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eLearning

11th International Conference on e-Learning 2020

11 th International Conference on e-Learning
@ Belgrade Metropolitan University, Belgrade, Serbia

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PROCEEDINGS

The Eleventh International Conference on e-Learning

eLearning

11th Conference on e-Learning 2020

Belgrade Metropolitan University

Belgrade, 24-25 September 2020.

www.metropolitan.ac.rs

Publisher

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

For Publisher

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The official language of the eLearning-2020 Conference is English. English will be used for all printed materials, presentations and discussion.

THE PROMISES AND PITFALLS OF PERSONALISED ELEARNING

ELIZABETH FITZGERALD

The Open University, UK, Institute of Educational Technology, elizabeth.fitzgerald@open.ac.uk

Abstract: *Personalised learning has been around for decades, and never really seems to diminish in its appeal. To educators, its attraction is obvious and logical: we all know that our students learn differently – at different times, different speeds, and respond differently to teaching materials and course resources. To learners, especially where they are part of a larger cohort of students and may become 'lost' in the crowd, having a personalised learning experience that is tailored to their individual needs and should help them to reach their specific goals, is very desirable.*

However, the field of personalised learning is not without its challenges. In this talk, we examine what is meant by personalised eLearning, how it is enacted but also the problems inherent to this work. We consider pedagogical, technical and economic issues as well as considering the wider impact, not just on teachers and students but also at an institutional and even governmental level.

Keywords: *Personalised eLearning, pedagogical issues, impact.*

1. INTRODUCTION

Personalised learning is not new. Educators can clearly recognise that students learn in different ways to each other: some prefer a summary of the work, then the detail, and others vice versa. Some claim to prefer visualisations or auditory media over written text (although most people are mostly visual [1]). The concept of learning styles as a personalisation mechanism is still an enduring and appealing notion although they have now been widely discredited by a number of educationalists and learning scientists [2, 3]. Leaving aside any issues relating to special educational needs, or issues such as dyslexia, what we know is that most of us learn best through a variety of different formats [4] and that effective teaching will incorporate a range of strategies to help each individual learner on a case-by-case basis.

However, with a growing number of online learners, it is useful to consider how personalised learning can be translated effectively into an online environment. Now more than ever, schools, colleges and universities across the world are engaging in online learning. There are also large cohorts of students learning on Massive Open Online Courses (MOOCs), Badged Open Courses (BOCs) and through Open Educational Resources (OERs). eLearning is thus likely to be experienced by millions of people over their lifetimes, across a range of formal and informal/non-formal educational settings. In the midst of all these other learners, it is easy to feel lost in the crowd. So how can provide tailored, personalised learning for every one of those learners, to help them feel looked after and help them feel motivated to achieve their goals?

2. PERSONALISED ELEARNING: WHAT, WHEN, HOW?

Few frameworks exist that suggest how personalisation can occur in solely eLearning environments, as much published work into personalised learning examines face-to-face settings, particularly in the classroom and with a focus on learners under the age of 18 [5, 6]. However, Martinez [7] gives an example through five different dimensions of how personalisation can occur in online environments. She proposes:

- name recognition;
- self-described personalisation (allowing learners to describe their own preferences and attributes, including through quizzes or questionnaires);
- segmented personalisation (putting learners into groups based on common characteristics such as job title or level of learning);
- cognitive-based personalisation (using information about cognitive processes, strategies and abilities to deliver content aimed at specific learner types); and
- whole-person personalisation (this takes into account many factors including learning orientation and psychological aspects of the

learner that feed into a dynamically-updated learner model, which in turn interacts constantly with the system).

Whilst a welcome first step into describing how learning can be personalised through online experiences, these dimensions are somewhat limited as they mostly just consider the individual rather than the complex and rich environment in which learning takes place. Factors such as peers, teachers, modes of learning, who controls the personalisation and how/when it is done – these are all crucial aspects to consider when designing personalised eLearning.

To overcome these limitations of the work by Martinez, my colleagues and I put together a framework for modelling dimensions of personalisation in eLearning [5]. This was done through careful scrutiny and conceptual analysis of the published literature of personalisation in eLearning throughout in the last decade. Our grounded approach expanded Martinez's model into six dimensions:

- What is being personalised
- The type of learning where personalisation occurs
- What personal characteristics of the learner may be addressed
- Who/what is doing the personalisation
- How is personalisation carried out
- The impact/beneficiaries of the personalisation

These dimensions were formed from the case studies in the literature, and can be used as both an evaluation framework and also a design framework for considering future eLearning experiences. These dimensions are considered next.

What is being personalised

What teaching and learning resources/taught content can be personalised? This can be done by the learner or made more prescriptive by an external body e.g. examination board syllabus etc.

Type of learning

We referred to formal, non-formal and informal education, where there are differences in who is control of the learning and where/how it occurs.

Personal characteristics of the learner

Here we consider what aspects of the learner can be used to provide personalisation towards. Examples include demographic information, existing knowledge/skill level and learner interests/relevance to learner practice.

Who/what is doing the personalisation

For this aspect, it may be automated – the software carrying out the personalisation based on an algorithm – but otherwise this would be teachers, peers or possibly the learner themselves.

How is personalisation carried out

Under this aspect, we refer back to the aspects identified by Martinez [7], in an increasing level of sophistication, including name recognition, cognitive-based and whole-person recognition.

Impact/beneficiaries

A number of beneficiaries need to be considered, from the learners themselves (micro level), through organisations/institutions (meso level) right up to government and policymaker level (macro level). Other key stakeholders may include commercial entities such as software developers, and particularly those companies who provide educational software and platforms. The concept of micro, meso and macro level beneficiaries is further explored in [8].

Examples of how these dimensions have been used to evaluate existing case studies of eLearning, including adaptive assessment, personalised books and learning analytics can be found in [5].

3. THE BENEFITS

'All learning is social' is a well-used phrase within education, and certainly personalised learning is underpinned by important cognitive and socio-constructivist principles [9, 10]. It might also be said that "all learning is personal", as it is critical to consider how personalisation relates to the individual learner, and how it can affect their learning experience.

Studies have shown that personalisation can provide greater learner agency and increased motivation [11], as learners feel that they are being given special treatment to help them learn more effectively, instead of being just part of a large crowd where 'one size fits all'. It can also produce increased ownership in terms of an individual's learning and greater relevance to their everyday activities and goals [12]. In one study, it was found that personalised assessments were regarded as more effective [13]. These benefits can, in turn, lead to improved rates in student satisfaction and retention, both of which are prevailing issues across many universities today [8]. The offer of personalised learning might also help justify any increases in tuition fees, which have been seen across many Higher Education Institutions in the UK in recent years.

However, the notion of personalised eLearning is not without its problems.

4. THE CHALLENGES

There are a number of issues in terms of how personalised eLearning is provided and even why it should be provided in the first place.

Personalised eLearning enables content and resources to be provided in a supposedly 'optimal' way to learners. Whilst this may be a really good way for learners to gain new understanding, particularly for difficult and/or new concepts, the 'real world' isn't like this and will not necessarily be as accommodating to them throughout life. It is better for learners to be able to develop compensatory skills when provided with material that is not delivered in a particular preferred mode, and indeed a lack of this ability to compensate, may well cause problems for learners further in their educational journey [14].

In addition to this, learning preferences – however they are measured – are not fixed [1] and often change according to the learner's environment (including physical, technical and socio-cultural aspects). Learners need human-directed input rather than be at the mercy of a software algorithm or an automated process – otherwise we risk de-personalising the learning and losing the valuable social contact (from both peers and teachers) that is key to essential learning [14].

With a growing investment of venture capitalists such as Google and Facebook into personalised learning, there is also the concern that profit will be of greater importance than pedagogy in terms of how these products are designed and offered [14]. However, in order to engage with these products, schools must have supportive staff (at all levels), the necessary budget and an IT infrastructure/network that is capable of supporting such solutions [15]. Personalised eLearning may suggest that individual devices need to be used (e.g. tablet computers) which can drive costs even higher. Even if sufficient devices are available, the software or algorithm used in the platform may 'lock' learners in to particular profiles or groupings, rather than dynamically update their profile [2], thus providing taught material that is less suited to the learner as their needs will have changed and they thus require different materials.

Additional costs can also creep in as a result of having to prepare course materials in different ways to accommodate different learner profiles [8]. Cheaper/free Open Educational Resources could be used instead, but these rarely offer personalised learning [15].

Lastly, there is the potential misuse of student data that is used to generate whatever personalisation occurs – who has this data, who has access to it, how is it used? This is becoming an increasing worry, particularly around ownership, ethics, privacy and commercial value of student data [15, 16]. Student dashboards and learning analytics are fast becoming tools not only for positive, but also negative learner engagement [17].

5. THE WIDER IMPACT OF THIS WORK

In the current climate of the global COVID-19 pandemic, many more educational institutions are turning to eLearning as a short – or even long – term solution to enabling the provision of education to its students. The skills and knowledge to be able to teach online effectively are more important than ever, and it is not just first-world countries who are interested in this. A recent Rapid Evidence Review by Major and Francis [18] provides an overview of existing research on the use of technology to support personalised learning in low- and middle-income countries (LMICs). This report was produced in response to mass school shutdown as a result of COVID-19 and is intended to inform educational decision makers, including donors and those in government and NGOs, about the potential for personalised eLearning in LMICs and to yield meaningful policy implications. Twenty-four studies (across twelve countries) published since 2006 were analysed and the report is structured into four themes, with key findings and recommendations as follows:

- Technology-supported personalised learning appears to offer significant promise to improve learning outcomes, including potentially 'out-of-class' and 'out-of-school' learning.
- The adaptive nature of technology-supported personalised learning to 'teach at the right level' is key as it enables students to learn at their own pace and according to their current proficiency.
- Technology-supported personalised learning may be most beneficial in closing educational gaps for lower attaining students, potentially including those returning to school after an absence.
- Any introduction of personalised learning technology should not be interpreted as decreasing the importance of the teacher, but rather enhancing it.
- Implications for cost and infrastructure are unclear, but using existing hardware solutions is likely to help to reduce costs and increase access.

It is clear from this report that there is great potential for personalised eLearning in LMICs although the authors of that review admit that this work is in its infancy. However, this critical and timely analysis adds to the weight of evidence to support personalised eLearning for school-age learners in LMICs.

6. CONCLUSION

With an ever-growing number of online learners, it is critical to find ways in which learning can be made individual and personalised. This paper has examined the ways in which personalised eLearning can be designed or evaluated, via a framework of six different dimensions. It is clear that personalised eLearning is a contentious field, full of false promises and challenges, many of which have yet to be resolved. However, the potential advantages of personalised learning, when done appropriately, are attractive to a wide variety of stakeholders at different levels, not least of all the learners themselves.

With an ever-growing number of online learners, personalisation looks to be an ongoing concern for many educationalists in the years to come. Over time, I would hope that the pitfalls relating to this work can be reduced or eliminated, and there will be promises of more effective learning, more satisfied students who are achieving or even exceeding their goals, overseen by knowledgeable and innovative educators who have maybe taken an evidence-based leap into personalised eLearning.

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DYNAMIC CLIPS-BASED EXPERT SYSTEM TO SUPPORT PERSONALIZED LEARNING PROCESS

NEBOJŠA GAVRILOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, nebojsa.gavrilovic@metropolitan.ac.rs

DRAGAN DOMAZET

Belgrade Metropolitan University, Faculty of Information Technologies, dragan.domazet@metropolitan.ac.rs

Abstract: *Expert systems use human knowledge to solve problems that require a high degree of intelligence. Expert systems are often used in medicine to diagnose a patient's disease or in the industry to support the execution of certain processes. Such systems use expert knowledge in a particular domain as a mathematical model or as a set of rules that affect an algorithm that solves a specific problem. During the development of an expert system, it is necessary to clearly define the facts, rules, and actions that affect the operation of the system and to design in detail an algorithm that solves the specific problem for which the system is being developed. The primary goal of this paper is to analyse literature and present the process of designing an expert system, to present the software architecture of the system within which the expert system is a component and a concrete example of the use of rules that provide specific teaching material for each student. CLIPS (C Language Integrated Production System), developed by NASA's Johnson Space Center, will be used as the rule-based programming language.*

Keywords: *Expert systems, Distance learning, learning process, learning objects*

1. INTRODUCTION

Belgrade Metropolitan University (BMU) uses fine-grained learning objects (LOs) for developing teaching materials for all courses. Learning objects are stored in a special repository of learning objects that allows searching, downloading, modifying teaching materials and presentation to students by LAMS (Learning Activities Management System) [1]. The authors create teaching materials in the form of LOs using the mDita editor (authoring tool) developed by the BMU development center. Using the above editor, the authors of the teaching material can also add LAMS additional activities for testing knowledge and student assessment.

Such a set way of creating teaching material enables the development of various software components that can be directly related to the LOs repository and combine LOs into learning processes of different levels, content, specific only to a particular student. One of them may be the expert system that will be the subject of this paper. An expert system is a program that is specifically intended to model human expertise or knowledge [1]. The expert system can, within the software architecture of the system, be positioned between the LOs and LMS repositories in order to perform scheduling through a defined algorithm LOs.
Defined research questions within this paper are:

Research question 1: In what way, within the review of available literature, is the application of expert systems in elearning performed?

Research question 2: How is it possible to apply the CLIPS-based expert system as a software component within the current BMU elearning system?

The second chapter of this paper presents an analysis of selected papers in which the application of expert systems in the field of elearning is performed, as well as the specific application of CLIPS expert systems. The third chapter shows the positioning of the expert system component within the current BMU elearning system and the fourth chapter the process of generating basic and specific teaching material for students. The fifth chapter describes the process of defining the rules in the expert system, while the sixth chapter shows the integration of the CLIPS component of the expert system with other components of the BMU elearning system with an example of implementation. Chapter seven presents the conclusion.

2. BACKGROUND

Expert systems are computer programs that originate from the branch of artificial intelligence in the field of computer science research. Research involves understanding the application of intelligence in the development of computers that should simulate intelligent behavior [2]. These systems should use the concepts and methods of symbolic inference and self-locking computer (software). Knowledge is almost incomplete and uncertain and as such must be related to the weight factor. Applying a set of methods to use incomplete knowledge is called reasoning with uncertainty. An important subclass of the reasoning method is "fuzzy logic", and systems that use this logic are called unclear systems or "fuzzy" systems [2].

The inference machine is a program that locates the appropriate knowledge within the knowledge base and enables new knowledge by applying logical processing and problem-solving strategies. The development of an expert system using shells brings various advantages. Expert systems can be built to perform a specific single task by entering into the shell all the necessary knowledge about the domain of the task to be solved. In this case, the reasoning machine applies the knowledge to a specific task embedded in the shell [2]

Figure 1 shows the software architecture of an expert system. The Data Support module contains four types of data: user information, learning behavior, resource information, and resource evaluation. In addition to the above module, the software architecture of the system also includes:

- User database contains personal data of users, registration and other relevant data obtained by data mining (interests, learning patterns, preferences for learning resources). The system implies the most accurate records of personal data of users.
- The learning behavior database allows you to record student behavior during the learning process. Behavior refers to downloading, reading, collecting, and evaluating learning content or resources. The referral system analyzes students' preferences (through monitoring and recording) and records them in a database.
- The teaching materials database stores various information related to learning resources (content) including course descriptions, exam questions, additional literature.
- The resource assessment database stores student reviews or assessments of the learning resources the student has gone through. The database provides master data for a collaborative filtering algorithm that generates learning recommendations for students by analyzing resource assessment data and calculating similarities between users or resources.

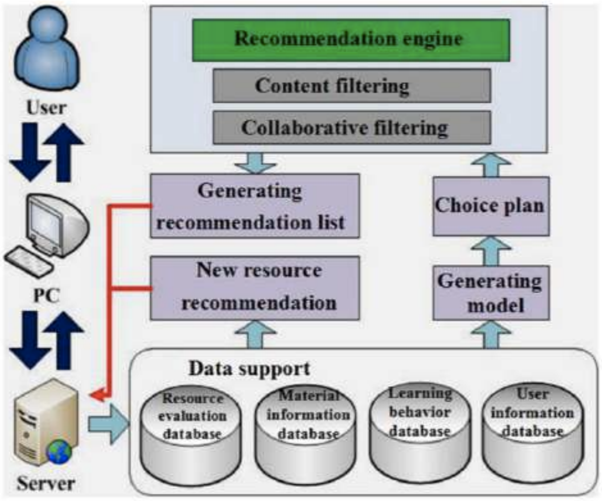

Figure 1: Components of the software architecture of an expert system [3]

"Recommendation engine" is the basic module of the system as well as the center for the implementation of personalized recommendations for learning resources. The four basic steps that take place within this module are:

- downloading the database and forming a matrix of user resource evaluation
- calculation of deficiencies in the obtained data
- algorithmic correction of the obtained values (cold start or incorrect content filtering)
- finding users with similar preferences and ways of learning, generating learning processes

The resource recommendation module allows you to solve cold start problems. Performs analysis of interests, hobbies, professions of students in order to recommend the latest content within the relevant areas. If the content has not been previously rated, it is not possible to find a list of recommendations. Student activities are collected from all devices and with the help of various technologies, the initial definition of recommendations is performed, and after the first feedback from users, each subsequent one.

The interests that the student can bring in (science and technology, management, better life) enable the system to make a recommendation of a course such as "Technology and Culture". The recommendations are based on linking data from students' self-reporting and their activities. Students need the help of artificial intelligence and expert systems to find and select resources according to their individual interests and needs [3].

C Language Integrated Production System (CLIPS)

An expert system can also be developed using three diagnostic algorithms based on the rules of the CLIPS system [4]. For the purposes of the research, an expert system consisting of 63 rules was created. The web environment chosen for the implementation of the expert system is AMP (Apache, MySQL and PHP), the rules are defined through CLIPS and based on algorithms [4].

Positioning the expert system as a software component within the system allows the expert system to obtain information about the student from the distance learning system and to select the teaching material from the repository of learning objects based on the information obtained in this way. Basic information about the student, his habits, the results of the knowledge test and the decisions that the student makes during the learning process are stored within the student model [5].

Software (expert system) for defining the schedule of lectures on one course can be developed using only rules or only functions or only objects. It is recommended that there is always a combination of rules and objects that are affected by the defined rules.

The four-layer system framework (system for defining the schedule of lectures on courses), the level of presentation allows data manipulation (courses, teachers, classrooms, time intervals as desired and time intervals for exemption) using a web browser. The data control level receives requests from the client side and controls the flow within the system. The business logic level allows application software to receive system messages from a web server and access a database on a database server. Scheduling rules and domain knowledge are defined through the knowledge base. Within the planning process, the stored data from the database needs to be translated into facts that are loaded into working memory. Matching facts and rules uses a reasoning mechanism that sets the solution based on rules and knowledge from the domain. The obtained results are stored in a database and displayed on a web page. The expert system is used to place knowledge in a scheduling system and provides the ability to deduce knowledge. In this case, CLIPS is a productive tool for an expert development and delivery system. The system's web pages were developed using JSP (Java Servlet Pages) and Java. JCLIPS is used for communication between the Java part of the system and the CLIPS language. Scheduling rules and knowledge from the domain are defined within the CLIPS rules and are stored in the knowledge base. These rules allow a combination with existing facts in order to find a feasible solution while the inference mechanism concludes by deciding which rules are satisfied by certain facts. Supporting changes within the expert system is possible through the allocation of knowledge base, facts and inference mechanism. If there are changes in the requirements, it is possible to modify certain rules in the knowledge base and changes in the data require modification of the facts. In an expert system, facts change by entering new facts through web pages into a database. Newly entered data can then be automatically translated into CLIPS facts in working memory. Knowledge engineers can add or change appropriate rules if requirements change. Also, it is necessary that in that case the mechanism of inference remains independent of the actual rules and facts and thus remains unchanged while the rules and facts change [5].

The priority of the rules within the expert system must be adopted in order to properly define the possibility of restrictions. First, the rules are executed with greater prominence. Possible limitations within the system must be defined as rules of the expert system. Clients enter data through a web page, the data is stored in an Oracle database and the server translates into CLIPS facts. The locking mechanism can automatically execute the locking and achieve a feasible solution for the constraint network [5]. Construction of an expert system (in this case to define the course schedule):

- Instructor requirements and available resources (classrooms, computers) are turned into facts
- Expertise (hard and soft constraints) has been turned into rules
- The inference mechanism as a result should allow for a feasible schedule in accordance with facts and rules

The rules can be divided into three different guidelines. The first guideline sorts and divides the rules into clusters according to their values. Thus, the values in one cluster can be higher and the values lower in the other. The second partitioning policy allows each cluster of a rule to satisfy a self-control property (allows none to be properly replicated to other different clusters within which the action does not require the existence of that rule for inference). The third guideline enables the division of rules according to priorities (lowest and highest priorities). The inference process is defined using CLIPS as if-then-else in algorithmic languages [5].

The ability to generate rules within the CLIPS expert on-the-job learning system based on user input parameters is the basis for frequent rule changes and modifications. Experts from specific domains enter their experiences related to a specific task, the agent within the system encodes and parses them into a machine-readable file. The embedded part within the system (logical editor) transfers descriptions (experiences) from the file and generates rules that can be used as a basis for building a rule database. The knowledge base (rules) refers to the rules based on the source from which the knowledge was transferred. Also, within the system, it is possible to define a component that analyzes information so that it is readable by the machine and the average user.

The machine-readable language coding agent component converts human knowledge into XML files (using objects and metadata) in order to constrain the XML schema. Improving the accuracy of the system is possible through the development of a translation algorithm, so that agents can perform operations using it.The process of defining and transferring knowledge within an expert system is shown in Figure 2. The logical editor within the system uses XML to define self-descriptive, self-determining rules where human language is converted into machine-readable syntax. In order for the CLIPS structure to be supported, it is necessary to define an XLS template. The organizational knowledge base contains the source and transfers information based on the rules for knowledge transfer with the possible exchange of knowledge through the system. The aim of the system is to enable the conclusion of adaptive rules that enable effective learning in the workplace (an example could be medicine where additional clinical information from a fellow doctor can improve the training and learning of a specific topic).

Application of an expert system for workplace learning

An expert system for workplace learning is defined by [6]:

1. Hybrid semantic techniques and artificial intelligence - the algorithm enables the translation of semantic coding into human-readable or machine language.

2. Integration of organizational management guidelines - the organizational knowledge base integrates the knowledge of related experts who know the domain of knowledge. Integrated knowledge provides feedback to the agent system and defines the rules of knowledge. The advantages are: accuracy in achieving goals, efficiency in performing tasks and creating common knowledge.

3. Real-time data download - agents can provide users with the necessary feedback to help them learn

4. Data transfer from multiple platforms - integration with various platforms is possible according to the XML language for input data

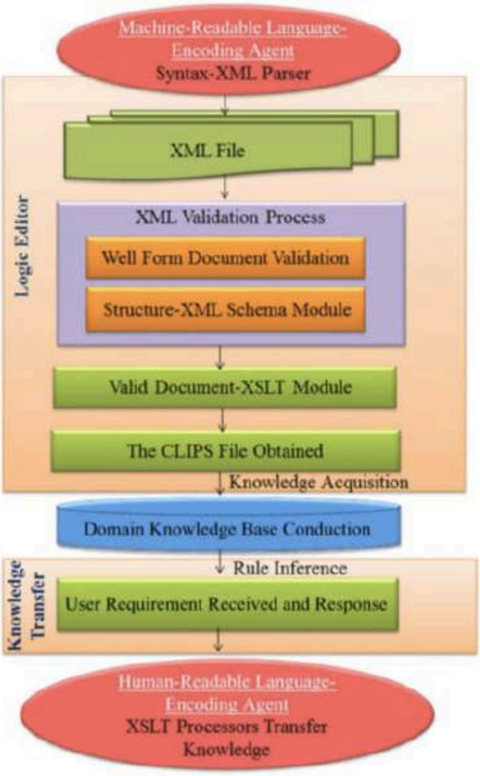

Figure 2: Example of generating expert system rules using CLIPS language [6]

The approach of expert system development can be oriented for domain experts and analysts whose knowledge enables the development of two information models: CIM (computation-independent model in the form of an ontology) and PIM (platform-independent model, defined by a set of rules). The application of the MDD (Model Driven Design) approach enables the application of the mentioned information models as the main objects. Also, by applying this approach, it is possible to:

- Define the model as a key object in the software development process and present the model as a formal specification of the function, structure and behavior of the system in a particular context.

- The software development process involves the transformation of models from more abstract to less abstract

The context of the development of rule-based expert systems implies the application of the MDA (Model Drive Architecture) version of the said MDD model. Set on a four-layer metamodeling architecture, it contains layers:

- Meta-metamodel layer M3 - the highest layer that defines the abstract language for the specification of the complete metamodel (metamodel is the basis for defining any modeling language, such as UML)

- Metamodel layer M2 - is the top layer that describes the modeling language and relationships within the model. All models are on this layer

- Model layer M1 - the bottom layer that describes any subject area (say software). All concepts of previously developed models are on this layer
- Actual layer M0 - the lowest layer that defines the different objects of the real world

With different types of transformation, it is possible to translate a previously created model into text or rules that can be applied at the level of the expert system. In this way, the author of the teaching material can use different models for creating rules without having advanced knowledge of software development or specific rules [7]. The rules, after transformation from the model, can be converted to the CLIPS language. The application of visual modeling requires the extension: "Rule Visual Modeling Language" which is an extension of the UML language for this type of modeling.

RVML enables:

- Use of separate graphical elements to represent all elements of logical rules (without stereotypes or classes as in UML language)
- Assigning subjective probabilities to the facts and rules of the expert system
- Display types of logical rule actions (modify, add, delete, stop)
- Based on the above steps, the final diagram of rule creation through different models looks like in Figure 3.

