation of *Tribes* in the BMU communication and learning system, we conducted user testing on existing VR chat apps. Participants were introduced to VR mobile technology in the laboratory, i.e. in the production studio, *Digital Mind (DM)*. The participants were six students and four lecturers.

In our research we used a Samsung Gear VR with a powerful smartphone - the Samsung Galaxy S7 Edge. The Samsung Gear VR headset includes a touchpad and back button on the side, a proximity sensor to detect when the headset is on, and an accelerometer and gyroscope to detect when users tilt or move their head. User interface is controlled by eyegaze, tapping and swiping on the touchpad or with additional controllers that can be connected via bluetooth. When using the headset it is favorable to stand up or use a swivel chair for a better 360 degree experience. Users also had earphones with microphones for verbal communication inside the VR chat rooms. We tested the VR chat applications *Vtime* and *AltSpace*, but ultimately decided to use *Vtime* as our UI model. These VR apps provide options to upload pictures, play videos or 360° images that can be displayed and shared with other participants.

Competencies of students and lecturers: Only a few students had prior experience in using this technology, but it was used for entertainment purposes - they played computer games and watched 360-video demonstrations. Other users had no prior experience in using VR technology. All users were introduced to the technology by a demonstrator, and they were encouraged to try the virtual tour of the Samsung VR Gear to learn how to navigate through VR space. After the presentation they got their task list.

Their task list was: to start the application on the smartphone, to attach the smartphone to the headset, to put on earphones, to enter the chat application, to create an account, to confirm an email (on the/their desktop or other mobile device with web access), to put the headset back on, to log in, create a username, to choose or create a custom avatar, enter a chat-room and participate in a conversation.

Students handled technology much easier and completed their tasks with more success. Everybody had difficulty with registration since eye gaze and the touch pad on the

side of headset are not designed for typing on a keyboard (users had to type in an e-mail address and their name in 3 input fields). That means that the GUI has to be simple and easy to use. Using a virtual keyboard for typing in this environment should be avoided or reduced to a minimum. Participants also found it useful to have web support of the app on the/their desktop (or other mobile device) so that they can check their status and profile online, after they finish the chat session, or before they put the headset on, as it is provided by *Vtime* chat on the web address vtime.net.

One of the four lecturers that participated in testing apps didn't feel comfortable with this technology and had a very negative attitude towards VR technology in general. Most of the participants felt uncomfortable speaking first in the chat-rooms and they needed encouragement to use the microphone and speak. It was very important for them to find the person (avatar) who would explain how things work once they were inside the VR environment. Furthermore, *Vtime* is public space, so they never knew who they would meet in the room. That resulted in additional fear and anxiety.

We believed that this anxiety would be reduced if they knew that the application is dedicated and tailored for their University. In the interviews after their first VR chat experience, they confirmed that they would feel more comfortable speaking in their mother language and if they knew that all users were part of the BMU community.

The concept and architecture of the application *Tribes* would be similar to *Vtime*. It would combine a desktop web application with a mobile VR application. The desktop application would also provide asynchronous CMC via message boards, so that users could discuss certain topics, upload media and send invites and messages to users on their list in order to schedule their meetings in a/the VR environment.

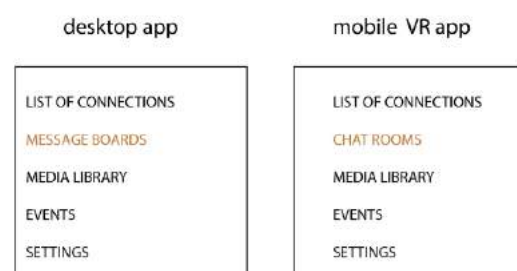


Image 2: Content proposal for the VR application

Security and media requirements

In order to implement the *Tribes* app in the BMU system, we had to collect more specific requirements. The first issue was concerning secure access to the mobile VR app. BMU has a database of students so that all login data could be automatically generated and sent to users via e-mail.

Users would be advised to change their passwords upon logging in.

In VR, users are represented by avatars which are usually custom built. In the BMU VR app, we should have avatars which look similar to the real people they represent – both lecturers and learners. This could be communicated as a recommendation for users in the tutorial. All users have their names floating above their head when they enter the VR chat-room.

The second issue concerns media sharing. When in chat rooms, students and lecturers should be able to share and present media files – such as images, presentations, videos, and PDF files. When wearing a headset, participants can't concentrate on text and reading, so the media should be more visually oriented.