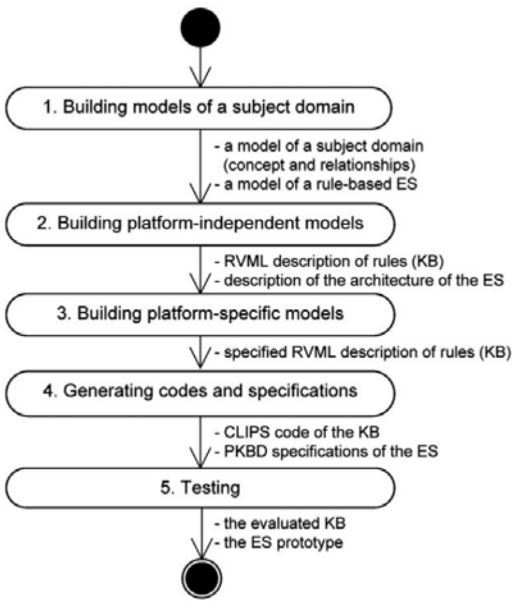

Figure 3: Basic steps in the process of creating expert system rules [7]

3. EXPERT SYSTEMS

Positioning the expert system as a software component within the current BMU system allows the expert system to obtain student information from the current LMS and to select teaching material from the LOs repository based on the information thus obtained. Basic information about the student, his habits, the results of the knowledge test and the decisions that the student makes during the learning process are stored within the student model.

To begin with, the role of the expert system is to take information about the student from the student model, apply facts, rules, and actions, and to define specific teaching material according to the student's needs. The CLIPS rule-based language and tool (which includes an integrated editor for writing program code and a debugging tool) will be used as an expert system [2]. CLIPS word shell is used for the part of the expert system that performs reasoning and contains basic elements such as:

1. fact-list, and instance-list: Global memory for data
2. knowledge-base: Contains all the rules, the rule-base
3. inference engine: Controls overall execution of rules

The inference engine concludes which rule should be executed and at what point.

Three ways of presenting knowledge within the CLIPS expert system are:

- Rules, which are primarily intended for heuristic knowledge based on experience.
- Deffunctions and generic functions, which are primarily intended for procedural knowledge.
- Object-oriented programming, also primarily intended for procedural knowledge.

Software (expert system) can be developed using only rules or only def functions or only objects. It is recommended that there is always a combination of rules and objects that are affected by the defined rules. CLIPS (C Language Integrated Production System) is designed to allow integration with C and Java programming languages. The advantage of CLIPS is that it can be called from a procedural language, perform its function, and then return control back to the calling program.

In this way CLIPS can be integrated with the current BMU system, LAMS displays LOs located in the LOs repository while CLIPS as a component located between the repository and LAMS groups LOs and creates a learning process for a specific student in the system. The application of CLIPS is also possible in another way, where the procedural code is defined as an external function and is called by CLIPS and when the execution of the external code is completed, the control returns to CLIPS.

Figure 4 shows the communication method between the LAMS and the expert system. By going through the teaching materials, students send the facts to the expert system, the system processes them and sends back the expertise in certain learning processes for the students. Within the expert system, two components of inference and knowledge base are presented.

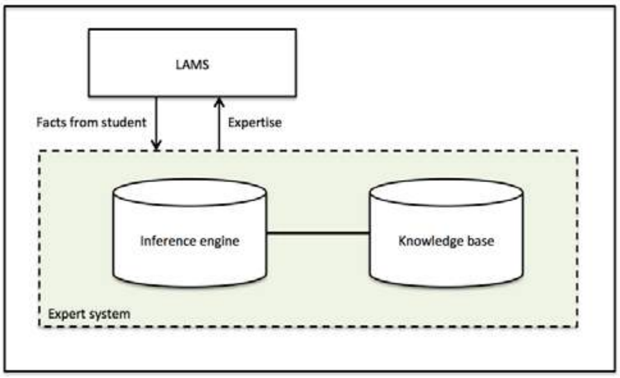

Figure 4: Positioning the expert system component in the current BMU system

4. PROCESS OF GENERATING BASIC AND SPECIFIC LEARNING MATERIALS

Figure 5 shows a list of teaching materials for different levels of student knowledge (A, B and C). The formation of teaching materials for different levels of knowledge is created independently beside the expert system and the author of the teaching material can manually create three versions for each lesson. During the creation of the teaching material, the author uses the syllabus and the body of knowledge.

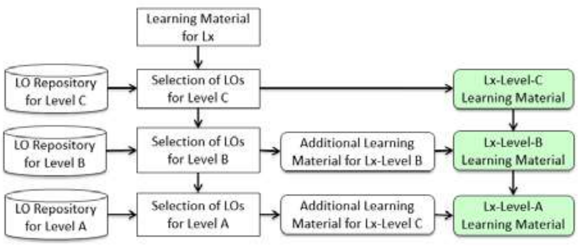

Figure 5: Development of learning materials for lesson Lx at levels A, B and C (basic) by an author

Another option available to the author of the teaching material is to use the software tool mDita editor through which, based on version C of the teaching material, he would add learning objects for B and A versions of the teaching material (or adding sections in learning objects according to a certain level). In that way, the author of the teaching material creates three versions of the teaching material according to the level of knowledge.

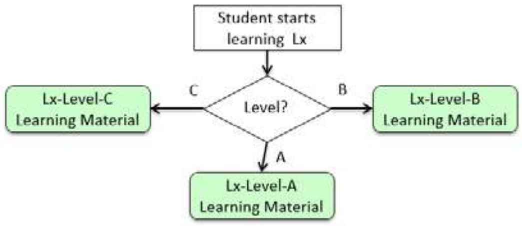

Figure 6: Use of learning material of lesson Lx at level A, B or C by a student

Figure 6 shows how the student, during learning, chooses the version of the lesson to use (A, B or C level).

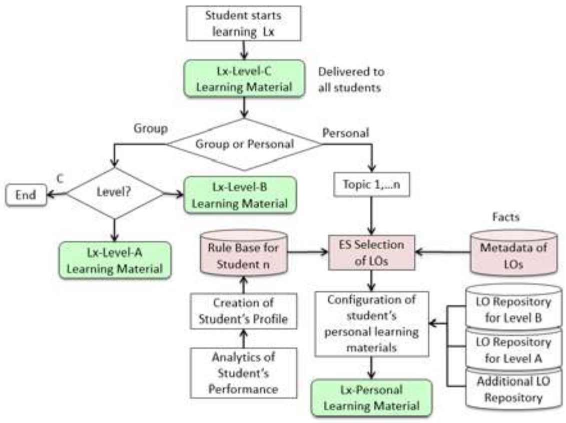

Figure 7: Grouping and personalization of learning material using expert systems

The student, in addition to choosing three different levels of teaching material for one lesson (figure 7), can also choose the fourth option, which includes personalized additional material (after the obligatory passage through the C version of the teaching material).

Metadata and identifiers of learning objects represent facts defined within the expert system. Metadata for versions A and B of the lesson can be supplemented with metadata of additional materials to read a specific topic covered in the lesson. For each lesson, according to the plan and program, the main topics that need to be covered are defined (from 1 to n). For each topic within the lesson, the reasoning machine within the expert system uses rules and facts to select learning objects (based on the ID and metadata of the learning object) that should be placed in additional teaching materials. The process is repeated for each topic, until the last topic defined in the lesson plan.

The facts within the expert system are: learning object metadata, lesson metadata, metadata of additional material for a certain topic.

Rules within the expert system are generated from the student model. The student model is obtained by analyzing the achieved student results and additional information obtained through an interview, questionnaire or directly from the professor and course assistant. It is necessary to determine whether the student reads the text of the lecture or uses demonstration examples (pictures, program code) or video and audio materials. The set of rules must be as dynamic as the student model and must be generated on a weekly basis and can also be fixed and does not have to be changed. The set of rules must cover a certain level of the student, his ambition for a certain grade, defined study programs and the curriculum of the course.

The system can be further improved by generating rules from students' grades in other subjects, the achieved level of knowledge or monitoring students in other subjects from week to week.

5. SETTING RULES FOR LEARNING MATERIAL

As already emphasized, the facts and rules of the expert system will be defined as:

Facts: metadata of learning objects; identifiers of learning objects; lesson metadata; metadata of additional materials for reading a certain topic that is covered in level A and B lessons; main topics of the lesson based on the curriculum (from 1 to n);

Rules: generated data from the student model (analysis of student results, additional information through interviews, questionnaires, from the professor or assistant), information (whether the student reads lectures, uses pictures, program code, video, audio material);

Facts examples - LOs:

1. LO "Design process" belongs to the topic General Design Concepts (fact based on body of knowledge)
2. LO "Design process" is classified in advanced level. (fact based on LO metadata)
3. LO "Design process" has a duration of 35 minutes (fact based on LO metadata)
4. LO "Design process" has defined keywords design, processes, design phases, solution model (fact based on LO metadata)
5. LO "Roles of project activities" belongs to the topic General Design Concepts (fact based on body of knowledge)
6. LO "Roles of project activities" is classified in the middle level. (fact based on LO metadata)
7. The document "From Design Concepts to Design Descriptions. Pdf" presents additional material for the topic "General Design Concepts"

Facts at the level of body of knowledge and LOs can be automatically downloaded from the LOs repository (based on the body of knowledge used and LOs metadata) and it is also possible to further improve the current metadata with new ones.

The CLIPS expert system combines defined facts and rules and enables greater freedom and flexible learning processes for each specific student. With such detailed rules, learning process can be created from a single topic, knowledge area or knowledge unit of the used body of knowledge without restrictions to be at the lesson level.

6. IMPLEMENTATION OF CLIPS EXPERT SYSTEM

The simulation of the CLIPS expert system for the purposes of this paper will be performed by interaction between the student and the system (through questions and answers YES/NO) and initiated through the CLIPS IDE. Real implementation in the BMU system will be performed using feedback from students from LAMS and information obtained from the LOs repository (instead of manually entered responses in the CLIPS IDE in the simulation). Two topics were chosen for the demonstration example due to the complexity of the code (presentation of decision-making and student returns). The learning process continues by moving from one LOs to another, or to aditional material and can last as long as the student wants to go through the teaching materials.

CLIPS IDE settings:

The student comes to the expert system from the obligatory C level within which he has passed through all the necessary basic level learning objects of a certain learning process in the LMS.

The example within this paper includes defined facts, rules and defined questions on the basis of which the expert system (answers to questions represent a simulated student model) performs actions and guides the student through the adaptive learning process.

Within the C level, from when he came to the expert system, he read the learning object "General Design Concepts" basic level, which belongs to the first topic of the learning process.

Based on that, the first question a student gets when accessing the system is:

Question 1: "Did you use additional video material to learn General Design Concepts?".

- The student can answer with "Yes" or "No".

The system records the student's answer and displays the second question:

Question 2: "Did you need additional material to learn General Design Concepts?".

- If the student answers the first two questions with "Yes", he will receive additional PDF teaching material on the specified topic and the message "You should read" From Design Concepts to Design Descriptions.pdf ".
- If the student answers the first question with "No" and the second with "Yes", the system asks the student for additional information with the following question:

Question 3: "Do you know how to apply general design concepts?".

- The student's answer "Yes" to the question gives the system information that the student has the ambition for a higher grade and should take additional information from the student through the following question:

Question 4: "Do you know how to draw a class diagram and generate program code from it?"

The student's answer "No" means that the student does not have enough knowledge for the advanced level, and he should be given a middle level learning object to determine his knowledge (in the example the message "Learn from middle level learning object" is written).

If the student answers the question with "Yes", it is necessary to show him additional examples of the class diagram and the generated program code and thus enable the student to learn from the additional teaching materials of the mentioned topic.

The conclusion of the system when the student answers the first offered question with "Yes" and the second with "No" is that the student needs to be given a learning object "General design concept" middle level and in our case it is a learning object "Roles of project activities". The student came from the basic learning process of level C, does not want an advanced level and therefore it is necessary for the system to display the learning object middle level.

If the student answers the first two questions with "No", the system concludes that the student does not have enough knowledge and shows him the learning object "General design concept" basic level.

By combining different answers (which simulate different data obtained from the student model) it is possible to connect the student with teaching material adapted to his level of learning and ambitions on a specific topic. Using CLIPS, it is possible to define a number of combinations of facts and rules that will give the student learning objects adapted to his level of knowledge and learning style. For example, within this paper, six different rules were used that simulate information from the student model. Also, it is always possible to define an action in the form of requesting additional information from the student or showing the learning object after the conclusion has been made.

Entering rules within the CLIPS is shown in Figure 8.

Figure 8: Example of writing rules in CLIPS

The outputs from the expert system (CLIPS IDE 6.3) in the form of allocating LOs for a specific student is shown in Figure 9. Based on the information from the student, studentu se prikazuje personalizovani nastavni materijal.

After that, the student can choose to continue the learning process where the system, according to the rules, will continue to allocate LOs and aditional material according to the information received from the student.

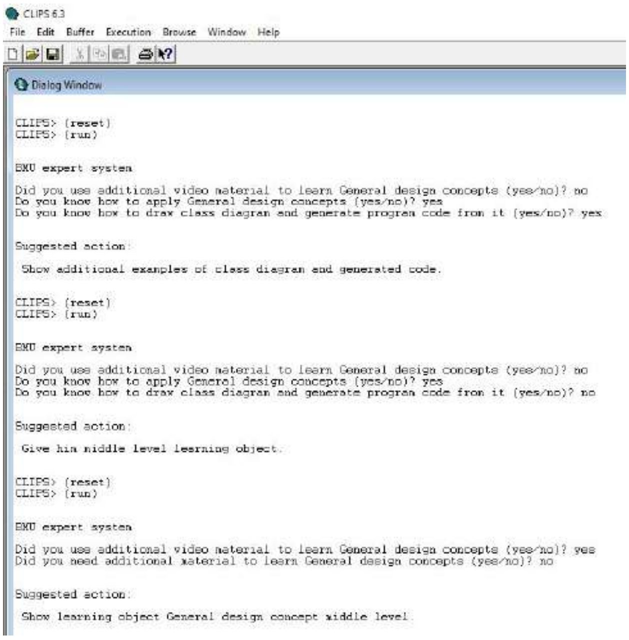

Figure 9: Outputs for CLIPS IDE

7. CONCLUSION

The answer to the first research question was obtained on the basis of the performed analysis of the selected literature. The application of the facts and rules within expert systems enables a clear setting of the learning process within the distance learning system. Facts can be automatically generated if they are specified in the syllabus (or in another document), can be created based on the body of knowledge of the subject, taken from the repository of teaching material (in this case LOs) or manually defined by the author of the teaching material. Precise and clearly defined rules (from student model) enable the expert system to formulate the learning process in the right way according to the needs of a specific student.

Another research question posed at the beginning of this research required a simulation of the implementation of a component of the CLIPS-based expert system within a case study. Based on the above example, possible communication with LMS (in the case of BMU it is LAMS) is shown, from which it is possible to obtain rules based on information about the student and with the repository of learning objects from which facts are obtained. The simulation of the implementation of the expert system enabled an overview of the process of generating personalized teaching material in the form of learning objects for all students who have gone through the basic C level. Also, in addition to the teaching material, the example included the application of additional material that the student can receive.

In addition to the above, there are several different rule-based languages for implementing expert systems. CLIPS was chosen as the best solution according to the current components of the BMU system. Future research can be based on other rule-based languages and additional components that can be integrated with the expert system in order to check the work of the expert system (check the acquired student knowledge based on the learning process and update student models and rules within the system) as well as easier automatic setup rules.

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INTELLIGENT RECOMMENDER SYSTEM FOR PERSONALIZED ONLINE LEARNING (IREP)

JOVANA JOVIĆ, MIROSLAVA RASPOPOVIĆ MILIĆ, SVETLANA CVETANOVIĆ, NEBOJŠA GAVRILOVIĆ, DRAGAN DOMAZET, RALE NIKOLIĆ

Belgrade Metropolitan University, Faculty of Information Technologies,

jovana.jovic@metropolitan.ac.rs , miroslava.raspopovic@metropolitan.ac.rs , svetlana.cvetanovic@metropolitan.ac.rs , nebojsa.gavriloric@metropolitan.ac.rs , dragan.domazet@metropolitan.ac.rs , rale.nikolic@metropolitan.ac.rs

ELAINE SILVANA VEJAR

Northeastern University, Boston, USA,

e.vejar@northeastern.edu

Abstract: *Adaptive e-learning environments incorporate Artificial Intelligence techniques for providing personalized content for learning in various educational domains and academic levels. Adaptive and personalized learning content for the students is based on student characteristics. Student profiling represents pre-requirement for providing personalized instructions based on observed student behavior without interventions of human instructors. This work proposes a framework for Intelligent Recommender System for Personalized Online Learning (IREP) with the goal to enhance the quality and efficiency of studying, by designing and developing personalized learning environment. IREP is based on student profiling and rule-based recommender system for retrieval of needed learning content. Personalized learning presumes personalized learning content retrieval in order to create different learning paths based on student individual needs, capabilities, preferences, and learning objectives. IREP's proposed architecture is generalized, which allows extension that can cover wider centralized or distributed knowledge bases.*

Keywords: *E-Learning, Distance learning, personalized learning*

1. INTRODUCTION

In the past decade various innovations have impacted direction in which teaching and learning has been developing with both innovating teaching mechanisms and implemented technologies. One of the innovations that has triggered direction in which teaching has been going is personalization of learning. Personalized learning incorporates several dimensions including student profiling, student-centeredness, student-individualization, and overall a flexible learning environment [1]. Personalized learning includes personalization of learning materials based on learning analytics and educational big data [2][3]. Numerous researches have focused on creation of developing e-learning systems that can support personalization of learning content and adaptively create personalized learning paths for each student or group of students with similar characteristics [4]. Most personalized e-learning systems often disregard characteristics of student profiles, which include student learning preferences, motivation, learning needs, background knowledge, etc.

The term learning analytics has been introduced to describe the process of understanding the behaviors of learning process from the data gathered from the interactions between the learners and contents. The Learning Management Systems (LMS) that combine content delivery, discussion forums, and quiz and assessment allow to monitor students' learning activities and from the analysis. Using these analysis instructors can identify "at risk" students and their undesirable behaviors. Hwang et al describe that learning analytics can assist in identifying the status of students' learning and problems they face in the learning process [5]. By analyzing these learning behaviors and the interactions with the content, the goal of personalized learning is to design a personalized and adaptive learning contents, practices and user interfaces to maximize the learning of individual students. Learning analytics integrates and uses analysis techniques related to data mining, data visualization, machine learning, learning sciences, psychology, social network analysis, semantics, artificial intelligence, e-learning, and social aspects [6][7].

First step towards achieving the fully implemented personalized system is to include student profiling. Learning analytics can be used to accomplish student profiling. Actually, incorporating learning analytics with student profiling can potentially address several challenges in learning personalization: lack of studying effectiveness in learning, lack of student motivation and engagement, lack of in-time analysis of teaching/learning effectiveness when introducing new instructional methods and educational technologies in courses, in-time introduction of intervention of activities for "at risk" students, and in long term reduction of dropout rates of students.

The goal of this work is to propose framework for the Intelligent Recommender System for Personalized Online Learning (IREP) system with the aim to predict learner strength and weaknesses, identify learning style for each learner, identify and recommend learning content that is proper for the learner knowledge level and interests. This system takes into consideration different student profiles and matches them with appropriate learning content, which is best suited for each student and is dynamically updated with each system usage during the learning process. To achieve this, learning materials are divided into smaller, modular units referred as learning objects (LOs). LOs have complementary knowledge attached, such as LO duration, difficulty level, keywords, which we refer to as LO attributes. The goal of the IREP is to provide general software architecture for the system that provides workspace that connects student profiling with specific learning content. In designing the environment for personalized learning this work considers: (i) dividing learning materials into LOs, (ii) representing knowledge in the form of ontologies, and (iii) student profile characterization. The overall goal is to: (i) predict learner strength and weaknesses, (ii) identify learning style for each learner, (iii) identify and recommend learning content that is proper for the learner knowledge level and interests, and (iv) help learner make progress.

This paper is organized as follows. Section 2 outlines the proposed framework for the IREP with the outlined recommendations for student profiling, content modeling and recommender system. Section 3 presents software architecture for IREP. Section 4 concludes the paper.

2. IREP FRAMEWORK

Personalization in e-learning can be treated as the combination of automatically adapting learning content to the interests and knowledge levels of learners, as well as the possibility of making learning decisions in a self-regulated manner. Artificial Intelligence plays a key role in personalizing learning experience for each learner. In order to offer personalized and dynamic content for each learner it is important to classify accurately information in terms of knowledge retrieval, domain ontology and profile characteristics for each learner. Classifying information accurately in terms of knowledge domain, is extremely beneficial in automation and minimization of needed resources, which can be tedious and time-consuming task when done manually. Proper knowledge information categorization is crucial for repurposing learning content, recommending learning content to learners based on their abilities, providing visual representation of knowledge domain and generating personalized learning paths to those who are struggling and those who need more challenge.

Main approaches that are used in IREP framework are:

- Student profiling – modeling of student characteristics and behavior during learning,

- Content classification – ontology domain content classification enriched with attributes,

- Recommender system – automatic generation of rules based on the highest predicted value matching between student profile characteristics, and matched learning content.

2.1 STUDENT PROFILING

IREP treats "student profile" as a set of static information containing data about the student characteristics. On the other hand, "student model" represents creation, modification, and maintenance process of student profiling. Unlike the profile, student model is an abstract representation of the student containing information about student dynamic behavior and predictions of the same. In other words, the student profile keeps static information about the student, while the student model keeps both, static and dynamic. Student model is a base for AI-based personalized e-learning systems and a crucial factor for designing an adaptive learning system that can utilize student competencies and learning achievements, for delivering personalized content. Profiling may involve techniques to represent content skills (e.g., mathematics, art history), knowledge about learning (e.g., metacognitive knowledge), and affective characteristics (e.g., emotional state). Student models generally represent inferences about users (e.g. their level of knowledge, misconceptions, goals, plans, preferences, beliefs and etc.), relevant characteristics of users (stereotypes), and users' records, particularly past interactions with the system. Therefore, student profiling observes student behavior and creates a qualitative representation of cognitive and affective knowledge. This module partially accounts for student performance (time on task, analysis of assessments of his/her acquired new knowledge, observed errors) and reasons for adjusting feedback to the student. On its own, the student model achieves very little; but with usage of artificial intelligence (AI) techniques and rule-based expert systems, can be more efficient. In order to construct a precise Student Model, it is necessary to take into account appropriateness of student characteristics that influence student learning, psychological states during the learning, and methods and technologies with the best precision for profiling.

In order to achieve better student profiles, it is necessary to choose adequate set of data about each learner. Roughly taken, IREP data can be divided into two groups (as seen in Figure 1), student specifics and LOs knowledge domain attributes. A short description of each specific/attribute is given in Table 1.

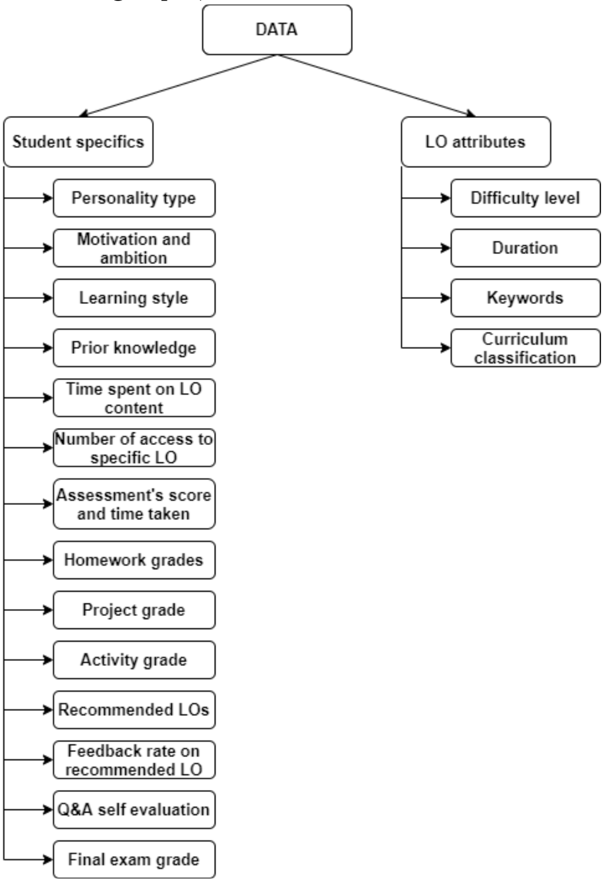

***Figure 1**: Student specifics and LO attributes*

Table 1: Data description

Student specific / LO attribute Name	**Description**	**Datatype**
Personality type	Psychological classification of different types of individuals based on the Myers-Briggs Personality Type Indicators [8].	Category (extrovert/introvert, sensitive/intuitive, thinking/feeling, perceptive/judgmental)
Motivation and ambition	Level of the inner driving force that pushes individuals to do and accomplish thing, comprised of a strong desire, ambition, etc.	Category (low, medium, high)
Learning style	Psychological classification of preferred learning style based on Felder-Silverman model.	Category (active/reflective, visual/verbal, sensing/intuitive, sequential/global)
Prior knowledge	A set of student achievements before college, such as points earned on entrance exam, high school grades, etc.	Number (0 - 100)
Time spent on LO content	Time spent in learning specific LO.	Number (minutes)
Number of accesses to specific LO	Number of accesses to a specific LO during the learning process.	Number

Assessment scores and time taken	The number of scored points in the assessments performed after one or more LOs.	Number (0 - 100) Number (minutes)
Homework grades	The number of scored points on homework.	Number (0 - 100)
Project grade	The number of scored points on project working.	Number (0 - 100)
Activity grade	The number of scored points based on activity and engagement during learning process.	Number (0 - 100)
Recommended LOs	LOs delivered to student.	Text
Feedback on recommended LO	Rating: Student’s rate about satisfaction with the recommended LOs. Difficulty level and duration estimation: Student’s estimation about LO duration and difficulty level from their point of view.	Rating: Number (1 - 5) Difficulty level estimation: Category (basic, intermediate, advanced) Duration estimation: Number (minutes)
Q&A self-evaluation	Answers on Q&A.	Text
Final exam grade	Grade based on overall exam score.	Category (5 - 10)
Difficulty level	Difficulty level classification of specific LO.	Category (basic, intermediate, advanced)
Duration	Time needed to learn a particular LO.	Number (minutes)
Keywords	Specific keywords marked by teachers during the LO creation.	Text
Curriculum Classification	LO classification based on adequate curriculum.	Category (e.g. IEEE SWEBOK)

2.2 CONTENT CLASSIFICATION

In order to properly model learning content, according to its knowledge domain, it is necessary to use different set of data. One of the approaches in achieving more enriched information and efficient knowledge domain modelling is by using the ontology model for learning content. LOs versatility and searchability can be enriched with a set of metadata. Nowadays, there are few commonly used metadata standards, for example IEEE LOM and Dublin Core metadata standards [9]. Even though metadata can be used to manage LOs multimedia, metadata are not enough when it is necessary to describe the semantic of LOs textual information content [10].