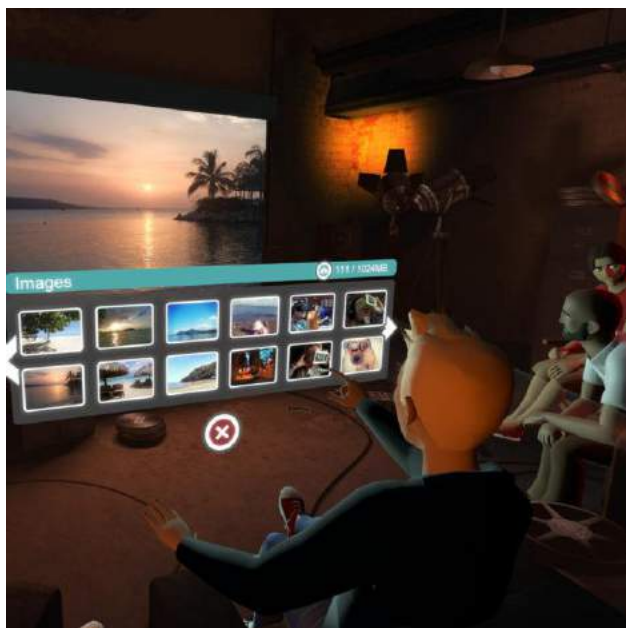


Image 3: Avatars sharing media files in the *Vtime*

Uploading images and media should be possible through a mobile device connected to a headset, but also via the desktop web app. Every user would have a unique media library that could be accessed from both platforms.

While testing the *Vtime* app, most participants successfully performed the task of uploading and sharing media.

There are also issues concerning client-server architecture. Most Distributed Virtual Environments (DVEs) broadly deployed today are online games with significant scalability limitations. For example, first person shooters are typically limited to between 8 and 16 mutually interacting players. MMORPGs blur this line, as *World of Warcraft* allows thousands of active avatars to share the same server, but in practice no more than a few hundred can gather within mutual interaction distance of each other without causing performance problems, or even crashing the server [7]. These desktop applications and mobile devices have additional issues due to Wi-Fi connectivity. The servers are responsible for connecting users to the environment and keeping all users

updated about any changes that occur [8]. In order to provide functional communication and smooth rendering of multimedia in a VR environment, chat rooms would be limited to 4-5 participants.

6. USE CASE SCENARIOS

Scenario 1, Student - First time log in

The student gets instructions and login parameters via e-mail. The student installs the application on his/her mobile device and connects it to the VR headset. Student logs in and watches the application tutorial. The student creates his/her avatar and goes to the display board to see who is online. The student clicks on the online connection and asks permission to join the chat room or invites other users to his/her room. When in the room, the student can start a verbal conversation with other participants, upload or share media.

Scenario 2, Lecturer- Experienced user

The lecturer gets a request via e-mail to schedule an online meeting in the VR chat-room. The lecturer logs in to the web application to set the time for the event. Students get a notification about the meeting time. The lecturer activates the mobile app and puts the headset on. He/She invites students or gets requests from students to join the chat room (maximum four students). They start conversation, upload and share media. When the meeting is over, the lecturer logs out. In this formal conversation, it is important to follow the communication conventions such as not to interrupt someone when they speak.

These two scenarios revealed to us that we should distinguish between student - user and lecturer-user, both with graphics and sets of permissions.

7. CONCLUSION

Although mobile VR headsets have become increasingly affordable, they are still not widely used and people should adjust to the idea of introducing VR environments in higher education institutions.

In this research, we gathered requirements for implementation of a VR chat application in the BMU learning system. Based on the literature review and laboratory tests that we conducted with target users, we concluded that participants need to be well prepared for the technology and interface they will be using. In order to achieve a satisfying security level and better user experience, VR applications should be connected with the BMU database of students and lecturers. Before creating server architecture and continuing with further implementation in BMU system architecture, we will test the beta version of *Tribes* chat and measure its usability effects. Acquiring VR equipment still requires serious investments both for the institution and its students, so we must be sure that the application will be efficient and effective.

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Извор: локална база података COBISS.SR/NBS

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

37.018.43:004.738.5(082)

371::004(082)

37.02(082)

INTERNATIONAL Conference on e-Learning eLearning (5 ; 2013 ; Beograd)
E-Learning 2016 : proceeding / The Seventh Internacional Conference on
E-Learning, Belgrade 29 - 30. September 2016. ; [editors Tanja Ćirić,
Slobodan Jovanović]. - Belgrade : Metropolitan University, 2016 (Kruševac
: Sigraf). - 166 str. : ilustr. ; 30 cm

Tiraž 80. - Napomene i bibliogrfske reference uz tekst. - Bibliografija uz
svaki rad.

ISBN 978-86-89755-09-1

a) Учење на даљину - Зборници b) Образовна технологија - Зборници c)
Информациона технологија - Образовање - Зборници d) Електронско учење
- Зборници
COBISS.SR-ID 226228748



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