Typically, LOs are stored in Learning Object Repository (LOR), which is an integral component of LMS. LMS enables LOs to be combined with other LOs and creates individualized learning pathway for each learner or a group of learners with similar needs. However, in order for LOs content to be reusable in different learning paths, and to provide for efficient retrieval of LOs, LOs content have to be enriched with complementary knowledge, represented in the form of ontologies. Ontology can be treated as the most suitable semantic structure that on one hand allows the definition of the particular educational domain and, on the other provides different learning strategies [11].

The ontology can be visually presented as a graph in which nodes are relevant concepts of educational domain (topics, subtopics, etc.) and edges are binary relations between them. The graph structure enables learners to easier navigate through the educational domain and build their own personalized paths [12].

Figure 2 present ontology model for the generic knowledge domain. This knowledge domain structure is presented by using hierarchy where the curriculum is defined as the most general concept that is positioned at the top of hierarchy, knowledge areas constitute the first level of hierarchy, which contain knowledge units that further contain topics and subtopics. In this figure, only one knowledge area from the curriculum is presented. Each concept at the lowest level is broken down into LOs. LOs are the only nodes that actually contain content. One LO can belong to multiple concepts, which is indicated through adequate relations. The separation of concepts from content means that content can be changed without affecting the overall structure of ontology and vice versa [11]. It can be noticed that five types of relations are used in this ontology model:

1. Part of relation (PO) that describe that a subtopic is a part of another higher-level topic. For example, Subtopic 1 and Subtopic 2 are parts of Topic 1 from the Knowledge Unit 1.

2. Order relation (OR) can be defined in two ways: (a) as a mandatory relation representing that one or more LOs are prerequisite to LO that follows this relation and their contents must be learned first, and (b) optional relation representing recommendation which LOs may be learned in order to gain deeper knowledge about a topic. For example, LO1 is mandatory for LO3, which should be learned before learning LO3. On the other hand, in order to optionally improve knowledge acquired by learning LO4, learners can further access content of LO7.

3. Has resources relation (HR) enables searching for a specific part of LO, without having to search through the entire ontology tree.

4. Basic/advanced relation (BA) indicates that one concept is on the lower knowledge level than the other. For example in Figure 1, Subtopic 2 is in BA relation to Topic 3, indicating that Subtopic 3 is advanced concept to Topic 2. In other words, learner can acquire basic knowledge about Subtopic 3, by learning L05 and L06.

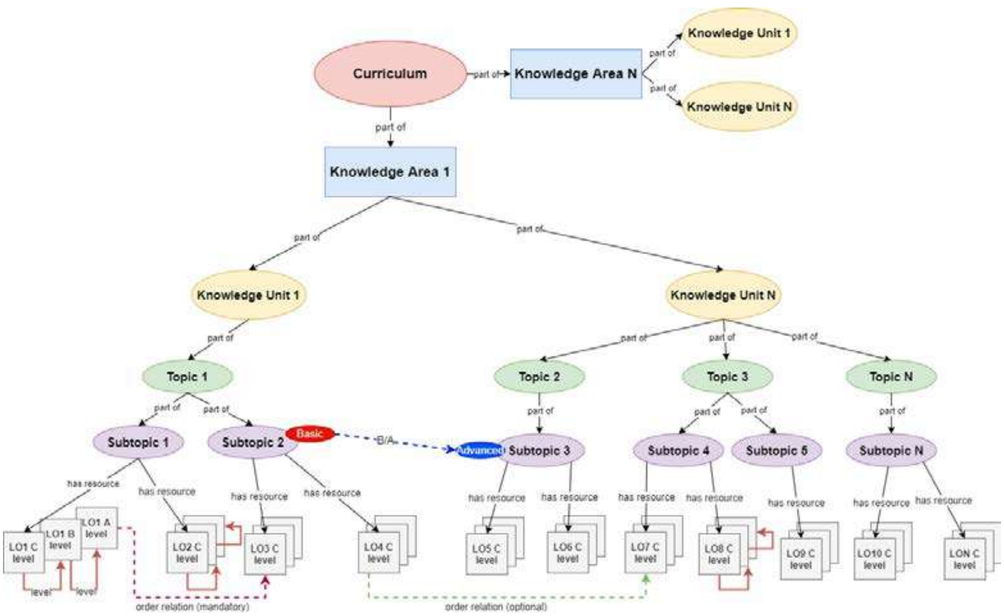

Figure 2: *Ontology model for a knowledge domain*

Ontology enables students to build their different learning paths according to their interest and previous knowledge but also ontology has many benefits for teachers. As it is shown in Figure 3, when the learning material should be divided into different lessons, teachers can use ontology to build them by specifying only topics, subtopics, particular LOs or combination of them that constitute each particular lesson. In addition, in the problem-based learning, when students learn learning material by solving different problems, teacher can determine the parts of learning material needed for problem solving also by using topics, subtopics or particular LOs from ontology. Learning outcomes for a course or program that lead instructors to focus on that students should know or be able to do after the course or program also can be defined by specifying topics, subtopics or LOs from ontology.

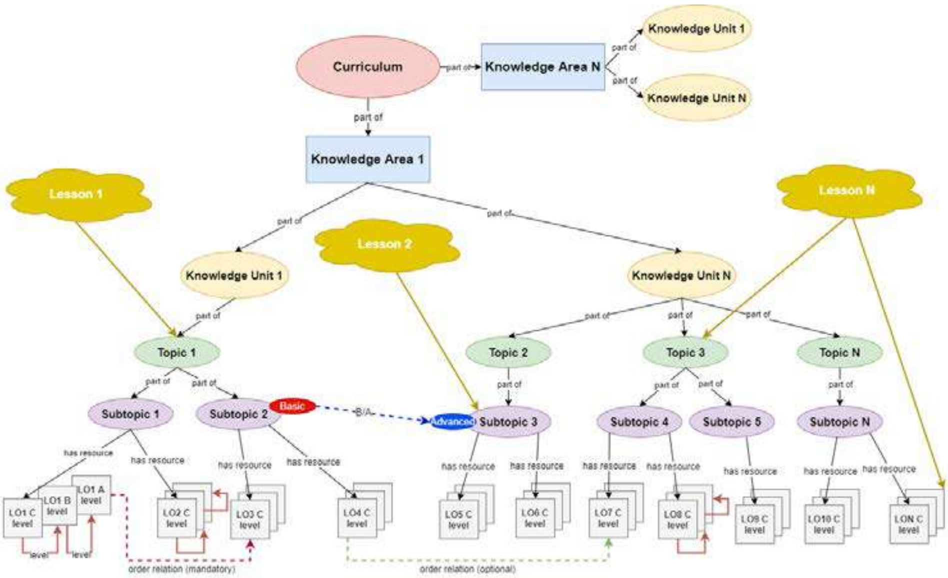

Figure 3: *Example of different view of ontology*

2.3 RECOMMENDER SYSTEM

The goal of the recommender system within IREP framework is to recommend learning materials in the form of LOs to students, by using three aspects: learner's background (knowledge level, learner's individual needs, capabilities, preferences, learning objectives), learning content and knowledge domain (learning outcomes that should be achieved for this domain). The goal is promote learners autonomy in the self-regulated learning, so that each learner can have personalized content. With the continuous acquisition of user information and learning behavior data, student profile characteristics are dynamically updated, while learning content recommendations are adjusted accordingly.

IREP's recommender system determines highest matching value between student profile characteristics (Learner profile model) and matched learning content (Content ontology model based on LOs).

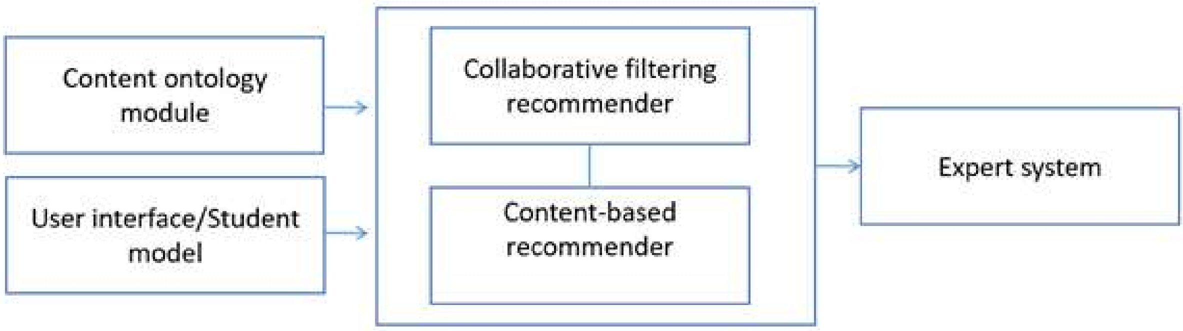

Figure 4: *Components of IREP's recommender system*

Recommender uses a hybrid recommendation method, which combines rule-based, content-based and collaborative filtering recommender methods (Figure 4):

- Rule-based (or attribute-based) recommendation approach uses predefined set of rules to make recommendations to the expert system. This approach uses predefined rules which are related to each course and its characteristics, such as curriculum, ECTS points, learning outcomes. Learning outcomes are defined for every curriculum, course and for each subset of LOs within lessons. Rule-based approach is foreseen to be used in several scenario: assign static rules that always apply, use for the newly assigned learning resource that has not been used yet by learners (cold start problem) and use for the new learner that has not filled learner profile (i.e. *if the student has no prior knowledge, assign beginners level learning content*).

- Content-based recommendation approach searches for related LOs based on what students with similar profile have used (gained from Learner profile model), along with LOs ontology model for more effective search and recommendation of related LOs (gained from Content ontology model). Recommendation based on content filtering can also find some of the hidden information to recommend newly added learning material and less-popular LOs.

- Collaborative filtering recommendation approach is used to recommend LOs after getting feedback from students. Student feedback can be in form of assessment scores, materials rating, time spent on reading learning content etc.

Recommender outputs are fed as inputs to the Expert system (Figure 4). These outputs are generated using collaborative filtering recommender and content-based recommender. In recommender system everything starts from collaborative filtering recommender where output from this part of the system is: “Creation of a list of LOs with the highest predicted evaluation for a given student”. That list of LOs is input into Content-based recommender. After processing, output from Content-based recommender is: „A list of LOs with the highest predicted evaluation completed with the highest LO similarity for a given user“. That list of LOs presents input to expert system where defined rules are applied on that list of LOs.

Expert system contains both pre-defined set of rules, using previously described rule-based approach, and dynamically generated rules that respond to modification in learner profile and content ontology model. The role of the Expert system is to make final ordering recommendations of LOs to a student.

3. IREP SOFTWARE ARCHITECTURE

Proposed software architecture for IREP includes following software components (Figure 5):

1. IREP Learning Environment

2. Learner Profiler Intelligent Software Agent (LP-ISA)

3. Recommender Intelligent Software Agent (RI-ISA)

4. Ontology Creator Software Agent (OCSA).

In order for IREP architecture to provide extendable and flexible integration with different systems, it is necessary to have environment that builds upon existing LMS. The intent of IREP Learning environment is to serve with multiple purposes:

- Presents recommended learning content

- Visualizes recommended learning paths for individual learner

- Collects data about learner activities

- Assigns student with set of problems/tasks to achieve problem-based learning pedagogy method.

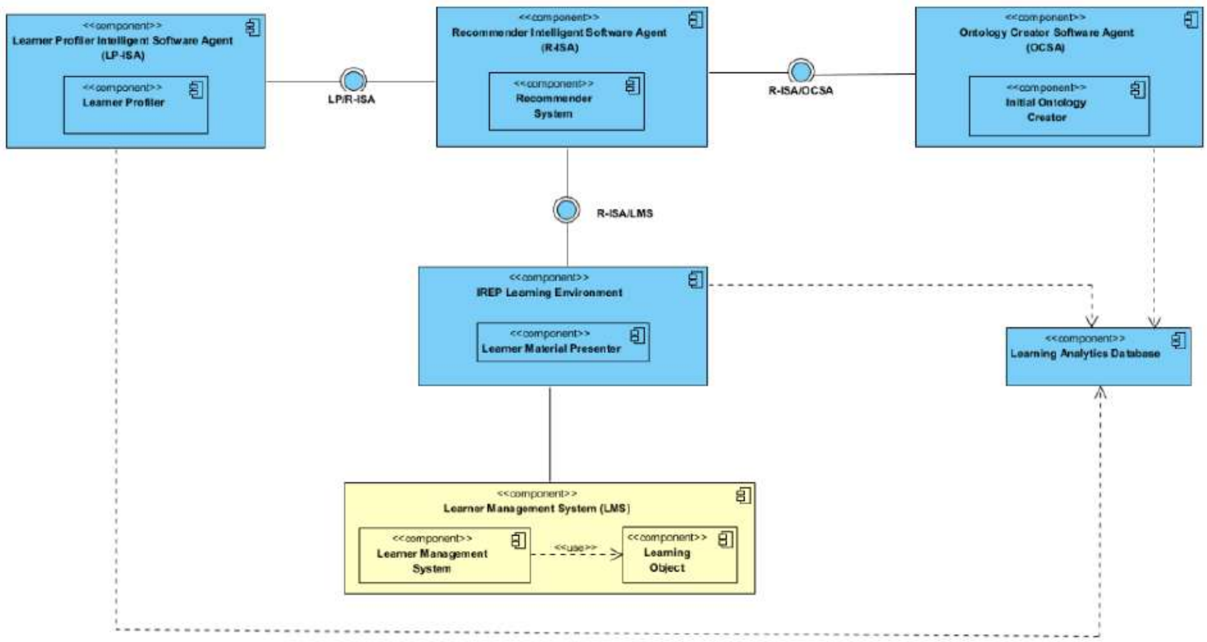

Figure 5: *Proposed software architecture for IREP*

LP-ISA extracts and defines the student model for each learner based on learner activities log, stored in Learning Analytics Database. Continuously collecting and updating data about the student includes: (i) collecting initial data related to the learner’s characteristics, (ii) learner model building, and (iii) improving and updating the learner model with additional observed learner’s activities during the learning. Based on the student profile and action during the learning, the student model, for example, may contain conclusions such as *Student motivation in learning Course A is very low*. The student model is updated after each student action within IREP Learning Environment and it is stored in the database. Except for LP-ISA, all other components from IREP's architecture also store and retrieve data from Learning Analytics Database.

The role of Ontology Creator Software Agent (OCSA) is to create ontology model for the knowledge domain to be learned. This ontology model consists of concepts, subconcepts and LO content as describe in Section 2.2. That ontology enables more efficient retrieval of LOs that are matched with each particular student profile.

The central place in the architecture has IREP's recommender system (RI-ISA). The role of RI-ISA is to determine highest matching value between student profile characteristics and learning content, as it is described in Section 2.3. RI-ISA receives information about student characteristics and profile from LP-ISA by using interface LP/R-ISA and the corresponding LO content from OCSA by using R-ISA/OCSA. The result of that matching, which is generated by the Expert system as a component of the Recommender system, consists of list of LOs with the highest predicted value for a given user profile. This list of LOs is placed in IREP Learning Environment component where it is presented to students. All these components from the architecture for IREP can be treated as the extension of LMS. They upgrade its main functionalities like course management, user management and PROGRESS TRACKING.

4. CONCLUSION

This work proposed a framework for recommender system for personalized learning that is based on student profiling, learning content characterization and recommender system that matches student profile with necessary learning content. Proposed framework was presented in the conceptual form, and hence, its architecture was given on a high level, so that it remains general enough to be used with any existing legacy and external systems. Future work should further develop each component in IREP architecture, and should define which methodologies and techniques are most suitable for learner profiling, while the recommender system should further explore how both dynamic and static rules can be implemented in order to deliver the most adequate learning content for each student profile.

ACKNOWLEDGMENT

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

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TOWARDS SECURE ONLINE STUDIES: APPLYING BLOCKCHAIN TO E-LEARNING

MARINA DAMNJANOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies,

marina.damnjanovic@metropolitan.ac.rs

VELJKO GRKOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies,

veljko.grkovic@metropolitan.ac.rs

NEMANJA ZDRAVKOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies,

nemanja.zdravkovic@metropolitan.ac.rs

Abstract: *In the past decade we have witnessed an increase in platforms and services providing online studies, courses, training, and certifications. Most recently, due to the COVID-19 pandemic in 2020, most universities have also switched entirely (or at least partially) to an online studies model. With all communication between faculty staff (teaching and administrative) and students being online, data protection has yet again surfaced as an ongoing problem. In this paper, we analyze the potential of e-learning platforms with blockchain running in the back-end. With innate blockchain properties in immutability and transparency, based on different use-cases and existing state-of-the-art solutions, we provide a model which can serve as a basis for a blockchain-based e-learning system.*

Keywords: *blockchain, data protection, distance learning, distributed ledger, e-learning, privacy, security*

1. INTRODUCTION

The recent global COVID-19 pandemic encouraged higher education institutions (HEIs) to completely switch to online or hybrid study models [1]. Apart from the courses themselves being held online, communication between faculty staff (teaching and administrative) is also conducted online [2]. While some of the HEIs were able to switch to an online communication model, other would have to implement either a commercial solution, or have one developed in-house. With most of the communication being done online, the issue of data protection rises again [3, 4].

The authors of this paper, being teachers and researchers alike, have identified key issues regarding sensitive data handling in HEIs. In this paper, we present a possible top-down solution, based on blockchain technology (BCT), as a possible step towards a learner-centric studies and secure online learning.

The remainder of the paper is organized as follows. In Section 2, we firstly present our motivation, where we identify key issues regarding handling personal data in education. Afterwards, we present a quick overview of BCT. In Section 3, we propose a model for an education information system (IS) based on BCT. Finally, in Section 4 we draw conclusions and set up a foundation for our research.

2. MOTIVATION

We start by defining the term education information. Namely, all learner's grades (including grade point averages, GPAs) during his/her studies, diplomas, certificates, etc., can be regarded as education information. This brings up two questions – who is the owner of this education information, and who can access this education information? Note that this information is different from scientific publications, thesis, patents, and technical reports developed by students during his/her education at any level. For these items, each HEI handles intellectual property (IP) in accordance with national copyright laws.

As stated in the Introduction, most communication within a HEI is conducted online, which includes education information as well. If this communication is not secure, it is prone to unauthorized access, modification, and deletion.

The aim of this paper is to introduce a top-down system for handling education information in a secure manner, by having the internal HEI IS connected to a private blockchain. Blockchains are append-only ledgers where data can be added relatively easily, and once data is added, it is almost impossible to modify or remove the data. This feature guarantees the integrity of the added data. Blockchain therefore creates an overarching mechanism to link disparate personal records, such as the previously defined education information.

Blockchain technology overview

Blockchain technology imposes fundamental changes to the way personal data, including the aforementioned education data, are being processed in a secure means. A Blockchain can be viewed as a shared, append-only distributed ledger, in which all transactions are stored in linked blocks [5]. A transaction is an event that is added to the blockchain, and also contains a unique cryptographic signature and timestamp, thereby making the ledger resistant to alterations. All nodes that are a part of the blockchain have a copy the verified transactions, named a world-state. Furthermore, all nodes are updated in real time. Apart from a set of verified transactions, the block also contains a header connecting that block to the previous one. All blocks form a chain (hence the name), and can trace back to the first block, called the genesis block. A blockchain relies on peer-to-peer networking, public-key cryptography, and distributed consensus, and these three concepts secure the blockchain.

Whereas within a centralized system there exists a node to control all others (e.g. server), in a blockchain no single node controls the process of adding a block to the chain. Conversely, each block is managed by all nodes, who share equivalent permissions. This level of decentralization exists in order to avoid potential security issues and is achieved through the process known as distributed consensus. The consensus mechanism establishes an agreement among the nodes to add a validated block. Depending on the algorithm, nodes can either compete for correct transaction validation (e.g. Proof-of-Work, PoW), be chosen randomly or pseudo-randomly (e.g. Proof-of-Stake, PoS), or apply a different algorithm altogether. In general, these algorithms can have different levels of complexity and require various resources (e.g. computational or electrical power).

Blockchain technology is often referred as the next disruptive technology [6]. However, note that blockchain presents a class of technologies, with different forms of distributed databases and variations in their technical and governance arrangements and complexity. All BCTs have innate properties of transparency and immutability, and current blockchain-based solutions have surpassed the initial use in cryptocurrencies [7, 8]. A variety of Blockchain solutions in healthcare, financial technology, supply chain management, and education are being developed, start-ups are formed and scientific research is being conducted [9 - 13].

Table 1 highlights the benefits of implementing a blockchain-based solution over a traditional centralized solution [14].

Table 1: Comparison between using a traditional centralized platform and a blockchain platform [14]

Aspects	Centralized platform	Blockchain-based platform
Data Handling	Supports create, read, update, and delete operations.	Only read and write options are available
Authority	Controlled by the administrator	Decentralized even in private blockchains
Integrity	Data can be altered	Data are immutable and auditable
Privacy	High chances of malicious cyberattacks	Data are stored using cryptography technology
Transparency	Databases are not transparent	Data are stored in a distributed network
Quality Assurance	Administrators are needed to authenticate data	Data can be tracked and traced right from its origin.
Fault tolerance	High risk of single point of failure	Distributed ledger is highly fault-tolerant.
Cost	Easy to implement and maintain.	Uncertainty in the operating and maintenance costs.
Performance	Fast (more transactions processed per second) and offer great scalability	Can handle minimal transactions per second, and scalability is a challenge.

As far to the author’s knowledge, implementing BCT in education is still a novel topic, and published papers still present different approaches as what should (and should not) be kept on the blockchain [15 – 19].

2. SYSTEM MODEL

Similar to the model presented in [15], our model consists of a learner, HEI and blockchain network itself. The learner can always access his/her education information through the blockchain client application programming interface (API). The HEI can create transactions that contain a learner’s education data, and can also access the data. The third and most important part is the blockchain network itself. The HEIs are the nodes in the network, while learners can choose to be a part of the network as well; however, for this option, an incentive system is recommended, similar to the mining system in Bitcoin and other cryptocurrencies. The model is shown in Image 1.

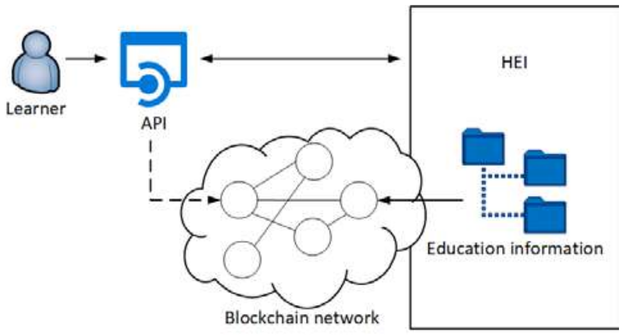

Image 1. Blockchain-based system model.

The learner, through the API, has an “eTranscript”, containing his/her education data. As the learner can always access this data, we argue that this model is learner-centric, as he/she is the owner of this data. The HEI can make a transaction with the learner’s education information e.g. when a learner enrolls the HEI, passes an exam, receives a diploma etc. This data will be encrypted, and can be accessed only by the HEI, the learner, and, if needed, an authorized third party. This new transaction is sent to the blockchain, where the other nodes in the network will verify it and add it to the blockchain. The data itself is small in size as it contains only alphanumerical values, and can be kept only in the blockchain. The blockchain is private, and the nodes can be different HEIs (e.g. different faculties in an university, different universities, research centers etc.).

Different BCTs can be used for developing such a system. The authors are researching technologies such as Ethereum, Hyperledger Fabric and Hyperledger Sawtooth for the system development. At this stage, we are actively collaborating with Belgrade Metropolitan University (BMU) and BMU’s Information System (ISUM) staff in order to develop a simple prototype of the system.

The innate security properties of BCT does not allow any data modification without achieving a consensus. However, this raises the issue of erasing data upon request. Namely, there are two Articles of the General Data Protection Regulation (GDPR) [20]:

- Art. 17 - Right to erasure (‘right to be forgotten’) where are listed the conditions under which it is possible and under which it is not possible to erase personal data.
- Art. 20 - Right to data portability where it is stated that every person has the right to transmit personal data to another controller without any hindrance from the controller to which the personal data have been earlier provided.

At this stage, we will investigate and define the form in which to store transactions of education data, so that the user ‘to be forgotten’ request does not become a problem. One of the reasons why certain data, which doesn’t contain personal data, shouldn’t be erased due to the needs of scientific research in the field of education. We will investigate how to enable data portability, i.e. data mapping from one controller to another, without compromising learner anonymity.

5. CONCLUSION

Using BTC, education data can be issued and viewed reliably by the learner, the HEI and by an authorized third party in a reliable and secure manner. By adding an eTranscript, BCTs can help HEIs to add an additional secure layer to their education data documentation process. The idea of a secure eTranscript can help HEIs to easily identify each learner with his/her learning path throughout all of his/her education. Adding blockchain to HEIs therefore presents a step towards secure online studying (both from the perspective of a learner, and from the HEI). The goal of this paper was to identify the potential of using Blockchain with educational documentation. This paper presents the first step in our research in BCT-aided education solutions, and is a foundation for future development.

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STUDENT MODEL IN INTELLIGENT TUTORING SYSTEMS - A SYSTEMATIC REVIEW

JOVANA JOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, jovana.jovic@metropolitan.ac.rs

DRAGAN DOMAZET

Belgrade Metropolitan University, Faculty of Information Technologies, dragan.domazet@metropolitan.ac.rs

MIROSLAVA RASPOPOVIĆ MILIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, miroslava.raspopovic@metropolitan.ac.rs

KAVITHA CHANDRA
University of Massachusetts Lowell, Department of Electrical and Computer Engineering, kavitha_chandra@uml.edu

Abstract: *With the rapid growth of technology, Intelligent Tutoring Systems (ITSs) became digital environments that incorporate Artificial Intelligence techniques in order to provide common tutorial services for learning on various educational domains and academic levels. ITSs provide adaptive and personalized tutoring for the students based on their learner profiles that may include characteristics such as: learning preferences, knowledge level, motivation, etc. Student modeling is a pivotal technique used in ITSs for providing automatic feedback and instructions in learning based on observed student behaviors. Student modeling contains knowledge about the student's cognitive and affective states while he/she is using the ITS. Dynamic changes in student characteristics in learning provides interesting but very challenging problem in building and evaluating a good student model. This systematic review reports key information about building and evaluating existing student models with a focus on the dominant student characteristics and methods used in building these models.*

Keywords: *e-learning, student model, intelligent tutoring system*

1. INTRODUCTION

The evolution of Intelligent Tutoring Systems (ITSs) has merged the educational field, psychology and artificial intelligence. ITSs represent computer-based instructional systems with models of instructional content that specify „what to teach“, and teaching strategies that specify „how to teach“ [1]. ITSs may have different structures, but the four basic components are Student Model, Tutoring/Instructor Model, Domain Model, and User Interface [2]. Student model deal with tracing the student knowledge and performance while learning. One of the task in the student model is to predict student performance based on student learning activities and characteristics.

Even though online learning has gained its momentum, it still has many shortcomings in comparison to the face-to-face teaching, especially in regards to contextual and adaptive support, lack of flexible support of the presentation and feedback, lack of the collaborative support between students and systems [3]. In order to overcome these issues e-learning research has explored its expansion towards the adaptive e-learning, which is suitable for teaching heterogeneous student populations based on their individual characteristics [4].

An adaptive e-learning environment based on monitoring of student activities, their needs, and preferences must be capable of managing learning paths adapted to each student [5]. On the other hand, an adaptive e-learning environment needs to provide personalization to the specific needs, knowledge, and background of each individual student [6]. Challenges in creating adaptive systems are not only different needs but also different learning characteristics that can be overcome by using the technique introduced in ITSs [7].

This literature review was conducted in order to find the most suitable practices used in order to accomplish previously listed activities with the intention to discover nowadays trends and identify future research directions, improvements, and innovations needed in this field. The goal of this work is to identify appropriate learners' characteristics that are important for student modeling, and to conduct the cross-analysis among the used techniques in order to identify possible relationships between them.

Other similar studies were conducted in this field. Sani et all review presented different papers focused on artificial intelligence approaches used in Student/Learner Modeling between 2010 and 2015 [8]. Abyaa et all focused on systematic literature review about learner modelling between 2013 and 2017, describing the different modelled characteristics grouping them in most global categories and the adopted modelling techniques and modeling types: automatic modeling and collaborative modeling [9].

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

2. RESEARCH QUESTIONS

A student model is a base for personalized e-learning systems and a crucial factor for designing an adaptive educational system. Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner, while an adaptive educational system refers to the technologies monitoring student progress, using data to modify instruction at any time [10][11]. Anyway, the development of current technologies has made personalized learning increasingly adaptive, adaptive learning increasingly personalized [12]. The process of a student modeling means continuously collecting and updating data about the student that includes: (1) collecting initial data related to the student's characteristics, (2) student model building, and (3) improving and updating the student model with additional observed learner's activities on during the learning [13][14]. The aim of this research is to analyze how student modeling can increase the efficiency and quality of studying, determine different categories of students based on their characteristics in order to apply personalized teaching materials, improve traditional and online teaching while reducing dropouts, and increasing students' motivation to study and learn, etc.

Student modeling includes different fields such as education science, psychology, and information technology. Therefore, in order to construct a precise Student Model, it is important to conduct different activities such as: (i) to choose appropriate student's characteristics that influence his/her learning, (ii) analyze psychological states during his/ her learning, and (iii) choose methods and technologies with the best precision for modeling.

The main goal of this systematic review focuses on following research questions:

RQ1: What are the characteristics of the students we should model?

RQ2: What are the most commonly used methods/techniques for modeling student characteristics?

RQ3: In which contexts are student models most commonly used?

RQ4: What are the common assumptions and conclusions?

3. DATA COLLECTION AND SELECTION CRITERIA

The methodology protocol adopted for systematic review in this study is based on Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) [15].

Papers were searched within the period from 2010 to 2020 from the Google Scholar, Research Gate, Academia databases. Additionally, lot of the papers are taken from similar review papers about student or learner modeling with their reached conclusions [9][16] but also papers backward referencing from papers cited within the literature that met the inclusion criteria.

Within the ITS's research field, there are multiple terms that relate to student modeling. Modeling of particular student's characteristics can be found in literature in order to resolve specific problems in e-learning. The PICO criteria were used to define the search string [17]:

- Population (P): student OR learner
- Intervention (I): modeling OR profiling
- Comparison (C): user modeling/profiling
- Outcome (O): effective, personalized e-learning in ITSs

Used search string was: (student OR learner) AND (modeling OR profiling) OR (user modeling/profiling *in order to achieve*) AND (effective personalized e-learning in ITSs).

This systematic review was conducted based on the following inclusion and exclusion criteria:

1. Reviews and papers published in relevant journals or conferences were included.
2. Abstracts, news, editorials, and web resources were excluded.
3. The papers closely related to student/learner modeling for use in ITSs were included. The particular student's characteristics modeling with unclear usage were excluded.

4. Only papers published from 2010 to 2020 were included.
5. Only papers reported in English were considered.

The following data were extracted from identified and read papers: (i) student's characteristics used in the proposed model, (ii) methods and techniques that were used for student profile modeling, (iii) purposes of the used student model.

In this research total of 104 papers were screened, out of which 6 were excluded because they were not written in English, 13 were excluded for not being published in a journal, 15 papers were excluded for being published prior to 2010, 2 papers were excluded for being the same papers or versions with previously included papers, and 6 papers were excluded because of the insufficient information about applying student modeling techniques. In total, 62 papers were included in this analysis (Figure 1).

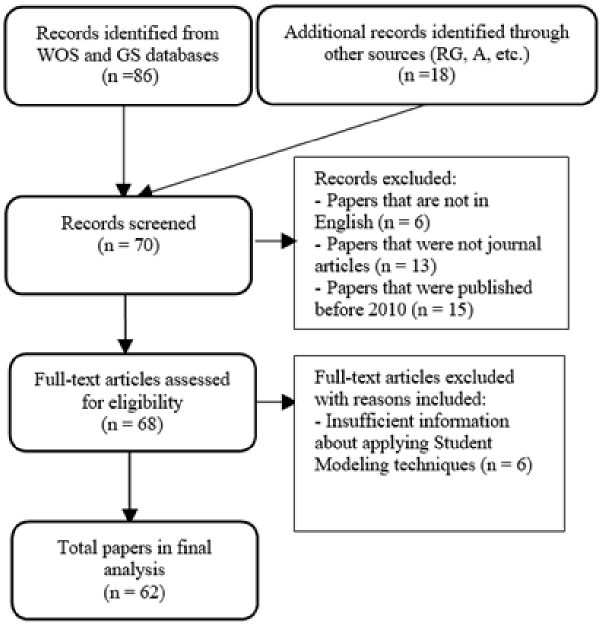

Figure 1: The process for data collection and analysis

4. RESULTS AND DISCUSSION

4.1 What are the characteristics of the students we should model?

One of the stepping stones in achieving student modeling is identifying student characteristics that could give us the most insight in student profiles. In literature, there are different categorizations of student characteristics that are used in ITSs, such as static and dynamic, domain-dependent and domain-independent, etc. Static student characteristics are immutable while using the system, and they typically refer to name, gender, preferences, etc. On the other hand, dynamic student characteristics can be changed during the learning process (knowledge level, motivation, emotions). Domain-dependent deal with characteristics such as knowledge, competencies, and learning goals, while the domain-independent student characteristics consider learning styles and personality.

As mentioned, categorization of student characteristics does not help much in discovering which characteristic will be the most important in student modeling in order to later enable greater adaptability in learning. Based on reviewed papers, student characteristics are grouped by their similarity. We identified five categories of students' characteristics: (i) knowledge (knowledge level, competences, skills, errors during the learning, misconceptions), (ii) personality (reactions in given situation), (iii) motivation (engagement, interests, learning goals), (iv) social (cultural background, individual or collaborative social style), and (v) cognitive characteristics (intelligence, organizational ability, learning style, working memory capacity).

The most commonly used student characteristics applied in reviewed papers with the intention to support and improve the teaching and learning process while respecting the individuality of the learner are shown in Figure 2. It can be seen that *knowledge* is the most commonly used characteristic (71%). On the other hand, *social characteristics* are researched in the least amount of papers (1%). *Motivation* is poorly considered in papers [3, 18] (3%) as an independent modeled characteristic, but its importance in the improvement of student performances in learning is usually stated.

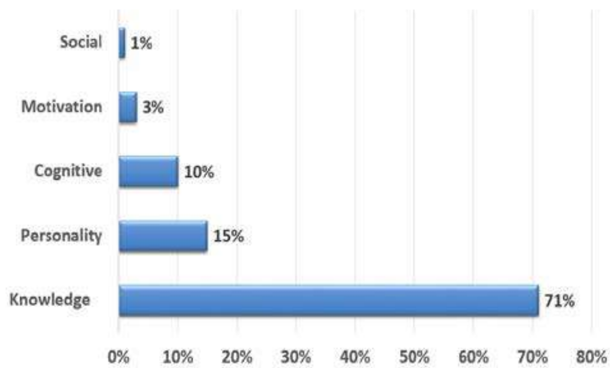

Figure 2: *Result analysis for RQ1*

4.2 What are the most commonly used methods/techniques for modeling student characteristics?

Based on reviewed papers, the most commonly used technique in ITSs with the intention to support the student modeling process while respecting the individuality of the student characteristics are shown in Figure 3. It can be seen that *Bayesian networks* (44%) and *Artificial Neural Networks* (33%) are the most commonly used techniques. On the other hand, *Item response theory* is researched in the least amount of papers (2%).

Despite the above results, the hybrid technique, in the form of a combination of applying different modeling techniques to construct a student model, is the most common in researched papers.

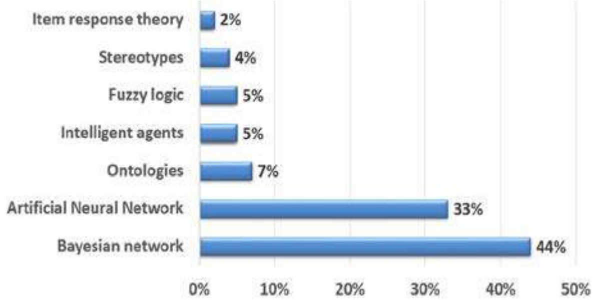

Figure 3: *Results analysis for RQ2*

4.3 In which contexts are student models most commonly used?

Contexts in which student models are most commonly used are:

- **Predicting student performances/student grades.** Predicting student performance is mostly used to help the teachers and students improving their learning and teaching processes. Some papers consider predicting student performances in order to determine "at risk" students and associated factors that influence their performance in order to provide measures for early intervention. There are also predictions aimed to identify students who can be individually assisted by the teachers so that their performance is better in the future.

- **Classification in different groups.** It can be noticed that some of the presented papers dealt with the student classification and clusterization for providing adaptability in the learning process. The most commonly used context is the classification of the students according to their learning style preferences.

- **Pairing student characteristics with learning materials.** Based on the student model, different learning environments provide appropriate adaptive learning content delivered to a particular student. There are a lot of recommendation learning techniques used in order to pair student characteristics with appropriate learning material.

4.4 What are the common assumptions and conclusions?

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

From a positive point of view, it is evident that student modeling represents a foundation of further support for individuals during the entire learning process. Precise student model can provide foundation for adaptive and personalized learning material delivery. Also, student model at the early stage of learning could be used to categorize learners and identify "at risk" students based on their online activity.

Although the present review demonstrates the benefits of using of student modeling in ITS, several negative assumptions should be noted. For example, prediction could be too prescriptive. Just because a learner prefers a certain type of learning it does not mean this is a constant preference as it may change with time or situation. Applying an adequate learning style does not necessarily mean success in completing the course, because other students' characteristics can contribute to the success or not. As such, course achievements should be interpreted with caution. On the other hand, modeled student characteristics correspond to numerous possible model parameter estimates that can make identical predictions about student performance. Moreover, the performance for different departments can significantly vary, as they may have different characteristics and structures [19].

5. CONCLUSION

This paper reviewed various characteristics and methods used for student modeling in order to deal with different challenges, such as personalized content delivery. The analysis showed that the most used student's characteristic is knowledge, while the most used modeling approach is Machine Learning, especially Bayesian networks. Predicting student performance is the most used scenario in student modeling. Future work will analyze a larger number of papers with greater emphasis on comparative analysis of the results achieved.

Acknowledgements

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

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The 11th International Conference on eLearning (eLearning-2020),

24 - 25 September 2020, Belgrade, Serbia

SECURE CREDENTIALING IN E-LEARNING USING BLOCKCHAIN

NEMANJA ZDRAVKOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, nemanja.zdravkovic@metropolitan.ac.rs

JOVANA JOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, jovana.jovic@metropolitan.ac.rs

MARINA DAMNJANOVIĆ

Belgrade Metropolitan University, Faculty of Information Technologies, marina.damnjanovic@metropolitan.ac.rs

Abstract: *A plethora of online learning platforms exist today: from universities offering online courses, various short and life-long-learning programs, webinars and specialized training. As the world shifts towards personalized learning, often from a distance, certification and credentialing has become more important than ever. Potential students and course-takers are often overwhelmed with the sheer number of options for different online courses, often with a steep price tag, yet not always with a certificate attached upon completing the course. In this paper, we examine blockchain-based solutions for certification and credentialing, and provide a model which can be incorporated within a higher-education institution's information system. The model takes advantage of the properties of blockchain: immutability, transparency and security and provides students with a secure proof upon completing their studies which can also be verified at any time.*

Keywords: *blockchain, certification, credentialing, data protection, e-learning, transparency.*

1. INTRODUCTION

The first Massive Online Open Course (MOOC) platform went online almost twenty years ago [1]. A MOOC consists of an online compilation of an entire course content, which brought changes in student learning trends. Whereas courses from Higher Education Institutions (HEIs) often follow a set syllabus, MOOCs give learners the freedom to choose what to learn, how to learn, often at their own pace. MOOCs can help learners in learning an acquiring knowledge in a manner that is advertised to be tailored for each student individually. Alongside the course material, these portals offer tests, assessments, homework assignments and often have exams. In addition, MOOCs encourage social learning by having forums and message boards, offering a "virtual classroom" for students from all over the world to communicate among themselves.

Online education portals like edX, Coursera, Udacity are getting a large influx of new learners as MOOCs have gained a notable significance in the present educational scenario [1]. Portals such as LinkedIn Learning offer professional training, while portals such as Skill Share and Udemy offer courses that are tailored for a wider audience, often with no previous background required, and usually cannot compete in quality compared to an online curriculum offered by a HEI. This is also reflected in their pricing policy – some portals offer free courses with a price for certification, others offer a monthly or yearly subscription. However, most often portals charge per course. Alongside MOOCs, a large number of HEIs are offering students the option of online enrollment, or offer blended learning as a combination of face-to-face and online studies [2, 3]. In addition, HEIs will offer their own courses (or a version of their courses) on other portals, which can further blur the line of the quality delivered content on a certain platform [4, 5].

Most MOOCs offer badges or certificates upon passing a course. These certificates are gaining more and more importance, especially for students from places where there is no access to quality education [6]. More often than not, these certificates do not have any credits or ECTS, but can serve as proof that a learner has knowledge in a specific topic. The badges and certificates are often delivered to the learner as a downloadable PDF file. Most high-ranked MOOCs have a system for validating the PDF by inserting a link in the PDF file to their website, where it has a record of the learner passing the course. However, with a rising number of MOOCs, proper credentialing and validating mechanisms fall short, as PDF files are susceptible to modification [7].

The aim of this paper is to introduce a system for credentialing the certificates gained from MOOCs and similar learning platforms by applying blockchain technology (BCT). Blockchains are append-only ledgers to which data can be added but changed or removed only in extraordinary circumstances. This feature guarantees the integrity of the data. BCT addresses interoperability issues by creating an overarching mechanism to link disparate personal records, such as badges and certificates from various learning platforms.

The remainder of the paper is organized as follows. In Section 2, we present a quick overview of BCT, how it can be related to credentialing, and present some related work in the field of education. In Section 3, we propose our credentialing system model based on BCT. Finally, in Section 4 we draw conclusions and set up a foundation for our research.

2. RELATED WORK

2.1 A quick BCT overview

Blockchain technology imposes fundamental changes to the way personal data are being processed, and can improve various data security solutions. A Blockchain can be viewed as a shared, append-only distributed ledger, in which all events (described by transactions) are stored in linked blocks [8]. A copy of this chain of blocks is kept by all nodes comprising the blockchain network. Each transaction contains a unique cryptographic signature decoupled with a timestamp, thereby making the ledger resistant to alterations. As the ledger is shared across all member nodes of the network simultaneously, all nodes are updated in real time. A block can be viewed as a data structure consisting of a set of transactions, and a header which connects the new block to the previous one. All blocks hence form a chain, and can trace back to the first block, called the genesis block. A blockchain relies on peer-to-peer networking, public-key cryptography, and distributed consensus.

The combination of these three concepts is what secures blockchain transactions. Unlike a centralized system, no single entity should be able to control the process of adding a block to the chain: each block is managed by all nodes who share equal rights. This is done in order to overcome security issues and is achieved through the process known as distributed consensus. This process establishes an agreement among the nodes in the blockchain network in the validation of each data block to be added to the chain. Depending on the consensus algorithm, nodes can either compete for correct transaction validation, be chosen randomly, or apply a different algorithm altogether. These algorithms can vary in complexity.

It is important to note that Blockchains are a class of technology; the term refers to different forms of distributed databases with variations in their technical and governance arrangements and complexity.

2.2 Related work

Blockchain is often referred as the next disruptive technology [9]. The properties of transparency and immutability that BCT offers have surpassed its initial use in cryptocurrencies [10, 11]. A variety of Blockchain solutions in healthcare, financial technology, supply chain management, and education are being developed, start-ups are formed and scientific research is being conducted [12 - 16].

Regarding credentialing in education, there is still only a small number of papers published [17, 18]. The authors of [17] state that Blockchain promises permanent authentication and storage for the growing alternative credentials market that is made up of various kinds of microcredentials, nanodegrees, MOOCs, and certificates and/or badges from various types of training programs, while giving users direct control and management over their credentials. They also point out the issue of scalability, especially when the Blockchain uses the proof-of-work (Pow) consensus mechanism, as does Bitcoin. One of the main conclusions found in [18] state that BCT allows users (learners, but potential employers as well) to be able to automatically verify the validity of certificates directly, without the need to contact the organization that originally issued them. Thus, it will likely remove the need for educational organizations to validate credentials.

3. SYSTEM MODEL

In this paper, we present a model for credentialing which can be applied to any learning platform (HEI online courses, MOOCs, skill-based or professional training platforms). The model is shown in Image 1.

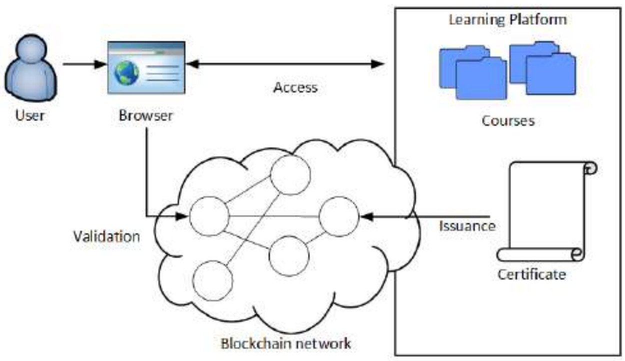

Image 1. Blockchain-based credential model.

We identify three main parts: the user, the learning platform, and the blockchain network itself. The user can be the learner, who can access the courses and/or training through their web browser, and can get access to courses provided by the learning platform. The learning platform

a) provides access to the learner, and b) issues certificates and/or badges upon course completion. The third and most important part is the blockchain network, which can be accessed by the user, and by the learning platform as well. The network can run independently of the platform, or the platform can be a part of the network. In the latter case, an incentive system can be applied (similar to the mining system in Bitcoin and other cryptocurrencies), where a platform can be awarded by being a part of the network. Users can be a part of the network as well, but as consensus mechanisms such as PoW require high processing power [10, 17]; it is advised that users can only access the network at certain cases. Other mechanisms, such as Proof-of-Stake (PoS) do not have high processing power requirements.

The two most common cases in credentialing are issuance and validation. These cases will be presented separately in the following subsections.

3.1 Issuance

Upon completing a course, a learner is often issued a badge or certificate. Most learning platforms have an automated system for generating these documents where certificate information (the name of the learner, course name, completion date, and in some cases credits, or expiration date) is added and a certificate file is generated. Within our proposed system, upon generating the certificate file, the learning platform will make a transaction to the blockchain. This entry will also have the certificate information, alongside metadata required for the transaction header, as shown in Image 2.

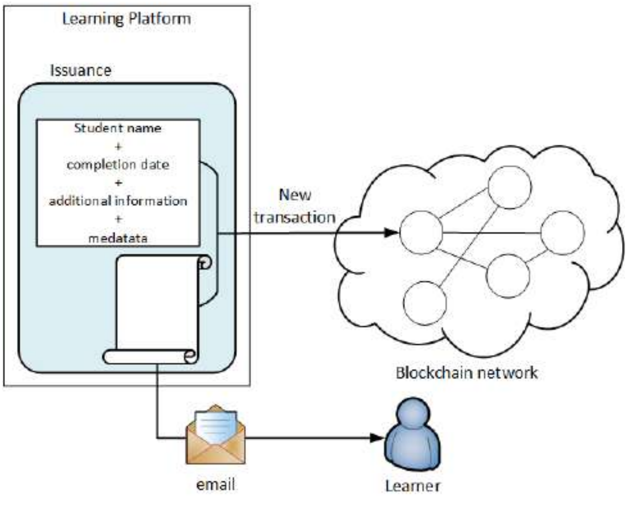

Image 2. Certificate issuance case.

This information will be encrypted, and can be accessed only by the learning platform, the learner, and an authorized third party. This new issuance transaction is sent to the blockchain, where the other nodes in the network will verify it and add it to the blockchain. It is important to note that the badge or certificate itself is not kept within the blockchain, only the metadata and the hashed value of the file. This ensures that the blocks within the blockchain are small in size, as they keep only alphanumerical data.

Once the transaction is added to the blockchain, it cannot be altered. Any attempts to modify the existing data on the blockchain must require a separate validation process; however, the earlier entered data remains on the blockchain, and can be traced back to due to the mechanisms that point to previous blocks.

Upon successful addition to the blockchain, the certificate file (the badge or certificate) is sent to the learner via email or an access link, alongside a link to connect to the blockchain to verify the document when needed.

3.2 Validation

The second case is certificate validation. Upon receiving the access link, the learner can verify its document by accessing the blockchain through a web browser. A drag-and-drop mechanism is added to upload the certificate file to the blockchain's input node, as shown in Image 3.

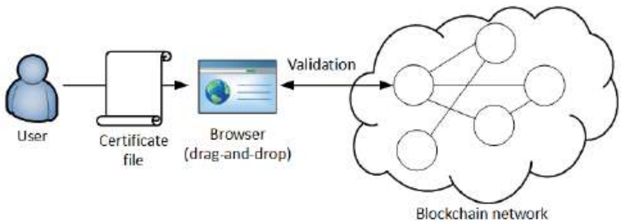

Image 3. Certificate validation case.

When the certificate file is uploaded, its metadata and hashed value is indexed and compared to previously validated entries in the blockchain. If a match is found on the blockchain, the certificate file is validated and a corresponding message appears on the web interface. If not, a negative message appears instead. The actor in this case is termed "user" because the learner (holder of the certificate) and/or learning platform can authorize a third party (potential employer, another learning platform, etc.) with the file and the access link to validate the file. Additional layers of security like two-factor authentication can be added as well.

The innate immutability property of BCT does not allow fraudulent or modified certificate files to be deemed as verified. Any tampering to the certificate file will result in a vastly different hashed value of the file, ensuring impossible verification.

Different BCTs can be used for developing such a system. The authors are researching technologies such as Ethereum, Hyperledger Fabric and Hyperledger Sawtooth for the system development. At this stage, we are actively collaborating with Belgrade Metropolitan University (BMU) and BMU's Information System staff in order to develop a simple prototype of the system for short online courses that BMU provides.

However, several open issues still remain. Firstly, should the blockchain be public (where anyone can be a part of the network) or private (where selected nodes comprise the network)? As the target group of the system are learning platforms, the authors tend to a private blockchain solution, where the learning institutions comprise the network, with the possibility to add the learners as nodes as well. The second question is regarding an incentive (reward, or mining) mechanism, for being a part of the network and validation processes. Learning platforms with subscription models can incentivize their subscribers to be a part of the network, in exchange for e.g. lower subscription rates. Finally, our research has high commercial potential, and competition does exist. A startup, Block.co [19], already has a similar mechanism for PDF file validation. However, their solution is towards the verification of any PDF files, while our research is focused on files that are exclusively badges and/or certificates from learning platforms.

4. CONCLUSION

Using BTC, data such as certificates from learning platforms can be issued and verified reliably. Blockchain can help learning platforms (especially with accredited courses) to add an additional layer to their credentialing process. We have presented a blockchain-based credentialing system can be easily deployable and connected to a learning platform. Issuance and validation via BCT could become a seamless process as the type of transaction is not difficult to implement. Adding blockchain to online learning platforms therefore presents a step towards secure online studying (both from the perspective of a learner, and from the learning institution).

The goal of this paper was to identify the potential of using Blockchain in the certification process of learning platforms. This paper presents the first step in our research in BCT-aided education solutions, and is a foundation for future development.

ACKNOWLEDGEMNT

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

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VIRTUAL LEARNING ENVIRONMENT

MILOŠ MILAŠINOVIĆ
University of Novi Sad, Faculty of Technical Sciences, milos.milasinovic@openlinkgroup.com

JELISAVETA ALEKSIĆ
University of Belgrade, School of Electrical and Computer Engineering of Applied Sciences,
jelisaveta.aleksic@openlinkgroup.com

MILOŠ JOVANOVIĆ
OpenLink Group, milos.jovanovic@openlinkgroup.com

IGOR FRANC
Metropolitan University, Faculty of Information Technologies, igor.franc@openlinkgroup.com

NIKOLA ALEKSIĆ
University of Belgrade, Faculty of Organizational Sciences, nikola.aleksic@openlinkgroup.com

Abstract: *Virtual learning environments (VLEs) are rapidly becoming an integral part of the teaching and learning process. They enable improvements in the efficiency of communication, both between students and teachers and among students.VLEs provide support and enhance the individual learning process by offering courses storages, forums, chats as well as mass communication opportunities. Educators need to understand that learning is a social process and that more than electronic lectures and e-mail discussions are required to provide an exquisite learning environment. The quality of course design, the use of appropriate tools, and the context of the course are key factors influencing success in the era of mass higher education and lifelong learning. Furthermore, the success of a virtual learning environment depends marginally on student acceptance and the use of such an e-learning system as well as students' innovations and computers.*

Keywords: *E-learning, Virtual learning environments, Education, Information technology*

1. INTRODUCTION

Virtual learning environments (VLEs) are swiftly converting into an essential component of the schooling and learning processes. They facilitate advances in the performance of interaction, both between learners and instructors and among students VLEs provide support and enhance the individual learning process by offering courses storages, forums, chats as well as mass communication opportunities. Educators need to understand that learning is a social process and that more than electronic lectures and e-mail discussions are required to provide an exquisite learning environment. The effectiveness of program layout, the application of proper devices, and the context of the program are essential determinants affecting success in the age of mass higher education and permanent education. Moreover, the realization of a VLE basically depends on student recognition and the utilization of that particular system as well as students' innovativeness and computer interests. There is a growing global initiative to practice the technologies based on the Internet as a method of inscribing various difficulties that higher education faces. An advanced feature of this method has the appearance of systems and approaches devised to make the design of studying more "distributed". Distributed studying is identified as studying held in the undefined place or time, but which incorporates the exercises of the on-campus learning system as well as those of the "distanced learners".

Due to the simple accessibility of the Internet, there has been a notable alteration in the education and schooling processes (Beller & Or 1998; Kiser 1999). Scholars are fundamental members of any educational environment. The essential point that distinguishes between VLEs and the conventional learning environment is the application of technology and a transfer of charge and responsibility to the students. Six dimensions are used to assess the factors, including student dimension, instructor dimension, course dimension, technology dimension, design dimension, and environmental dimension.
Focused on these methods, a effective VLE can be conferred as an place in which students:

1. are able and challenged to construct their knowledge (learning as knowledge building);
2. are all challenged to be active agents who are interdependent (community of learners);
3. perceive and experience the virtual learning environment as supportive of their collaborative learning (computer-supported collaborative learning). [1]

Though both conventional academic and virtual learning methods have prominently concentrated in the preceding decade, they nevertheless ought to be altered. Larson (2002) describes conventional educational learning as presenter-centered preparation of synchronized and cataloged crowds, restrained by classroom vacancy, while online studying is participant-centered, asynchronous, and accessible when and wherever. Likewise, Sauer (2001) defines virtual learning as adapting to accelerated obsolescence and demanding just-in-time education of ephemeral experience flexible to a particular venue, as opposed to more enduring and durable educational methods. Additional illustration by Smith (2001) identifies the unconscious intercommunication of the conventional classroom from the widespread of pre-preparation needed by distance-learning forms. Kerka (1996) recognizes the benefits and drawbacks of online education, compiling that virtual learning can be both utterly interactive and concurrently lonely due to the intrinsic challenges of strengthening cohesiveness and honest connectivity among student [1] [12].

2. BACKGROUND

A virtual learning environment combines real and virtual worlds to provide users with a sense of presence in the virtual environment. Such environments have emerged in teacher training programs as both effective and efficient approaches (Straub, Dieker, Hughes & Hynes, 2014) designed to support the management and operation of most aspects of an online course: the distribution of multimedia material (such as readings, lecture notes, assignments, and images); student-teacher and group discussions; exam and grade administration; and other teaching and administrative tasks.[2]
VLEs could be recognized by the next characteristics explained separately through this benefaction.

A VLE is manufactured space of information
We refer to the “architecture” of information instead of “structure” or “organization” of information to emphasize the fact that the structure results from analyzing the functional requirements of the environment. For education spaces, the practical conditions are diverse and still have not been thoroughly defined. Researchers must produce a more solid knowledge of the practical connection between how data is structured and expressed and how it can be applied in studying exercises and cooperations.

A VLE is a convivial space
An educational interactions occur in the environment, turning spaces into places. A set of Internet pages does not establish a VLE unless there is cultural cooperation regarding the knowledge. Cooperation can take numerous structures, including simultaneous (like chats) or asynchronous (electronic mail, panels) communication, singular or plural, text-based or audio and video, or even obscure interaction such as distributed objects. Students find themselves included in this space of information and observe their representational model and/or the model of the rest of the participants within the space. As soon as students see who else is interested in which information, the space becomes inherently social.

The virtual space is precisely presented
Educative communications transpire inside the setting, contributing to the spaces-to-places transformation. The key issue is not the representation per se, but what the students do with this representation. For instance, we observed that virtual space imparts on users' behavior even when space is only described by the text. (Dillenbourg & al., 1999). Notwithstanding, designs of the space may become an impression on the education process beyond motivational perspectives.

Students are considered as creators, not only as active participants
Students tend to co-construct the virtual space. In Internet-based environments, learning activities range from multiple-choice questionnaires to simulations and problem-solving. Simulations are described as self-sustainable studying settings. What is more specific to VLEs is the collection of exercises within which participants create and distribute articles. Frequently these articles are websites. In other words, the idea of the education activity in VLEs refers to something more affluent than in individual courses, closer to the concept of the project. The distinction among other settings and what virtual environments potentially advance can be defined as presenting students not only as 'active' but also as actors or members, contributing to the cultural and learning space.

VLEs are not limited to distance education
They also enrich classroom activities. Web-based education is often associated with distance education, while - in the practice- it is also widely used to support presential learning. The distinction between distance learning and presential one is dissolving.

VLEs incorporate varied technologies and several pedagogical methods
Comparable to a physical learning environment, a VLA combines a variety of devices bearing various functions: data, interaction, collaboration, studying, and supervision (Peraya & al., 1999). The very idea of the environment includes this notion of integration.

Most virtual environments overlap with physical environments
VLEs do not only include a widespread of software programs but also incorporate various physical tools that ought be distinguished in a classical teaching facilities.

3. RESEARCH

It is essential to settle on what was advanced within the individual learner. The process is concerned not just with the acquisition of subject-specific knowledge and skills, but with the development of more general, or strategic, approaches and skills. The author has argued previously that this development must also take place in the context of the acquisition of discipline or professional culture if both sets of knowledge and skills are to be of value to the individual in and applied by them too, new scenarios and fields of study and employment. This belief drives to an advent to program configuration which is output-driven and concentrates on the educational methods and the influence it derives on the student, preferably than an input-oriented aspect which converges on a form of content and its reception by the students:

- Identify learning outcomes - Whet is the course's goal? In which way was course altering the participants? Learning consequences should make transparent to students the direction of where they are heading at the end of the curriculum. They make the meaning for acquiring obvious as all the learning exercises and tests that make up the lecture should be in connection to the defined results
- Design Learning Opportunities - What can a learner do which will demonstrate that one or more Learning Outcomes have been met? Whatever the learners' current skill and specific knowledge are, these actions should be practical or "unique". Any learning opportunity (something learners are asked to do as part of their learning) is potentially a formative or summative assessment and should be related to the Learning Outcomes of the course.
- Utilize Deconstruction - Suitable to the students' capabilities, higher-level junctures can be pre-deconstructed toward lower-level opportunities for the student.
- Consider Group or Individual Learning - Learning opportunities/assessments can be examined for the nature and appropriateness of their collaborative/group working potential.
- Identify or Create Resources - one way of categorizing resources is as theory (subject-specific, information), external resources (e.g. reading lists, Internet resources, and lectures) and references (particular procedural suggestions or variety of guidances) and internal resources (other studying opportunities which are constructs of a deconstruction of the certain opportunity, or which highlights obligatory learning requirements). [3]

On the other hand, while research documents a positive connection between teacher's subject matter knowledge and their performance in the classroom, it has also been established that teachers with advanced preparation (in addition to typical coursework and fieldwork experiences) in teaching methods and strategies have a greater chance of successful longevity in the classroom [4]. When instructors are equipped in both content and teaching, it creates an immense contrast not simply to their quality of the course but also whether they're expected to begin and linger to his schooling (Darling-Hammond, 1999). A virtual reality learning environment allows for combined learning in content knowledge, teaching pedagogy, and problem-solving strategies [5].

To assist the VLE system evaluation this paper uses an integrated multiple criteria decision-making approach that combines the analytic hierarchy process (AHP) and quality function deployment (QFD).

4. RESULTS

Virtual learning by no means can be a replacement for classroom learning. But it can be used effectively to enhance the learning process. Virtual or online learning provides various channels such as mail, online chat and video conferences, through which students and instructors can interact with each other. Classes are not as interactive as they are live. Communication via email cannot replace direct communication. There can always be misunderstandings. The primary value attributed was its ease of use in posting and distributing documents, assignments, and announcements to students. An important secondary use was for communication, such as emailing students [2]. Amongst the numerous advantages mentioned by researchers, a great reason for the increase in virtual learning has been due to its capability to transform the limits of time and place. Students have the benefit of retrieving learning materials at their convenience in terms of when, where, which content, and how much [7]. Virtual learning provides students with more time to get familiar with the materials and focus their thinking (King, 2002). This makes discussions more succinct and focused, with opportunities to collaborate and easily share information [8] [9]. Students tend to be poorly interested in learning materials and courses in class. However, the students' interest was piqued after the implementation of the model. Students are used to seeking the solution to a problem on their own. Likewise, students were obligated to explore solutions on their own and, therefore, capable to remember what they studied for a longer time. There are several sorts of exercises that stimulate students' training. The Internet presents scholars with the chance to communicate with the instructor and other classmates. Moreover, it conquers constraints connected with the place and time. The conceptual framework for the development of problem-based learning via a virtual learning environment model is illustrated in Image 1.

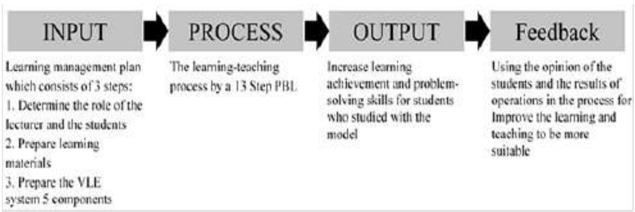

Image 1: Virtual learning environment model

Defining the purpose of learners and teachers

The perception of learners; and teacher's positions in the class are necessary for advancing the effectiveness of the model. The part of the learner is the most important and influences how education is done. Students have the responsibility of determining what and how they want to study regarding the concept of self-study. This suggests learners have to maintain their own account efficiently and be interested in each step of the training method. There are several studies on self-control supporting the importance of a well-structured problem-solving process [10]. The part of a teacher in the design is to build and operate instructional programs and supplies in extension to preparing programs for learners to be available for the class. Lecturers promote and encourage learners to convince them to investigate practicing their full strength.

Preparing for a VLE System

A virtual environment in online learning is established for teachers and scholars to communicate online as if it were a classical classroom. Students cooperate along with themselves and lecturers through social media. There are five elements of the VLE:

- *The studying management systems* - (SMS) produced for the study supported manage all learner data, including their profiles, activity flow records, logging statements, and progress reports.
- *The content system* - included instructional records and tools used to create content and explanations for a set of actions. Teacher demonstrations were conducted through the use of a streaming platform such as YouTube Live Streaming.
- *The cooperation system* - enabled learners to cooperate within an asynchronous medium, specifically an online chat room (Hrastinski, 2008)
- *Resources* - added to the website including curriculum content produced by teachers and students.
- *The evaluation system* - concentrated on the students' portfolio, which was a set of completed tasks, papers, duties, and exercises listed and distributed both in the form of publications and Internet content [12].

5. CONCLUSION

In conclusion, we have argued that the use of Virtual Learning Environments is an important and strategic means to facilitate education initiatives. VLEs are one of the most promising methods of delivering safe, cost-effective, convenient and flexible learning environments to supplement traditional teaching and offer an effective means of enhancing the student learning experience. The implementation of technologies in higher education requires a long process of planning where many different people are involved. This paper explains that virtual learning technologies, though equivalent to the “live” course form, are not affiliated with distinguished depravity of information alteration and do grant additional cost and admittance capabilities in analogous learning conditions. Moreover, given the rather meaningful associations between the sense of community variables and success and accomplishment obtained here, any development in the perspicacity of cohesiveness and assignment and cultural cooperation would be exacted to develop the acumen of education, fulfillment, and program resolution. Consequently, methods such as “social conferences”, intercommunication on general job-related matters, and timed competitions to determine and state difficulties all could raise the discernment of community and fundamental satisfaction and achievement. This paper observes that self-proclaimed studying consequences of these studies are in patter with those of stated results for “live” seminars. This is significant because it suggests that a minimal corporate investment in virtual learning activities, compared with “live” activities, can make an important contribution to employee satisfaction and success and employee self-worth measured by the receipt of an internationally recognized certification. [12] The results showed that problem-based learning via a virtual learning environment enhanced learning ability and problem-solving skills among students. Learner feedback regarding the design was assertive, as it accompanied their engagements and applied problem-solving to incite studying [11]. VLEs offer popular learning environments because of their convenience and flexibility, but their effectiveness remains an open question. Findings suggest that students learning basic IT skills in VLEs have better learning effectiveness than their counterparts in traditional classrooms. The effect of adopting new technology may be transitory in nature and not an enduring outcome. This finding indicates that the performance is not because of the transitory effects of novelty. Thus, it is reasonable to suggest that learning in the virtual environment is beneficial from a performance point of view. Most learners were satisfied with the high technical quality and reliability provided by our virtual learning environment. As a result of systems availability, students may have more chance to verbalize and articulate their current understanding [12]. VLEs can be used for supporting communication, study groups, and learning communities invaluable new ways that can complement traditional media and methods, rather than replace them [2]. The notable benefit of the unified strategy is that the evaluating standards are of importance to the stakeholders. It guarantees that the chosen system will fulfill the necessities and meet the stakeholders' expectations. Another benefit is that the approach can assure constant benchmarking and reliability. Therefore, the universities should continue to run the system to support and facilitate both teaching and learning [6].

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THE IMPLEMENTATION OF THE DICK AND CAREY INSTRUCTIONAL DESIGN MODEL INTO THE E-LEARNING PROCESS

Violeta Kitanovska, PhD of Pedagogy, Bitola, RN Macedonia

kitanovskavioleta@yahoo.com

Abstract: *The e-learning, today, is more than an alternative model of studying that can help students to optimize their learning or a trend in education. It is a necessity out of which the modern educational process is inconceivable.*

The permanent process of eLearning development and accomplishment is followed by many attempts to find out the most effective eLearning model that will facilitate the delivery of online learning environments and will lead up to optimal outcomes. Consequently, many eLearning instructional design models have been appeared.

This study elaborates how The Dick and Carey Instructional Design Model can be implemented to create pedagogically effective eLearning strategy. The use of The Systematic Instructional Design Model in eLearning will make the acquisition of knowledge and skills more efficient and will produce precisely measurable effects.

1. INTRODUCTION

As the eLearning tends to grow rapidly and has become an integral part of everyday teaching-learning process, pedagogical sciences are trying to achieve educational objectives and, at the same time, to meet learners' needs, by creating effective eLearning models that will produce the best results. In fact, creating an effective eLearning model means designing a strategy for online learning that will facilitate the development and the delivery of online learning through ensuring highly motivational learning environment, clearly and precisely defined learning objectives, structured learning contents organized into easy reachable "small portions of knowledge", providing self-control of the learning progress by giving a permanent feedback as an indicator of the personal achievements. There is a great variety of instructional design models dedicated to eLearning. Some of them are constructed over the basis of traditional ID models, adopting the traditional design structure and phases' organization into eLearning. The main intention is to fasten together the positive conceptual aspects and acquisitions of traditional models and the new contemporary challenges in designing eLearning courses. The planning and creation of learning models within an eLearning context, following the foundations of traditional models, integrate the educational technologies using a systematic approach, in order to give the learners a chance to successfully achieve the objectives and reach the finish line of success. Without the luxury of face-to-face learning interaction such an eLearning module should merge into a winning interactive strategy, providing learners all the benefits from eLearning course. But it is not quite easy. The traditional ID model organization, adapted to eLearning, should include several designing facilitators or designing elements to promote deliverable eLearning model.

2. BASIC DESIGNING ELEMENTS FOR E-LEARNING MODEL

The designing elements incorporated into the traditional model, will ensure simple, natural and effective learning experience, better connection between the learners and the eLearning content and, of course, satisfaction during the knowledge and skills acquiring process.

In this sense, one of the most important elements that should be taken in advance when creating a traditionally founded instructional design model for eLearning is learners' motivation. The motivation indicates whether a learners persist in course, shows the level of their engagement, the quality of their work and the level of their achievement [1]. Gaining learners' motivation increases learners' engagement and active participation into learning process. According to Keller's ARCS model [2], learner's motivation is essentially based on four components: attention, relevance, confidence and satisfaction. So, the stimulation of these components is seen as a highly inspirational way to enhance motivation and to achieve desired outcomes.

Another element that should be implemented into the ID eLearning model is a visual appealing. The first impression the learner gets for the eLearning course comes from its visual appealing. That's why the good graphic design, including photography, images, video, graphics, animations, multimedia elements relevant to the learning content, are often used as an initial motivating tool to improve learners' engagement and interactivity. Also, aesthetically appealing and eye-catching design, stimulates learners' curiosity, grabs their attention, attracts their interests and sustains their engagement. No power can keep learners active during the learning process more than an attractive visual environment.

When creating an effective eLearning model over the traditional model basis it is almost obligatory to implement the discovery mode of learning. Involving exploration into eLearning means giving opportunity to learn by doing. This enhances interest and interactivity, also supports the self-control over the learning process. It's quite beneficial when learners are allowed to learn more about the topic only by clicking on hyper-linked pages. Freeing up the navigation through learning materials or other supportive pages and scanning the new information by themselves can help the learner to create own paths of learning, build learning experience and understand the learning context better.

Each well organized eLearning model must give an answer to the challenge – interactivity. The interactivity needs to be incorporated into instructional design as a factor that enhances the learners' active participation and engagement into learning process. The interactions with learning content, from simple drag and drop interactions to interactive eLearning course or to virtual learning environment, keep the learners focused on learning and dedicated to their own learning progress. The human interactions, with the instructor and with the other learners, are also, very important. The instructor, during the eLearning course should build interactive learning environment, to teach and to instruct learners, to lead them from unknown to known, to mediate the difficulty, to get informed for the learners' outcomes and to give them a feedback for their own progress and achievements. He should support the collaboration and communication between the learners, too, by organizing group discussion in online forums, common issues group chats etc. It's essential for the learners to realize that they are not left on their own and can get the guidance and advice they needed.

Incorporating these advantages the eLearning instructional design model will overcame the core structure and the frameworks of the traditional learning design models and will rise to a contemporary learning model ready to confront the new educational challenges.

3. THE DICK AND CAREY ID MODEL IN E-LEARNING DESIGN

The Dick and Carey ID model is one of the most frequently used models for designing the teaching and learning courses. It is focused on planning and creating courses, rather than on the content delivery. According to the authors [3], learning process presents a comprehensive system that integrates the few basic components: instructor, learners, learning materials, instructional activities, delivery system and learning and performance environments and these individual components work together to bring about the desired learner outcomes [4]. The core structure of the model and its nine steps seems to be linear, but the revision step stresses the fact that the phases could be implemented in parallel, so turns the linear into iterative model. Each model step is a "consequence" of the previous step, but at the same time, it is a "precondition" for the next step. This way, the neighbor steps, influence each other directly. The revision step brings about the indirect relations among the others components. The Dick & Carey model offers a unique course design that provides structured guidance to ensure the goals achievement.

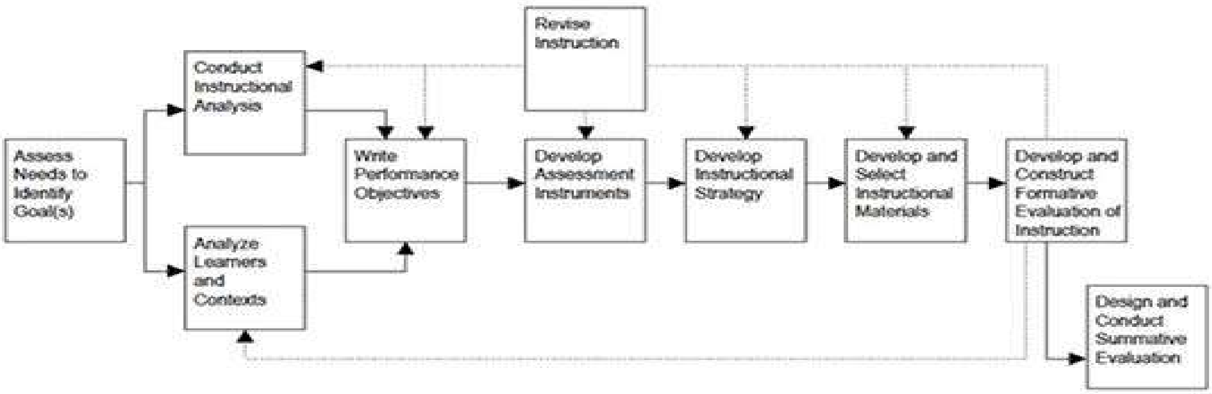

Figure1. The Dick and Carey Instructional Design Model

Contemporary point of view, underlines the fact that every instructional design effort tends to include computer or other devise for eLearning. Fitting to these requirements, The Dick and Carey model incorporates its components into eLearning design model. In fact, the comprehension of the model components and their organization makes the model applicable for online designing. Progressing from traditional to eLearning, the model keeps its substructure following the sequential steps order. Thus, it contributes in maximizing the efficiency of eLearning design.

Step 1: Assess needs to identify the goals

The first step of the model is identifying the eLearning goals and objectives. Setting clear objectives is obligatory at the beginning of every learning course. The course learning objectives should be derived from the main educational goal and associated to the learners' needs. They should point out the knowledge to be acquired and the skills to be developed during the learning process. While figuring out the learning objectives, the designer traces the path for creating an effective environment for learners' engagement, because installing the objectives will lead to clear course structure and the right learning strategy development.

Step 2: Conduct instructional analysis

Completing instructional analysis comprises the determination of learners' current knowledge base and skill sets in order to focus himself on the ways of filling the existing learning gap. In this step eLearning designer needs to clarify what the learner must know or perform as a starting position, to be able to achieve the learning objectives. The assessment of learners' educational background, the level of their learning abilities is the key element in designing an effective and engaging eLearning experience.

Step 3: Analyze learners and context

This step of the eLearning model does the analysis of the learners, identifying their existing characteristics, learning behaviors, habits, interests and needs, motivation, personal preferences, as to relate them to the instructional goal. In this step, the context and the settings for the performance are also determined because they are crucial for each learner's success. These activities help to specify the eLearning content with the basic intention to provide comprehensive and personalized eLearning environment.

Step 4: Write performance objectives

In association to the previously determined learning goal, this step requires setting down the performance objectives to precisely describe the tasks that should be realized. These specific objectives detail what the learners will be able to do at the end of the eLearning course. In fact, performance objectives are kind of criteria to assess learners' outcomes or to judge learners' performance.

Step 5: Developing assessment instruments

Every effective eLearning strategy needs to develop criterion-referenced assessment instruments. This means to create assessing exercises and activities, like multiple-choice questions, quizzes, tasks or interactive test, consistent to performance objectives, to check if the required objectives have been achieved by learners. Referring back to performance objectives, the assessment instruments will also prove whether the eLearning content has been mastered or not, so it will help to reveal the weaknesses of the eLearning process. One of the specifics in eLearning model designing is developing assessment instruments prior the instructional materials.

Step 6: Develop instructional strategy

This step includes bunch of components, determining the eLearning instructional strategy. At first, the learning strategy should take into consideration the settlements of the learning theories in order to develop an eLearning practice that best suites to learning goal. The way of context presentation, then, the instructor's and learners' activities, the forms of learners' participation (group or individual) and the use of assessments and tests must be determined. Defining the flow of whole teaching-learning process this step ensures that the learners will effectively reach the desired outcomes.

Step 7: Develop and select instructional materials

The seventh step offers the eLearning model instructional designer the opportunity to choose the learning materials that best fit to the learning goals and objectives and consider the learners' preferences, too. Online learning materials, tools and exercises might be effectively used for this purpose. Also, purposely created learning content, tutorials, scenarios, presentations, tests will work perfectly.

Step 8: Develop and construct the formative evaluation of instruction

Starting the step – formative evaluation, an instructional designer tries to evaluate the former steps to identify and to correct any weak areas that need improvement. The weaknesses detected by formative evaluation, should be fixed in this phase. This may mean rewriting text material, revamping online activities, rearranging the learning groups, reconstructing the examination materials etc. In any case, carrying out the formative evaluation usually controls all the aspects of eLearning process by involving target groups, so it ensures the effectiveness of any designing element.

Step 9: Design and conduct summative evaluation

The last step in The Dick and Carey ID model is summative evaluation. When the eLearning course implementation has finished, the summative evaluation is performed to verify the overall goals achievement. It is accomplished to check whether the eLearning model has reached the desired effects and it always comes after the revision, which progressively and interactively tests and assesses the model component during the design and development process, proves that the eLearning will work out effectively.

The Dick and Carey ID model provides new experience in creating effective eLearning model. Offering the system's point of view, this traditional instructional design model can be easily applicable when designing eLearning course. Its structure consisted of interrelated components that work together toward the previously defined goal, allows quick transformation from linear to iterative model, taking in advance the revision process, which could be conducted as many times as necessary, in order to improve all the model components weaknesses. This means that if the desired learning goal has not been reached, then the system will be modified until it does reach the goal. This leads to the establishment that the amount and the level of knowledge and skills acquired by learners will surely consist to the desired ones.

4. CONCLUSION

The need to find an efficient eLearning instructional model is a challenge that motivates instructional designers to search for the best eLearning design approaches. The traditional Dick and Carey model presents a specific way of planning and implementing eLearning course, bringing out optimal results. This model is recommended as one built over the considerations of pedagogical theories. It offers systematics framework for eLearning instruction. The model components are organized and interrelated linearly, but the revision component gives flexibility and iteration, so the designer can go back to the previous steps, to revise the course design until it meets and satisfies the learning goal. The model, also, considers the learners' characteristics, their interests, motivation, needs and prior knowledge level, as a basis for its design. Although, The Dick and Carey model is criticized as a predetermined objectives driven model it might be perfectly incorporated into eLearning model design, because the previously established learning goal brings relevance to the learning process, making the learners aware of what and why they have to learn and how the learnt is related to the real-world life. The traditional model, applied as eLearning model, supports learners' engagement and focus on learning, making eLearning goals achievement available.

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The 11th International Conference on eLearning (eLearning-2020),
24 - 25 September 2020, Belgrade, Serbia

SECURING ONLINE ASSESSMENTS USING CHRISTOFFEL SYMBOLS

NENAD O. VESIĆ

Mathematical Institute of Serbian Academy of Sciences and Arts, n.o.vesic@outlook.com

NEMANJA ZDRAVKOVIĆ

Faculty of Information Technology, Metropolitan University, nemanja.zdravkovic@metropolitan.ac.rs

DUŠAN J. SIMJANOVIĆ

Faculty of Information Technology, Metropolitan University, dusan.simjanovic@metropolitan.ac.rs

Abstract: *As more and more universities choose to have an online-only option for studying, the need for secure Learning Management Systems (LMSs) become more relevant. In-house built LMSs are used instead of expensive, commercial LMS solutions, and often they are not always secure, especially when it comes to taking online assessments that contribute to final grading. In this paper, we present an easy cryptographic model based on Christoffel symbols to hide alphanumerical characters for the purposes of securing online assessments taken on in-house LMSs, with detailed encryption and decryption methods.*

Keywords: *Christoffel symbols, e-Learning, encryption, online assessments, public key cryptography.*

1. INTRODUCTION

The recent COVID-19 global pandemic in 2020. has affected Higher Education Institutions (HEIs) on a global scale [1, 2]. More and more HEIs are compelled to switch to online or hybrid learning models, where the majority of students' pre-exam obligations are taken online, while exams themselves are most often taken with social distance precautions [3]. Needless to say, not all HEIs were fully prepared for the switch to online learning and online pre-exam and exam obligations [4].

With the switch to e-Learning, HEIs employ some form of Learning Management Systems (LMSs), often as a web-based application. The LMSs can be bought, or can be developed by the HEI itself (i.e. in-house development) which is usually the case for HEIs that focus on Computer Science (CS), Information Communication Technologies (ICT) and Electrical Engineering (EE). Most of the available commercial LMS solutions are often expensive, or do not have the built-in functionality required for the HEI. This can include, but is not limited to, an appropriate Application Programming Interface (API) to the HEI's Information System (IS), lack of course-specific options, and lack of adequate pre-exam options (assessments, tests, homework, etc.).

By opting for an in-house option, HEIs often have to pay less, can have continuous support by their own staff, and can further add needed functionalities. In other words, in-house developed HEIs can be tailored for every HEI individually.

The usual system model is a client-server model, where a student accesses the lesson repository located on the HEIs server, as shown in Image 1.

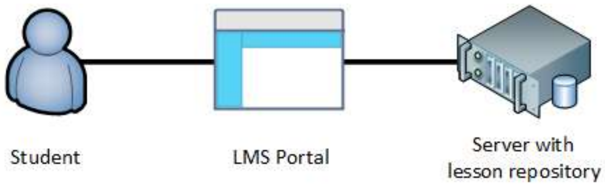

Image 1: Student accessing the course through the web-based LMS.

Although usually developed following software and systems engineering principles, the LMSs must needs certain requirements, such as functional and non-functional, structural, design, and performance requirements. Often overlooked are security requirements, as the majority of the systems are built to deliver lessons to the students. Most LMSs and similar learning platforms do not provide VPNs (Virtual Private Networks) when connecting to the platform, and communication of often conducted using Hypertext Transfer Protocol (HTTP) which is prone to security vulnerabilities [5, 6].

When implementing pre-exam obligations such as assessments, which are often in the form of checkboxes or radio buttons, input for plain text or code snippets, three major vulnerability cases can be identified:

1. The possibility of altering assessment/test answers,
2. The possibility of gaining access to the assessment/test questions through the HEIs database,
3. The possibility to gaining access to the HEIs database directly in order to modify assessment/test score.

The identified security vulnerabilities are shown respectively in Image 2.

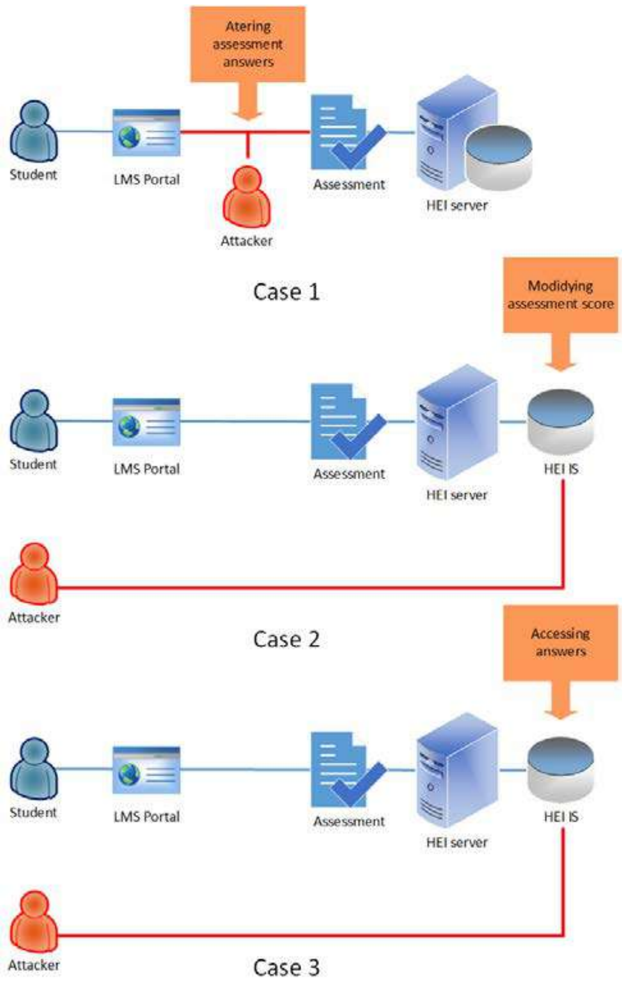

Image 2: Identified vulnerabilities when using an in-house developed LMS.

By adding a layer of text encryption and decryption that can be executed on either machine, an added layer of security can be achieved, without the need for VPN, licensing a secure socket layer (SSL) certificate, or applying similar solutions. The best of the authors' knowledge, there are no papers regarding the use of Christoffel symbol in this type of alphanumerical character cryptography.

The remainder of the paper is presented as follows. Section 2 gives an overview of the necessary differential geometry needed to present and prove the theorem. Main results are presented in Section 3, with the encryption and decryption algorithms respectively described, followed by concluding remarks in Section 4.

2. NECESSARY DIFFERENTIAL GEOMETRY

An N-dimensional manifold M_N equipped with a symmetric metric tensor $g_{\underline{ij}} = g_{\underline{ij}}(x^1,...,x^N)$ is the Riemannian space $\square_N$ [7, 8]. The covariant affine connection coefficients of this space are Christoffel symbols:

$$\Gamma_{i.\underline{jk}} = \frac{1}{2}\left(g_{i\underline{j},k} - g_{\underline{jk},i} + g_{\underline{ik},j}\right), \qquad (1)$$

for $\left[g^{\underline{ij}}\right] = \left[g_{\underline{ij}}\right]^{-1}$, $g_{\underline{ij},k} = \frac{\partial g_{\underline{ij}}}{\partial x^k}$ and $g^{\underline{i\alpha}} h_{\alpha jk} = \sum_{\alpha_0=1}^{N} g^{\underline{i\alpha_0}} h_{\alpha_0 jk}$.

If $g_{\underline{ij}} = g_{\underline{ij}}(t)$ for $x^1 = t$, the corresponding space $\square_N(t)$ is the Riemannian spacetime. The parts $\square_N(t)[u]$ of the family $\square_N(t)[u]$ are the slices.

The Christoffel symbols Γ^i_{jk} of the Riemannian spacetime $\square_N(t)$ are equal to 0 if all indices i, j, k are different from 1. If $i=1, j>1, k>1$ we have $\Gamma_{i.\underline{jk}} = -\frac{1}{2} g_{\underline{jk},1}$. If $j=1, i>11, k>1$ we have $\Gamma_{i.\underline{jk}} = \frac{1}{2} g_{\underline{ik},1}$. If $k=1, i>1, j>1$ we have $\Gamma_{i.\underline{jk}} = \frac{1}{2} g_{\underline{ji},k}$. If $i=j=1, k>1$, we have $\Gamma_{i.\underline{jk}} = 0$. If $i=k=1, j>1$ we have $\Gamma_{i.\underline{jk}} = 0$. If $j=k=1, i>1$ we have $\Gamma_{i.\underline{jk}} = g_{\underline{1i},1}$. If $i=j=k=1$, we have $\Gamma_{i.\underline{jk}} = g_{\underline{11},1}$.

The Christoffel symbols $\Gamma_{i.\underline{jk}}$ should be organized as a block-matrix:

$$\mathbf{B} = \left[\mathbf{B}_1 \quad \ldots \quad \mathbf{B}_N\right], \qquad (2)$$

where

$$\mathbf{B}_k = \begin{bmatrix} \Gamma_{k.\underline{11}} & \cdots & \Gamma_{k.\underline{1N}} \\ \vdots & \ddots & \vdots \\ \Gamma_{k.\underline{N1}} & \cdots & \Gamma_{k.\underline{NN}} \end{bmatrix}. \qquad (3)$$

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In [9], the matrix-valued functions are applied to encrypt and decrypt text. The property of non-unique factorization of matrices is the reason why the encryption method presented in [9] is secure.

3. MAIN RESULTS

This section consists of the proof of Theorem 1, followed by the algorithm for encryption and decryption.

Theorem 1. The components of $g_{\underline{ij}}$, the metric tensor □ of the Riemannian spacetime $□_N(t)$ and the corresponding Crhirstoffel symbols $\Gamma_{i.\underline{jk}}$ satisfy the equation

$$g_{\underline{ij}} = -2\int \Gamma_{1.\underline{ij}} \mathrm{d}t + c = 2\int \Gamma_{\underline{i.1j}} \mathrm{d}t + c, \qquad (4)$$

where $i, j \geq 2$, for a function c independent of t.

Proof. In the case of $\Gamma_{i.\underline{ij}} \neq 0$, we obtain

$$\Gamma_{1.\underline{ij}} = -\frac{1}{2} g_{\underline{ij},1}. \qquad (5)$$

After integrating the last equality by t, we complete the proof of this theorem. □

As a mean to secure the connection between a client's (student's) browser and the server-side application, the algorithm must be equipped with both encrypting and decrypting parts. As stated before, most of the assessment answers are in the form of plain text or cone snippets, or checkboxes (indicators) which can also be passed as plain text, as shown in Image 3.

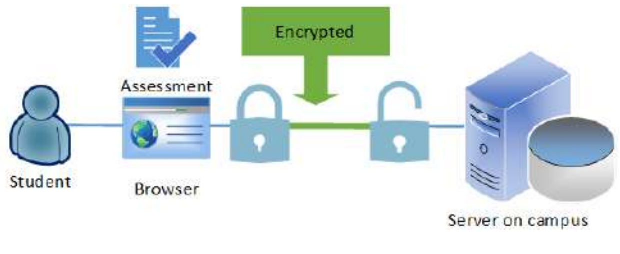

Image 3: Secure connection between the student (client) and the HEI (server).

3.1 Algorithm

The next function of positive integers m and n where $m \leq n$ is necessary for the following algorithm [3]

$$\mathrm{mod}1N[m,n] = \begin{cases} n, & m \mid n, \\ \left\lceil \frac{m}{n} \right\rceil, & \text{otherwise} \end{cases}. \qquad (6)$$

Let the characters be organized in the table T of the type $p \times q$. The position of the character ch in the $u-$th row and in the $v-$th column is $z = u + i \cdot v$, where $i^2 = -1$ is the imaginary unit.

The character from the position $Z = U + i \cdot V$ is therefore hidden by the polynomial $p(t) = t^2 - 2U + U^2 + V^2$.

3.2 Encryption

For INPUT we have the text τ of c characters and the private key: The square matrix valued function $C[u]$ of the type $v \times v, v^2$ □ c, the table of characters T of the type $p \times q$;

E1: $k = 1$

E2: Let the $(k-1)-$th character of the text τ be placed at the position (u^k, v^k) in the table T. Transform the pair (u^k, v^k) to the pair

$$\left(\overline{u}^k, \overline{v}^k\right) = \left(u^k + m_l^k \cdot p, v^k + m_r^k \cdot q\right), \qquad (7)$$

for $m_l^k, m_r^k \in$ □ ;

E3: Transform the pair $\left(\overline{u}^k, \overline{v}^k\right)$ to the polynomial

$$p^k(t) = t^2 - 2\overline{u}^k \cdot t + \left(\overline{u}^k\right)^2 + \left(\overline{v}^k\right)^2; \qquad (8)$$

E4: $k = k + 1$;

E5: Until $k \leq c$, repeat the steps E2 to E4;

E6: $k = k - 1$;

E7: From $\hat{k} = \frac{1}{2} v \cdot (v+1) - k$ square polynomials $q^1(t), ..., q^{\hat{k}}(t)$ whose roots are real and different of 0;

E8: Schedule the polynomials $q^1(t), ..., q^{\hat{k}}(t)$ before, between and after the polynomials $p^1(t), ..., p^k(t)$ in the following order:

E8.1: At least v of the polynomials $q^i(t)$ schedule before the polynomial $p^1(t)$;

E8.2: The rest of the polynomials q^i schedule between the polynomials $p^1(t), ..., p^k(t)$ and after the polynomial $p^k(t)$;

E8.3: The result of the last two steps (E8.1 and E8.2) is the ordered set S of the polynomials $q^r(t)$ and $p^d(t)$;

E9: Form the right triangular matrix ρ with η rows of the polynomials from the set S;

E10: Supplement the matrix ρ with the elements above the diagonal to the symmetric matrix $\tilde{\rho}$ of type $\nu \times \nu$;

E11: Select a real index number u_0 and form the matrix $C[u_0]$;

E12: The matrix $\tilde{\rho}$ transform to the matrix $\tilde{\rho}$ whose elements are $\tilde{\rho}_{ij}(t) = (C[u_0])_{ij} \tilde{\rho}_{ij}(\tilde{\rho}(0))^{-1}_{ij}$;

E13: Select the index i_0 and form the Christoffel Symbols $\Gamma_{i_0 \cdot \underline{jk}}$ with respect to the matrix $\tilde{\rho}(t)$ as the matric tensor. The public key is $\mathbf{B}_{i_0} = [\Gamma_{i_0, \underline{jk}}]$.

E14: Send the message (i_0, u_0);

OUTPUT: Public key $\mathbf{B}_{i_0}$.

3.3 Decryption

INPUT: Public key $\mathbf{B}_{i_0}$, message (i_0, u_0), and the Private Key: the square matrix values function $C[u]$ of the type $\nu \times \nu$, $\nu^2 \gg c$, the table of character T of the type $p \times q$;

D1: Obtain the components $C[u_0]$;

D2: $i = 1, j = 1, \text{text} = ""$;

D3: If $i_0 = 1$ then the element $(\mathbf{B}_{i_0})_{ij}$ transforms to

$$\pi_{ij}(t) = -2\int (\mathbf{B}_{i_0}(t))_{ij} \, \mathrm{d}t + c_{ij}[u_0], \tag{9}$$

and to

$$\pi_{ij}(t) = 2\int (\mathbf{B}_{i_0}(t))_{ij} \, \mathrm{d}t + c_{ij}[u_0] \tag{10}$$

otherwise;

D4: Solve the equation $\pi_{ij}(t) = 0$ by t;

D5: If the solutions of the equation from the step D4 are real, then $text = text \circ ""$. If these solutions are complex numbers $(z_{ij})_{1,2} = a_{ij} \pm i \cdot b_{ij}$, $b_{ij} > 0$, then

$$text = text \circ T[\mathrm{mod}1N[a_{ij}, p], \mathrm{mod}1N[b_{ij}, q]]; \tag{11}$$

D6: $j = j + 1$;

D7: If $j > v$, $i = 1+1$, $j = i$;

D8: repeat steps from D3 to D7 if possible;

OUTPUT: text.

5. CONCLUSION

In this paper, we have provided an algorithm for encrypting and decrypting text (or in general, alphanumerical characters) using Christoffel symbols. Continuing work started in [9], the authors aim to expand the use of Christoffel Symbols for cryptography. Further research will include implementing the encryption and decryption algorithms in a scripting language that can be easily implemented either side of the client/server system.

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HOW TO LEVERAGE CORPORATE E-LEARNING PLATFORM, FOR MAKING TOOL USED IN CREATING CANDIDATES' PROFILE, WHICH TURNS BUSINESS OPPORTUNITIES INTO PROSPECTIVE CLIENTS

MONIKA ZAHAR

CDS, Dublin, Ireland, monika.zahar@comtrade.com

SRDJAN ATANASIJEVIĆ

CDS, Dublin, Ireland, srdjan.atanasijevic@comtrade.com

MELANIJA VASILIJEVIĆ

CDS, Dublin, Ireland, melanija.vasilijevic@comtrade.com

Abstract: *In the age of globalization and technological advances, having a qualified, experienced, and committed workforce is the key to a company's success of every leading provider of software development services and innovative IT solutions. However, before delivering outstanding results for the customers, building joint teams, and addressing various client's needs, for a successful business proposal, it is crucial to outline how talented and qualified your team is. This paper presents CDS experiences and practices in the usage of eLearning technologies to successfully create a course that will help with making standardize ways of presenting teams for future project engagement. The authors of this paper have the primary intention of showing how to establish a process for timely response to the client's demand for experts, provide effective staffing solutions, and have a higher degree of client satisfaction due to a more efficient candidate selection process.*

Keywords: *Corporate Education, E-Learning, Human Resource Management, Project Engineering, Resumes, LinkedIn*

1. INTRODUCTION

Background of the study

Engineering companies, delivering digital transformation from ideation to production through Agile distributed teams, must strengthen their offerings to accommodate all customers' new demands and help them succeed. Delivering managed software engineering services, these companies aim to build long-term relationships and loyalty with their clients, to become their partner, not just a supplier. In today's digitally-driven business and competitive market, to accomplish this, speed is imperative [1].

The challenges facing these organizations are how to timely offer the best talents that have both professional qualifications and soft skills, always having prepared resource pool for upcoming opportunities, ready to be engaged when clients need them most. The most immediate way to achieve this is to have employees' regularly updated resumes, that could be well-matched and optimized to client requirements, as an entry card for winning all future project engagements. Together with the resumes, being a company brand ambassador on social media and keeping LinkedIn profile up to date and synchronized with the resume information is equally important. Supporting these questions and staffing efficiency, the CDS company needed to make a standardized and unified way of presenting candidates' profiles. Intend was to establish such a tool that will help create a robust talent pool, increase the probability of gaining business opportunities, and give the client short turnaround time.

In his article [2], Chin examined the gap that exists between classroom instruction for resume writing and actual recruitment practices and concluded how important is to provide accurate and reliable teaching, which is following the voices of professionals involved in the recruitment process, to enable his students writing resumes confidently. CDS encountered similar shortcomings with the previous staffing process [3]:

- The company had specific standards and candidate profile templates; however, they were not adequately adopted, and employees did not update their resumes on time.
- Without clear guidelines, everyone interpreted the candidate profile template in their way, so it is noticed that in most cases, the candidate's experience and qualifications were not appropriately presented.

- Market conditions and requirements have changed. Earlier, it was essential to emphasize years of experience and technological skills, but today the focus is on the third dimension: domain knowledge. Therefore, CDS intended to standardize all three aspects in presenting candidate profiles.
- Accordingly, candidate educational background and obtained certification should not be prioritized.

Research focus

The main challenge became more precise: how to ensure that company's talent base and qualification of expert team members are well presented in the business proposals through their profiles. Moreover, in order to keep employees confidentiality and protect a business from unforeseen circumstances, there is a question of how to establish the most efficient and convenient way of presenting available candidates for future project engagement before contract agreements. Today, when digital leaders are moving much faster, it is critical to meet tight schedules, can deploy staff quickly, and create much more efficient staffing systems and processes to resolve the gap between timely response to clients' experts' needs and fast preparations of candidates' profiles. CDS has recognized that these challenges require a completely different approach and rethink the company's current staffing model.

Expected results

The goal was to create a unified, comfortable, and accessible tool using a corporate e-learning platform that will help all employees and project managers emphasizes skills and expertise according to project requirements, which lowers time consumption. Moreover, one of the company's objectives was how to adopt a standardized procedure for candidates offering within the whole company.

Image 1: Course content structure: Moodle e-learning platform and imported SCORM Package

2. METHODOLOGY

CDS authors had the intention of making good course experience, which is adapted to the way software engineers think, that was not just another online generic training. They used the expertise and practical knowledge that they acquired while working closely with human resource experts and resource management specialists. Beside them, close collaboration with engagement managers and program managers gave them better insight into clients needs and pain points, insight into required technical skills and levels of needed experience, which was one of the main factor of success of the candidate's profile preparations for project interviews. Those are just few amongst many reasons that make the course practical tool, that resolved many challenges on a quest to conquer new projects and opportunities.

Course sections are completed within two target groups:

- For company engineers, with the primary intention of bringing advice and information on how engineers can present themselves in the best light on social media, in their resumes, or on the project interview.
- To help human resource managers, sales, and project managers to effectively prepare project team offering, providing more consistency across the projects.

Course form

The endless benefits of eLearning determinate that CDS corporate PMO EDU platform (Moodle-based eLearning platform developed and maintained within the company) was the most appropriate place to store the structured materials [4,5]. Besides the fact that materials are placed online, therefore, are easily accessible for all employees, they are available at any given time no matter the location, device participants are using or pace of learning they choose to follow. After the participant is enrolled in the course, he/she is able to navigate through all course content without restrictions. All materials that are part of the course content are easily downloadable and can be used to resolve specific questions or situations while preparing the resume or editing social media profile [6].

Image 1 presents which course content is structured within the Moodle platform and which one is imported using the SCORM package.

The course is published on the corporate PMO EDU eLearning platform. Still, primary learning materials, downloadable templates, reusable examples, list of phrases, links to videos, and additional reading materials are created using the Authoring tool exeLearning (free software tool that can be used to develop educational interactive web contents), exported as a SCORM (Sharable Content Object Reference Model) package and afterward imported into PMO EDU platform as a standard course segment [7,8].

CDS experts decided on using authoring tool exeLearning, presented on Image 2, and SCORM package interchange format, due to their numerous benefits for all course stakeholders:

- The primary benefit is interoperability. Producing e-learning content, most of the time, goes hand in hand with your clients/employers or other targeted groups asking for content integration into an LMS that already exists. SCORM package is compatible with many platforms is an adequate solution that is time-saving and promotes cost-effectiveness as there are no additional costs for integrating content.
- Overcoming the problem of the authors' joint work was another motivation since the collaborative development of e-course can sometimes make it difficult for co-authors to work on one project at the same time. Changes that each author makes in the Authoring tool exeLearning are easy to save and edit. Co-authors can continue editing content by just opening the document in the browser with one click.
- Working in the eLearning Authoring tool (exeLearning) for creating an e-learning course that could be exported in any format as SCORM is user friendly, following the "What You See Is What You Get" technique, offering a list of functionalities even suitable for beginners in content creation. Often the content expert, author, is not the person with the technical expertise to encapsulate this content into an online course. Therefore this tool is perfect and easy to use solutions for experts from various domains.
- Due to its durability, it can be used with any preferred system that the company already has. exeLearning does not require significant modifications with new versions of system software.

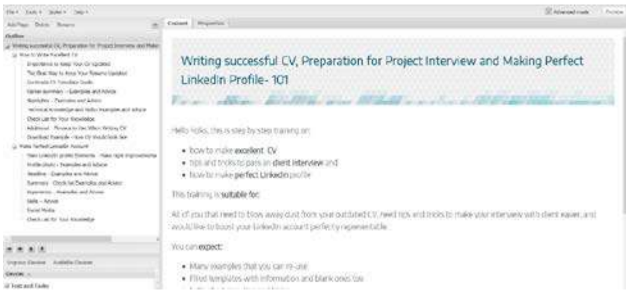

Image 2: Course structure in exeLearning tool

Since the author used the Authoring tool exeLearning to create and export the course in SCROM format, amongst many benefits, there are fewer limitations that user should be aware of when deciding on usage of this tool:

- It allows for a finite set of variables to be passed to and from the hosting LMS, for example, completion, numeric scores, bookmarking, etc.
- It has a limited set of metrics you can store with your quiz results, like score, pass/fail, complete/incomplete, total time, etc.
- Exported SCORM versions have to be well compatible with the version of the moodle platform.

Deciding whether to use the SCORM package format isn't straightforward, and there are pros and cons to both options. If authors have time to invest in developing entertaining content, the presented form is a great idea, as they tend to look polished and engaging.

3. RESULTS

Course structure

This training is sectioned into two topics of learning [9]:

- The first topic is related to resume preparation as it is one of the main tools that provide an opportunity for future work on numerous software solutions and projects. Being the first thing that is presented to the client, the candidate must make it impeccable.
- The second topic is intended to help participants make an excellent LinkedIn profile and manage their social media in an acceptable corporative manner (Professional ID card in the additional text).

Each course topic is divided into smaller learning units that are distributed as following: resume topic has ten units, while the LinkedIn topic contains nine units. The goal of this micro-distribution is to make a positive psychological effect on the content quantity and better learning experience for course participants. Learning during working hours can sometimes be challenging due to work in a fast pace environment, simultaneous engagement on various projects, and other reasons. The concept of this course allows participants to go through educational materials while using short breaks between meetings, early morning coffee hours, or even while waiting for the feedback on the component they worked on. Therefore the whole course is composed of 20 units as mini-lectures, that require between 5 -10 minutes to be read [10].

As shown in Image 1, the first thing that participant encounters when he/she enrolls in a course is the landing page. This page encloses high-level information about training: summary description, expectations participants could have knowledge-wise, learning objectives, information on targeted training audience, completion requirements, navigation, and trainer's biography. This structure of the landing page gives participants a chance to get a better understanding of what is ahead of them and to also virtually meet their teachers that ensures trust in course value and content quality [11].

Every topic has various types of materials that were provided by the authors of this course. Those reusable examples and downloadable templets can be reproduced (copy/past system) when participants decide to prepare their resumes and professional ID card in general. Resume writing can be challenging when the vocabulary is lacking buzzwords and sentences to connect a candidate's professional history into a career summary. Therefore, CDS authors did research and, as a result, conducted document with all practical terms that participants can copy, adjust to their needs, or use as an idea or guideline when writing a resume or even LinkedIn stories [12].

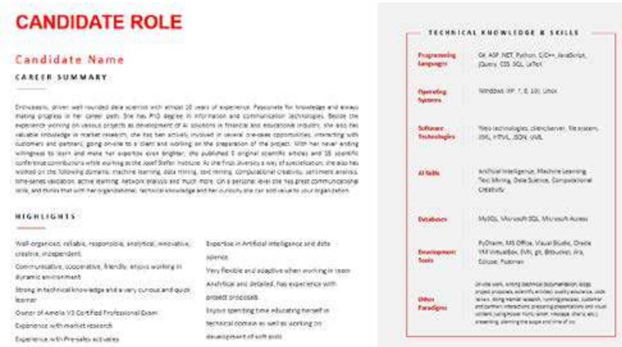

Image 3: Example of anonymized resume template

Image 3 presents an example of one anonymized resume template, an approach that is established to keep the most sensitive personal data safe as one of the successful blind offerings for project and sales managers.

Course completion

At the end of each topic, there is a "Checklist". It contains the most important takeaways for the related subject. By self-examination, participants will be able to determent if he/she mastered the content within the topic, or if there is a need to go back and read it once more. There are no restrictions regarding the content reading pace. The participant has as much time as it is necessary to go through each unit and is always able to go back or forth, an unlimited number of times. Answers in the mentioned section are not required to be provided by a participant in order for him/her to start the next chapter. The only intention of this section is better self-preparation for the final Quiz.

A participant is going to be able to pursue in course completion when all materials that are provided are marked as read - meaning: they have to open the SCORM package and read every topic, unit, go through all provided examples, and additional reading materials. When done thoroughly, the subject in the Moodle portal where the SCORM package is embedded will be automatically marked as complete. If a participant feels ready to take the final Quiz immediately after reading all materials, he/she can do it. Yet, if the participant feels like he/she doesn't have enough time or wants to read materials once more, he can postpone the final Quiz with no limitations.

The main goal of the final Quiz is to confirm that participants developed awareness about the importance of the course subject, as well as to verify that they adopted vital takeaways. Therefore, most questions are the multichoice type that requires the ability to reproduce knowledge and think critically to answer correctly. The question bank contains 20 items in total, divided into two categories to cover each topic, as presented in Image 4. The final test is generated by randomizing system choice of 5 questions from each category (10 in total), where answers are always shuffled and distributed each time differently.

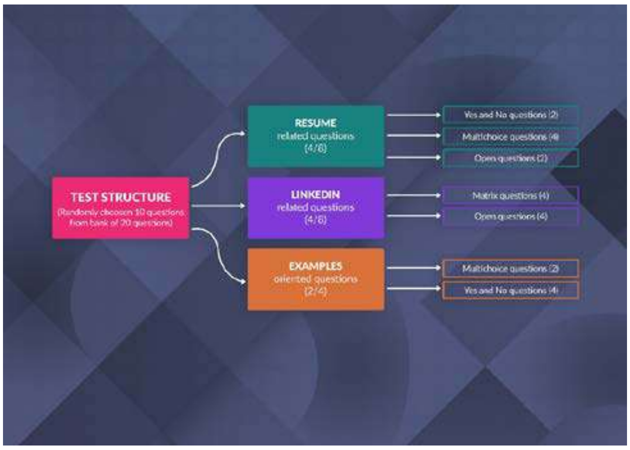

Image 4: Final Quiz structure

The final Quiz can be taken an unlimited number of times until the participant gets a passing grade. The bottom line for successful test competition is 80% correct answers from the final test or 8 out of 10 questions. In case the participant didn't pass the test, he/she will be able to go back and see which answers were incorrect and use this option for knowledge advancement. All failed attempts are saved to the participant's profile so she/he will have insight in this information at any time.

After the participant successfully passed the test, he/she will be asked to fill the survey and give the authors feedback on content quality, places for improvements or leave any additional comments and taught regarding course overall impressions [13, 14]. This step is also required to be done before getting the certificate.

Image 5: Certificate of completion

As a proof and personal evidence that the participant completed the course, he/she will be able to get a certificate of completion by clicking the link that is provided at the end of the course page, presented on Image 5. Every issued certificate is personalized with the participant name and signed by the director of CDS. The platform automatically notifies the trainers about new course completion and the information and goes to the certificate database in the CDS PMO EDU portal.

4. DISCUSSION

Considering that the eLearning platform could require high self-motivation, implies one-way communication, and less interaction, there was an intention to avoid possible difficulties of understanding parts of the content. The main goal was to adopt improved and standardized way of presenting candidates profile through the whole organization [15]. Therefore, the authors hosted two separate online knowledge sharing sessions for project managers, as well as for engineers, to present a new approach [16,17]. More than 100 participants had an opportunity to see the course demo live and learn about it and its benefits first hand. The main feedback about the course from this session was:

- Project managers considered this tool as an engine for generating great future project opportunities by teaching their subordinates how to improve resumes and professional ID card, without investing vast amounts of time.
- Engineers considered that after completing the course and using all provided additional materials and templates, the needed time for CV preparation would be cut in half. As soft skills are often put in the background compared to the improvement of technical knowledge, they recognized this course to be straight forward and gave detailed instructions for each needed section in a resume or LinkedIn. Participants would recommend this tool to the other colleagues as a practical solution to the successful preparation of a professional ID card.

In the first three months after the establishment of this tool, and its active use, the level of acceptance of CDS candidates for new projects has increased significantly: CDS employees candidates have 40%, while CDS contractors candidates 25% acceptance rate increased. In the coming period, CDS will strengthen the activities of the new staffing process, promoting good practice through more knowledge sharing sessions, to adopt a standardized procedure throughout the company. After complete adoption, more extensive studies will give more specific benefits and effects of the new CDS staffing approach [18].

Presented solution can be implemented not just in software engineering companies, but in any business practice in which a company needs a partner to perform specific tasks, handle operations, or get access to diverse technology expertise.

Nevertheless, benefits also have students as soon as they graduated from job seekers. CDS used the opportunity to introduce this course to the students of partner technical faculties, giving them entry to professional resumes, valuable insights, and a complete guide on how to be appropriately prepared for the first job applications and career development. More than 100 students of master's programs and finishing years of bachelor's degree program participated in the session. They declared that they would use all provided materials, tips, and tricks for writing their resumes.

Future improvements will be made according to feedback from practice. The presented approach could be more improved, providing different resume templates specific for each professional role and seniority. The authors could prepare customized resume examples for the positions like project manager, business analyst, solution architect, technical lead, frontend developer, backend developer, quality assurance engineer, etc. These unique profile templates could summarize and highlight the essential responsibilities, activities, qualifications, and skills for a particular role. It will help project managers and employees to update it quickly and customize depending on the candidate's competences and experience for the required position, emphasizing the client's requirements.

5. CONCLUSION

Standardize and anonymize resumes provide a compelling blind offering, ensuring that personal data and sensitive pieces of information will not be exposed before contract agreements (GDPR requirements). Together with this, if candidate social media profiles are not well aligned with prepared resume, client's needs, and company values, blind offering helps to present candidates' qualifications without bias. This will minimize the negative impact of scanning offered candidates through their social media profiles.

In collaboration with CDS project managers and their experience in the new approach during the preparation of candidate profiles for new project opportunities, certain advances are identified. According to their feedback, more reusable profile phrases will be created, simplified for their customization. Also, the list of technologies will be expanded. Bad practices and examples will be more highlighted to draw people's attention to what they should not use in their profiles.

The conventional approach, presented in this research, provides effective staffing solutions for human resource managers, projects, and sales managers, while gives engineers practical tools for creating a resume and LinkedIn profiles. Usage of a corporate e-learning platform in the creation of this tool proves all its benefits: scalability, consistency, and accessibility. The authors of the presented tool will further refine and optimize it to be in line with market trends, company needs, and customer requirements.

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DIGITAL TOOLS AND PLATFORMS FOR ONLINE TEACHING MATHEMATICS IN PRIMARY SCHOOLS

ANA VRCELJ
Primary school “Kantrida”, Rijeka, ana.vrcelj@skole.hr

NATAŠA HOIĆ-BOŽIĆ
University of Rijeka, Department of Informatics, natasah@inf.uniri.hr

MARTINA HOLENKO DLAB
University of Rijeka, Department of Informatics, mholenko@inf.uniri.hr

Abstract: *The paper presents the results of a preliminary research about the digital tools and online platforms which can be used in teaching mathematics online in primary schools. Special attention is given to identifying the tools which provide the possibilities for formative and summative assessment of students, as well as implementation of gamification and Game-Based Learning. Recommendations for teachers based on the existing literature and experiences for using the tools are also provided. The presented research will continue under the project “Digital games in the context of learning, teaching and promoting inclusive education”.*

Keywords: *Online teaching of mathematics, digital tools and platforms, Microsoft Forms, Kahoot!, Matific, Loomen Nearpod, Digital games project*

1. INTRODUCTION

The “National curriculum for primary education” is the initial document for compulsory education in the Republic of Croatia, which enables the development of basic education competencies essential for the realization of personal potentials, continuing education and lifelong learning. One of the goals of the new curriculum is to modernize teaching. Curriculum guidelines suggest replacing the traditional methods of teaching by a modern constructivist approach, which involves student-based teaching and includes interaction with students [1]. This approach develops children's potential for linking relevant information, facts and enhancing the creative and active aspects of learning. In contrast, the traditional approach is based on using textbooks, learning through memorization and recitation. Traditional approach seems to have a number of limitations when developing critical thinking, problem solving and decision-making skills in students [2], [3].

Currently, the educational system is implementing an experimental phase of curricular reform named “School for life” (in Croatian, “Škola za život”), which places emphasis on acquiring knowledge, developing ability and willingness of students to solve problems, making decisions, metacognition, critical thinking, creativity and innovation. Students should be trained for communication, collaboration, information and digital literacy, and the use of technology. The main goals of the experimental program are to enhance problem solving competencies of students, to increase the satisfaction of students with the school and the motivation of their teachers [4].

However, this new approach to education faced its first obstacle in an unexpected situation due to the COVID-19 pandemic which resulted in developing the emergency eLearning protocols [5] in countries all over the world. Due to the COVID-19 pandemic situation, and the suspension of direct teaching, Croatia switched to online teaching "overnight".

Although the Croatian Ministry of Science and Education (MZO) responded quickly by organizing TV classes and creating recommendations for teachers, as well as the fact that many teachers were trained for at least basic use of information and communications technology (ICT) in teaching through the “School for Life”, there were still some difficulties. One of them was related to the selection of appropriate digital tools and online platforms for learning and teaching, suitable for different school subjects. The main problems were related to the lack of evidence which evaluates each tool or platform and recommends the best possible option for teachers’ and students’ needs.

This paper emphasizes on teaching of mathematics and describes the digital tools and platforms used by primary school teachers. The aim of this preliminary research is to critically evaluate tools and platforms to state advantages and disadvantages, especially in relation to the formative and summative assessment of students and the possibility of implementing gamification and Game-Based Learning

(GBL). Recommendations for teachers based on existing literature and experiences for using those tools are also provided.

This research will continue within the scientific project "Digital games" so the possibilities of using games for improving motivation for learning mathematics in primary schools will be further investigated.

2. TEACHING SUBJECT OF MATHEMATICS IN CROATIAN SCHOOLS

Following fast development of computer sciences and importance of mathematics in every aspect of education, and in line with the "National curriculum for primary education"; in 2019, MZO published a new "National curriculum for the teaching subject of Mathematics" with detailed learning outcomes and guidelines on teaching and learning in a field of mathematics in elementary schools [4]. This was crucial for mathematics education since studies reported that using modern technologies early in education has revealed improvements in students' achievement [6]. Recent studies also supported learning numeracy by stimulating and creative applications (apps) as well as by using elements of gamification and GBL to engage students. Such approaches promote learning much more than using traditional approaches to learning. For example, the first gadget used in Croatian elementary schools were tablets, which seem to be intuitively designed for educational settings such as elementary classrooms [7], [8].

New guidelines from the curriculum suggested that teachers may have more autonomy in organizing and developing lessons. They are allowed to adjust the order of teaching lessons to achieve learning outcomes as well as use different tools, according to their preferences, for the purpose of producing interesting and motivating contents for their students. In line with this, at the beginning of the school year the majority of teachers organised their lectures differently than previous years, according to needs of their own students. However, following emergency protocols, some teachers possibly found themselves having problems due to the result of "open hands". As already mentioned, the suspension of direct teaching due to the COVID-19 pandemic situation forced teachers to start online teaching. Croatian MZO responded promptly with organizing distance teaching through TV on three channels: HRT3, SPTV, RTL2 [4]. For most of the teachers, the order of the planned teaching lessons was not the same as for the lessons provided on TV distance teaching.

Distance teaching through TV was complemented by work materials - assignments and activities for students, available online on "School for life" webpage. Therefore, in a very short period, teachers were forced to switch to online classes and establish virtual classrooms by using some digital platforms recommended by MZO. Some of the used digital platforms were: Loomen, Microsoft Teams, Edmodo.

Chosen platform was used on the daily bases to communicate with students. In addition to online platform, teachers occasionally used other tools, recommended by MZO or found by themselves, to support the online learning activities and assessment. Some examples are: Testmoz, Mentimeter, Spiral, Microsoft Office 365, LearningApps, Quizlet, Socrative, GoSoapBox, Kahoot!, KwikSurveys, Flubaroo, Google Forms, and Hot Potatoes [4]. Some other digital tools and platforms were used for communication among teachers, headmasters, and parents (e.g. Yammer, e-mail, Viber, WhatsApp) as well as for administration of students' grades (i.e. e-Dnevnik).

In many situations, teachers were forced to learn through experience since they received only short description of the recommended platforms and tools while the more detailed information about the advantages and disadvantages or possible technical difficulties they might encounter were not provided.

One of the useful recommendations that teachers received was about encouraging asynchronous teaching. Synchronous teaching, such as videoconferencing, seemed to be a good option [9] at the time of COVID-19 pandemic because it was conducted in real time and all ambiguities would be discussed immediately. But, the main problem with online synchronous teaching is that this type of teaching relies too much on digital technology which requires students to be present at a specific time in a specific place, without considering external impacts such as problems with Internet or owning devices needed for online class [10]. Also, global systems such as Microsoft's communication and collaboration platform Teams were burdened globally due to the current COVID-19 pandemic situation.

3. DIGITAL TOOLS AND PLATFORMS FOR TEACHING MATHEMATICS

As previously described, Croatian education experienced a switch to enforce full online learning in a very short period of time. This also affected the teaching of mathematics which is usually one of the more demanding subjects for students. A number of mathematics teachers decided to use some of the following digital tools and platforms since those tools are designed with some features specifically appropriate for mathematical teaching: Microsoft Forms [11], Kahoot! [12], Loomen [13], Matific [14], and Nearpod [15]. In order to encourage students' motivation to learn, teachers more or less successfully tried to introduce the elements of gamification and GBL using selected tools.

Teachers often tried several tools "on the fly" because they would quickly give up on some and replace them with new ones. The most common reasons were technical problems, which the teachers and students were both facing, inadequacy of the tools for students or unavailability of a digital license for the full versions of tools.

This chapter gives a brief overview of several tools which have been tested for learning mathematics from 5th to 8th grade of primary school and highlights their advantages and disadvantages, with the aim of making recommendations for future teaching in an online or hybrid e-learning model. The emphasis is on elements for summative or/and formative assessment and repetition of mathematical tasks for students.

Microsoft Forms

Microsoft (MS) Forms is part of the Microsoft Office 365 suite and it is free to use for all Croatian students and teachers [15]. Microsoft Forms has a math package that is easy to use for creating quizzes, which makes this platform popular for both teachers and students. MS Forms requires logging into MS Office 365 with a unique AAI@Edu.Hr identity that each student receives by enrolling into schools and each teacher by employment [15].

MS Forms allows the following types of question to be included in the quiz: true/false, multiple choice and essay question type. The main advantage of MS Forms is the fast feedback which reduces stress on children, but also a possibility of making exams more attractive by inserting images [16]. One of the advantages of MS Forms for teachers is detailed statistics of students' answers which allows teachers to focus on students' learning process. In addition, MS Forms can be used to design the Escape room game so that students could repeat the acquired material in a fun way and solve as many mathematical tasks as possible. For example, the goal of the game is to free the math teacher by solving all the tasks correctly.

However, MS Forms has a number of limitations. Firstly, technical issues, such as displaying images from prepared questions. Secondly, MS Forms does not allow to set a duration of a quiz. Exam duration is also an important factor of the learning process since time plays an important role in strategic problem solving [17]. Also, MS Forms does not allow creating a database of questions which means that each student has the same questions which increases the risk of cheating during an exam [18].

Image 1: MS Forms – Escape Room example

Kahoot!

Kahoot! is a free digital game-based tool, intended for students in various institutions. Kahoot!'s limitation is preparation for the class. Before first usage, it is necessary to download the application to the device and enter the assigned code. An important fact is that students do not need a Kahoot! account to solve the quiz [12]. However, once a student downloads an app, every future usage of Kahoot! is very easy, which is the main advantage of this popular tool. Kahoot! offers two types of questions in the free version: true/false and choosing the multiple-choice question with one correct answer [15]. These types of questions are the most often used in quizzes or exams. Kahoot! allows insertion of an image into each question and limitation of the duration of time, which may be stressful for children, [17]. Additional advantages are work-dynamics, encouraging the competitive spirit, and learning through play.

In contrast, the disadvantage of this digital tool is that Kahoot! requires usage of one's own device (mobile phone, tablet) and Internet access, but also requires a premium or pro version for several types of questions. Using Kahoot! turns the working atmosphere very quickly into a "playroom" [19], which may result in disbalance in the working atmosphere [19]. However, the elements of gamification (collecting points for each correct answer, rank-lists of the best students, etc.) can improve the motivation of students. To conclude, Kahoot! is a digital tool which encourages social interaction among students, although giving quick feedback should be used sparingly. [20].

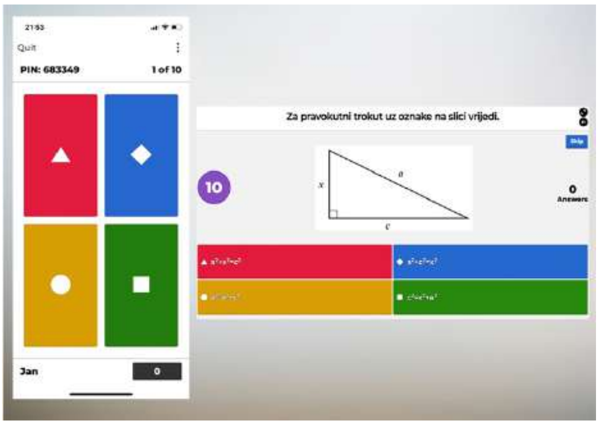

Image 2: Kahoot! Quiz screen on mobile phone and desktop computer

Loomen

Loomen is a free, open source software tool for creating e-courses, distance learning and combined live and distance teaching based on the Moodle tool [21]. Moodle is the most popular platform for online teaching used by millions of users worldwide [22]. In Croatia, to access Loomen, a unique AAI@Edu.hr identification is required. In addition to files of various formats such as websites and books, the Loomen also offers interactive elements such as forums, chats, tests, wikis and even games (e.g. Hangman, Crossword, Millionaire, Sudoku) [14].

Creating a test in Loomen allows more than 10 different types of question formats, including numerical question, and most importantly for math, it allows usage of HTML editors and LaTex notations [14]. This tool offers many test settings including time limit and restrictions regarding the test access and navigation among questions which enable teacher to determine the actual knowledge of the students, compare the students' abilities, and discourage cheating. In Loomen, students may take the exams as many times as the teacher allows them [23].

Unlike the before-mentioned digital tools, tests created at the Loomen platform allow students to upload their response as an image, which allows them to scan or photograph a handwritten solution directly from the notebook. This allows students to solve mathematical problems in a traditional way, without using complex digital skills. This may result in reduced anxiety during the test and improve test results. Similar to MS Forms, Loomen software is providing detailed statistics, however, Loomen seems to be better when talking about the ability to create a database of questions. Those databases allow teachers to randomly select a number of questions [23]. The teacher has an insight into all the tests, Loomen provides statistics on how much time the participant spends on each question and how many times the participant has changed his answer.

Another advantage of the Loomen is that it was intended only for users from the Croatian academic community and was not affected by the workload of global users during the COVID-19 crisis. To conclude, Loomen is a free Croatian Moodle platform for students, which provides many features that meet the teachers and students needs [9].

Image 3: Loomen – quiz and its statistics

Matific

Matific is a platform for online learning based on games, intended for students ages up to 12 years or until the 6th grade of elementary school [11]. The platform is intended exclusively for teaching mathematics. The platform archives progressive learning, while encouraging the development of skills and critical thinking in students [11].

The main advantage of the Matific platform is that it supports the Croatian "National curriculum for the teaching subject of Mathematics". It also supports multilingual classes, enables offline work and synchronization. The big advantage of Matific is that it offers a possibility to constantly save the data after each modification [11]. Saving data and detailed statistics for each student reduces math anxiety and possibly increases results of the learning process due to prevention of databases deletion [26].

The aim of this platform is to help students learn the material through various elements of the game. Matific allows students to learn at their own pace by solving worksheets, math problems or puzzles [11]. For more advanced students, bonus tasks can be added, while for students with reduced abilities, easier tasks or games can be chosen [24]. The emphasis is on developing problem-solving skills, encouraging conceptual understanding and developing self-criticism in students. Also, Matific platform contains a large number of tasks with real-life application.

Image 4: Matific **-** game example

The Matific platform has very detailed statistics where the teacher can monitor the progress of students at any time of the process. Through Matific, teachers may encourage students by symbolically awarding certificates for achievements, but they can also send reports of a child's performance to the parents via e-mail. Research has shown that the use of this platform has increased student's performance [25]. Matific is generally a helpful tool, although the main disadvantages are that for usage it requires a digital license (available for Croatian teachers from the 2019/2020 school year) and it is intended for primary school students only [11].

Nearpod

Nearpod is an online learning tool for delivering interactive lessons, videos, and assessments which can be used on any device [13]. The advantage of this digital tool is that teachers have complete control over the students' devices. Nearpod prevents students from interacting with other applications during class [19].

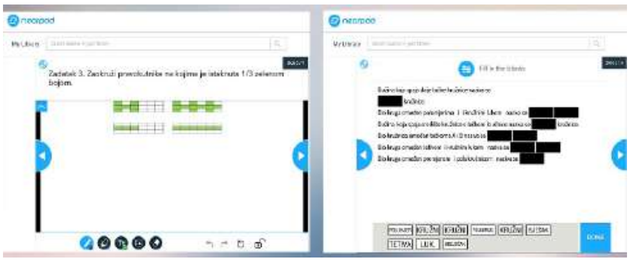

Image 5: Nearpod – quiz questions example

The software enables students to interact through various types of questions and solve problems through play and analysis [13]. This tool allows students to store all responses, but also provides response analysis, and stores responses in appropriate folders that can be used for different needs [13].

Nearpod can generate result reports for students, teacher, and parents. In addition to quality online classes, the Nearpod program allows users to create a quiz with attached images, which makes learning more interesting for students. It supports both synchronous and asynchronous modes of engaging which allows students to actively pursue literacy activities. Nearpod is a safe environment for students without any commercial ads even in a free version. To conclude, Nearpod integrates new technologies for learning and allows students to create authentic learning experiences which is crucial for their development [13].

4. FUTURE PLANS – PROJECT "DIGITAL GAMES"

The above-described preliminary research will continue under the University of Rijeka's scientific project Digital games – "Digital games in the context of learning, teaching and promoting inclusive education" [27]. Main objective of the project is to explore the possibilities of using digital games for learning, teaching and promoting inclusive education. One of the studies in the project focuses on encouraging the integration of computational thinking into the daily teaching of different subjects in the primary school using GBL. In the context of this study, the possibilities of using games for improving motivation for learning mathematics in primary schools will be further investigated.

The experiences with teaching mathematics during the transition to online teaching described in this paper will be used as a starting point to develop digital tools, especially those based on digital games and gamification, as well as pedagogical approaches and strategies such as computer-supported collaborative learning [7], [28], [29] which will increase students' motivation and consequently enable them to better achieve learning outcomes.

5. CONCLUSIONS

The paper evaluates digital tools and platforms for online teaching mathematics used by primary school teachers, specifically in relation to the formative and summative assessment of students and the possibility of implementing GBL.

The analysis based on existing literature and experiences in using the tools and platforms has showed that each has its advantages and disadvantages. According to this, it seems that Matific is the most suitable mathematical platform for online learning through GBL (if licences are available), intended for lower grade students, while Loomen is the most suitable online platform for students in higher grades because it enables designing tests with different types of questions and tasks. In addition, Loomen can be used as virtual classroom. Digital tools have also been shown to be suitable for occasional use while it is better to use online platforms for continuous, everyday learning.

What is currently missing is more comprehensive research on the comparison of digital tools and platforms which would help inform the teachers before use and not have them wasting time learning through their own experience. Also, there is a requirement for platforms where students are encouraged to learn and develop mathematical understanding through playing games. Because of that, this research will continue under the scientific project Digital games. It will result with the development of contemporary pedagogical-technological framework for the use of GBL and the design of digital tools as well as learning scenarios based on the framework applicable in practice for learning and teaching mathematics in primary schools. The research will use the Design Based Research (DBR) approach in order to prove the usefulness of the developed pedagogical-technological framework among students and teachers.

ACKNOWLEDGMENT

The research has been co-funded by University of Rijeka (Croatia) under the project "Digital games in the context of learning, teaching, and promoting inclusive education" (uniri-drustv-18-130).

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TAKING TWITTER TO THE CLASSROOM AS A MICRO LEARNING TOOL WITH IN A BLENDED LEARNING ENVIRONMENT

NAUMAN AHMAD

Senior Instructor, Mathematics and IT Department,

Centre for Preparatory Studies, Sultan Qaboos University, Sultanate of Oman.

Abstract: *Twitter is a social networking service to connect societies and public to exchange views and ideas online, also identified as micro-blogging site. Twitter uses tweets based on micro-bits of data that could be in the form of text, snapshots, videos etc. Micro learning is a process of learning where the contents are split up in tiny pieces and conveyed through tiny steps. This study had used Twitter as a Micro Learning tool, by splitting up the contents of a course unit in tiny pieces, with in a blended learning environment. Total number of participants were 42, divided in two groups of 21 each, Group A (Experimental Group) and B (Control Group). Group A studied course unit under blended learning environment, including face-to-face instruction, mixing up with text tweets through Twitter towards the revision of course contents, whereas Group B went under formal process of face-to-face instruction including face-to-face revision of contents. At the end students of both groups had attended exams for studied course. Statistical analysis for group means had been done on results of examinations for both groups. Moreover, a double check had been done to verify the outcomes of this study through the feedback of subjects from Group A, taken on a questionnaire for two stages Before and After the use of Twitter, towards recognized areas of evaluation, including: attitudes of subjects towards the use of Twitter as Friendly, Comfortable and Essential towards the process of learning, help of Twitter in Understanding and Learning the course contents, its help in getting better preparation in exam, and favourite mode of learning. Comparisons had been done on above mentioned key elements for Before and After stages. Positive effects on learning outcomes are extremely motivating for academicians and specialists related to combining the technology with education.*

Keywords: *Blended Learning, Classroom, Instruction, Micro Learning, Students Attitudes, Twitter*

1. INTRODUCTION

Education is very essential for one and all to prosper in life. It unlocks numerous openings that leads to a successful life, and acts as a key towards best achievements. Nowadays, education is thoroughly connected with information and communication technologies. Educators and educational organizations are integrating these technologies with face to face teaching as a blended learning mode to attain better learning results. Books are the main sources of receiving the information. A book is divided in chapters to organize and collect the related contents under the similar objectives within a chapter. A chapter is subdivided by the author and splitting is done to the subtopics in the form of numberings and sub numberings to further integrate and link the similar objectives in tiny parts. All the process is an effort the make the ideas and concepts understandable to the learner through small amount of information.

Formal process of instruction is based on face to face teaching where an instructor meets the learners for a period of one, two or more lectures, and the duration of meeting spans around one to two hours or more. The instructor has to instruct different groups of learners in a day and learners have to attend different lectures of different subjects, and these teaching and learning hours could be around seven to eight hours a day for both of them, and during these long hours the detailed concept development and discussion of small amount of information regarding each topic is indeed challenging [1, 2]. In general, the main focus of instructional process is on the exams towards the attainment of higher grades [2]. Though, blended learning is a modern technique in education, but integration of technology with education is a challenging practice, as it needs the installation and management of learning management systems and training of staff members, which is a time consuming and cost effective practice, and further specify that the industry of education has a continual need of new methods and techniques to enhance the learning experience, optimistically [3].

Face to face teaching is a formal mode of education using face to face conversation to instruct a course of study, and books, or notes etc. are the main sources of learning. Progressively, ICT (Information and Communication Technologies) based education is an emerging trend, where the educational contents are integrated with technology as a blended learning mode and is becoming prevalent [1]. Splitting up the contents of a course in tiny parts via micro learning technique support the learners to attain better concepts, learning and understanding [4, 1, 2]. Addition of electronic based techniques for the formal method of instruction through micro learning method gives encouraging and constructive results [5, 4, 2]. Blended learning through the integration of electronic communication tools along with formal method of education produces optimistic outcomes [6]. Blended learning is an addition of any learning practice with formal face to face teaching, which supports the learners to improve and develop the abilities [7]. Blended learning is a process that improves the learning expertise and efficiently supports the instructional results [8]. Educationists are continually adding the electronic communicational based technologies with formal mode of instruction to increase the learning outcomes [9].

[6, 5, 1, 2] declare the key elements to assess the performance of any electronic conversational technology through the learners' feedback, as follows:

- "Comfortability" while using the electronic communication tool.
- "Friendliness" while using it. Learners' reflection concerning the:
- "Essentiality" of the technology (e-tool) concerning the process of teaching and learning.
- Help of technology towards "Understanding" the course contents.
- Help of technology towards "Learning" the course contents.
- Help of technology towards "Preparation of Exam".
- "Favorite Mode of Learning".

Section 2 of this paper describers about the tool and technique used for this study; based on the context of existing literature. Section 3 explains the purpose of this research, section 4 explicates the used methodology for this study, section 5 gives the results, and section 6 speaks about the conclusion and future work. If the outcomes of this study are proved to be productive and positive; the impact would be significant for the educationists, field experts, educational bodies and institutions; related with the application of technology based environment for instruction.

2. WHAT IS MICRO LEARNING AND TWITTER?

Micro learning is a method of splitting the learning information in shorter parts and its usage through short time intervals [10]. Micro learning is an advance technique in education that helps in dividing the learning information in small parts, and is vital for the skills development [11]. [12] states that the outcome of informational communication results in micro learning; when it is centered on small bunches of data. Micro learning is a method of instruction that divides the contents of learning in tiny pieces, and these pieces are utilized in tiny phases towards the advancement of understanding and learning the course contents [2]. Micro learning is a fresh method in educational industry that provides encouraging results regarding the understanding and learning of studied contents [1]. Micro learning is very helpful in getting higher grades in the examinations [1, 2].

Twitter is an online social networking facility that connects users from multicultural backgrounds to convey and exchange their ideas, also identified as micro-blogging site [13]. Twitter uses tweets based on micro-bits of data that could be in the form of text, snapshots, or videos etc. [14]. The size of any tweet is restricted to maximum of 280 (two hundred and eighty) characters, which forces the concise, short and dedicated use of information [15].

3. PURPOSE OF STUDY

The purpose of this study is to assess the effects of Twitter as a Micro learning tool through splitting the contents of studied module in small pieces and its utilization for the revision of studied contents through tweets, as a blending learning mode by adding it to formal method of face to face teaching on experimental group "A", and to examine outcomes through taking the assessment of experimental group "A" and controlled group "B". Moreover, to get the feedback of experimental group "A" through survey questionnaire concerning their attitudes, reflections concerning the help of Twitter as a micro learning tool in understanding and learning the contents of studied module, its help in exams preparation and participants favorite mode of learning (Group A).

4. METHODOLOGY

This study has assessed the effects of Twitter as a micro learning tool on the assessment outcomes for the course module of IT "Computer Fundamentals". Total number of participants for the study was 42, having similar background, were divided in two groups A and B including 21 participants each, where Group A was the Experimental Group and group B was the Control Group. Group A had studied this course module within a blended learning mode, where the participants were requested to follow the tweets through Twitter as a micro learning tool for the revision of the course, after studying different topics, and were instructed to read one tweet at a time, to get the detailed idea about the micro topic, and to read the next tweet after ten minutes of time, at least. After the formal face to face lectures, the participants of group A had used their mobile electronic gadgets including smart phones or tablets etc. to follow the tweets. On the other hand, the control group (B) had studied the course within formal face to face study only, and also the revision of topics were done through formal face to face instruction. At the end both the groups had attended the examinations of the studied course module.

Firstly, this research has assessed the effects of Twitter as a micro learning tool on the experimental group A, and compared the examination results with controlled group B. Additionally, the participants of experimental group A had asked to give their reflection about the Twitter as a micro learning tool through a survey questionnaire, provided to them at Before and After stages, to compare the difference between these two stages.

This research has assessed the effects of Twitter as a micro learning tool within a blended learning environment via taking the group means of assessment grades of learned contents for both the groups.

Furthermore, the participants of experimental group had been provided a survey questionnaire having 5-pts Likert Scale, starting from 1…to...5, holding the choices: 1 (Strongly Disagree), 2 (Disagree), 3 (Uncertain), 4 (Agree), 5 (Strongly Agree) towards major key elements as follows:

- Comfortability" while using the electronic communication tool.

- "Friendliness" while using it. Participants' reflection regarding the:

- "Essentiality" of the technology (e-tool) concerning the process of teaching and learning.

- Help of technology towards "Understanding" the course contents.

- Help of technology towards "Learning" the course contents.

- Help of technology towards "Preparation of Exam".

- "Favorite Mode of Learning".

Assessments of Before and After stages have been done on survey questionnaire via taking the group means for experimental group A, towards the above mentioned key areas.

5. RESULTS

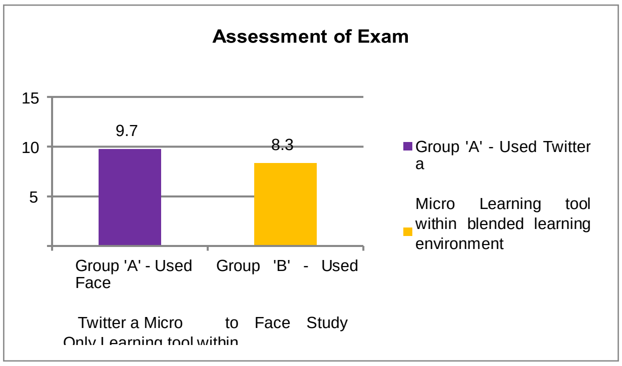
5.1. Assessment of Exam (Groups A and B)

Table 1 shows the outcomes of exams' assessment in the form of group means (averages) on group A (experimental group) and group B (control group). Figure 1 shows the data in graphical form. Results clearly indicate that group A, which was experimented through Twitter as a micro learning tool within a blended learning environment along with formal method of face to face study for the revision of studied contents had achieved better results, having the group mean of (9.73) out of 15 marks, whereas, group B that had attended all the lectures and revisions through formal instruction of face to face mode had achieved the group mean of (8.32) out of 15 marks. Therefore, mean results of group A minus (-) mean results of group B gave a difference of (1.41) that is equivalent to 9.4%. Hence, on average each participant of group A had an addition of 9.4 marks as comparted to group B, if counted out of 100. Following results validate the fact that Twitter as a micro learning tool within a blended learning environment has benefitted group A to get higher marks in their exams.

Table 1: Assessment of Exam (Groups A and B)

Exam Results: Out of 15 Marks	
Group A Used Twitter a Micro Learning tool within blended learning environment along with formal face to face study for the revision of studied contents Outcomes of Exam Assessment (Group Mean of Group A)	Group B Used formal face to face study and face to face mode for revision Outcomes of Exam Assessment (Group Mean of Group B)
9.73	8.32
Calculation of Means Difference in Exam Assessment = Group Mean of Group A – Group Mean of Group B Difference = 9.73 – 8.32 = 1.41 Calculation of difference in Percentage (Out of fifteen [15] marks) = 9.4%	

Figure 1: Assessment of Exam (Groups A and B)



5.2. Participants Attitudes Concerning Twitter - Group A

The results of participants' attitudes (Group A) concerning the use of Twitter as a micro learning tool with in a blended learning environment, taken through the feedback questionnaire is available in Table 2 and graphically presented in Figure 2. The data of participants' attitudes concerning the use of Twitter as a micro learning tool within a blended learning environment visibly describe the reflection at Before and After stages regarding key elements as its Friendliness and Comfortability while using, and its Essentiality as a blended learning mode. Initially, before the use of this tool the participants of group A had ranked these key elements with low averages (means), however, after using Twitter as a micro learning tool within a blended learning environment their feedback was highly ranked with size of change in the group means by (2.43), (2.62) and (2.48) concerning "Friendliness", "Comfortability" and "Essentiality", respectively.

Table 2: Participants Attitude Concerning Twitter - Group A

Key Elements	Mean		Size of Change
	Before	After	After-Before
Friendly	2.14	4.57	2.43
Comfortable	2.00	4.62	2.62
Essential	1.86	4.33	2.48

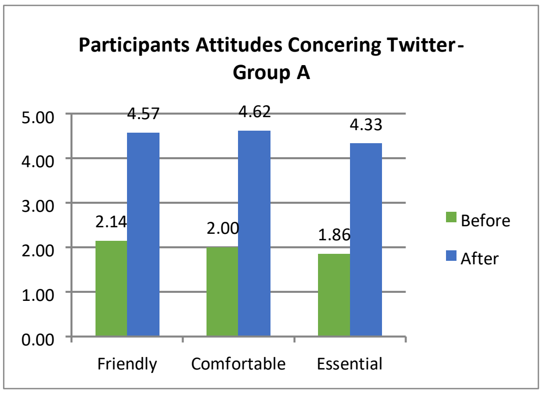


Figure 2: Participants Attitudes Concerning Twitter - Group A

5.3. Participants Reflection on other Key Elements (Understanding, Learning, Help In Exam) - Group A

Table 3 and Figure 3 show the details of participants' reflection for Before and After stages, concerning the help of Twitter as a micro learning tool within a blended learning environment towards its help in:

- "Understanding" the course contents.
- "Learning" the course contents.
- "Help in Preparation of Exam".

It can be seen that the use of Twitter as a micro learning tool within a blended learning environment has produced encouraging effects on the key elements with a big size of by (2.24), (2.14) and (2.29), respectively.

Table 3: Participants Reflection on other Key Elements (Understanding, Learning, Help In Exam) - Group A

Key Elements	Mean		Size of Change
	Before	After	After - Before
Understanding course contents	2.14	4.38	2.24
Learning course contents	2.10	4.24	2.14
Help in the Exam	2.05	4.33	2.29

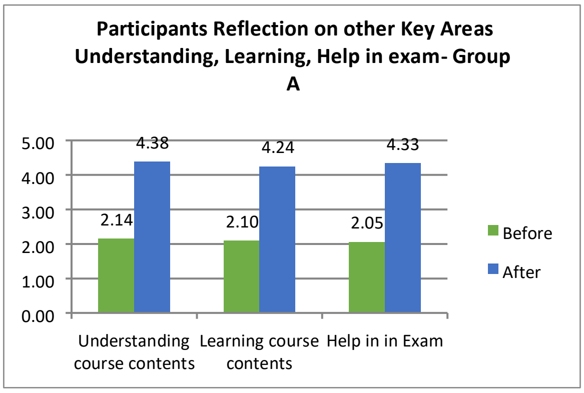


Figure 3: Participants' Reflection on Understanding, Learning, and Help in exam - Group A

5.4. Favorite Mode of Learning - Group A

Table 4, and Figure 4 express the reflection of participants' at Before and After the utilization of Twitter as a micro learning tool with in a blended learning environment, concerning the key element "instruction through instructor and supported with Twitter as a micro learning tool (as favorite mode of learning)". In the beginning, participants' of group A had valued this key element with a low average (mean), but after using the tool they had appreciated it optimistically, with a size of change by (2.38).

Table 4: Favorite Mode of Learning - Group A

Key Element	**Mean**		Size of Change
	Before	After	After - Before
Instruction through Instructor & supported with Twitter as a Micro Learning tool	1.90	4.29	2.38

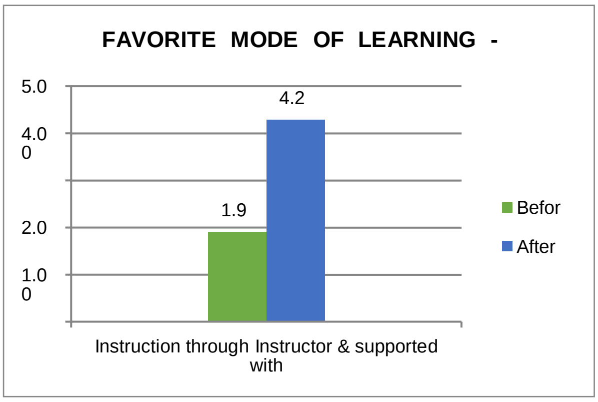


Figure 4: Favorite Mode of Learning - Group A

Above stated results of this study show the inclusive effects of Twitter as a micro learning tool within a blended learning environment towards the assessment of exam (better for group A [by 9.4%], as matched to results of group B), and regarding the key elements rated by group A through survey questionnaire, concerning "Friendliness", "Comfortability", and "Essentiality" are very practical with a huge size of change, at the After stage by 2.43, 2.62, and 2.48, respectively. Results are also very encouraging towards the key elements "Understanding" and "Learning" the contents of the course module and "Help in the Exam" with a size of change at the after stage by 2.24, 2.14, and 2.29 respectively. Moreover, participants have esteemed the use of Twitter as a micro learning tool with in a blended learning environment as a favorite mode of learning with a size of change at after stage by 2.38.

6. CONCLUSION AND FUTURE WORK

The results of this experiment proclaims that the use of Twitter as a micro learning tool within a blended learning environment assuredly effects the process of learning in an affirmative way, which helps the learners to achieve high grades in the exams as compared to formal process of face to face learning. As per the participants feedback towards key elements, Twitter as a micro learning tool with in a blended learning environment is friendly and comfortable while using, counted as an essential part of learning process, helps in understanding and learning the course material (that helps in developing the in-depth ideas of the learning contents), and helps in gaining high marks in the exams, and participants had rated the use of this tool within a blended learning environment as a favorite mode of learning.

Learning of the contents through teacher and assisted with Twitter through the division of contents in tiny parts (maximum of 280 characters) and used in tiny steps (reading the information after a gap of 10 minutes) for revisions in the form of micro learning is really helpful, as the contents get divided in tiny parts, unlike long durations of formal face to face lectures, or revisions, where many topics are discussed during these sessions, and the in-depth understanding and learning of every topic is difficult that results in compromised outcomes. Twitter does not need the installation of any kind of learning management system, and there is no requirement of special skills development for teachers or students, towards the use of any special software, program or technology, because the Twitter is a well-known tool. Hence, financially it is affordable and very economical, consequently, teachers should use Twitter as a micro learning tool, because of its global familiarly with everybody; it's recognition as a friendly and comfortable tool, by the subjects of this study, acceptance of its essentiality within a blended learning environment, recognition of its help in understanding and learning the course contents, positive help of Twitter as a micro learning tool for the process of examination towards getting higher grades, and finally, recognition of participants towards the process of instruction through instructor and supported with Twitter as a Micro Learning tool. The results of this study are in agreement with [2] that the use of electronic communication tool through the process of micro learning with in a blended learning environment positively effects the learning results.

Finally, the opening possibility stated in the start of this paper, concerning the encouraging effects towards the utilization of this technique by using the Twitter as a Micro Learning tool within in a blended learning environment has become significant, which has filled the gap in present literature. Therefore, this method has given contemporary outcomes, and the methodology has developed state of the art outcomes.

Considering the limitation of this research; as most of the participants had used their mobile phones for reading the tweets and doing the retweets, therefore, some subjects had old mobiles and batteries of those mobiles were little weaker, hence, sometimes they had to recharge the mobile for the next reading, which was very minor issue; in general, overall there were no limitations for this research. Consequently, this methodology is a supportive addition to the process of teaching and learning.

Dear educationists, field experts, educational bodies and institutions; a new methodology of using the Twitter as a micro learning tool within a blended learning environment is waiting for you; that is a free of cost solution. You can end your search, and feel free to practice it and get the outstanding results. Future work can be done through the use of Blogs, Webcasts, and Wikis as a micro learning tool with in a blended learning environment.

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The 11th International Conference on eLearning (eLearning-2020),

24 - 25 September 2020, Belgrade, Serbia

AFTERMATH OF TWITTER AS A TOOL OF LEARNING ON CO-EDUCATION

NAUMAN AHMAD

Senior Instructor, Mathematics and IT Department,

Centre for Preparatory Studies, Sultan Qaboos University, Sultanate of Oman.

Email: nauman@squ.edu.om

Abstract: *Digital transformation is continuously changing our lives, and educational sector is one of the major zone where traditional methods of teaching are getting blended with technology-focused tools. Twitter is a tool used for social interaction, which connects people to communicate online. It uses tweets as text, pictures, auditory, or audiovisual forms. Micro learning is a method of learning through small parts of learning contents, transferred through small steps. This study had used Twitter as a tool of micro learning, by dividing the topics of a course unit in small parts, delivered through the mode of blended learning. The number of subjects was twenty one, divided in two groups of male and female students. Instruction was done through blended mode, including; face to face, and integrated with text tweets using Twitter, used for the revision of course unit. Students of both groups attended the exam, and comparisons had been done on the outcomes of exam marks for male and female groups. The results of this study are very encouraging to enhance the learning outcomes, driven by gender diversity, through the integration of Twitter with instruction.*

Key words: *Blended Learning, Gender Diversity, Instruction, Micro Learning, Students Attitudes, Twitter*

1. INTRODUCTION

A process of teaching and learning, or the delivery and gaining of knowledge is known as education, where the learners get information regarding objects, processes, occurrences, and many more. Instructional methods play an important part towards the advancement of skills and acquisition of knowledge; worthy teaching and learning methodologies could positively increase the learning outcomes.

These days, the process of teaching and learning is methodically linked with information and communication technologies (ICT). Educational institutions are linking these information and communication technologies with formal practice of instruction, within a blended teaching and learning environment to achieve enhanced learning outcomes. An instructor conveys the knowledge about a topic, and the student understands the supplied information, develop the ideas on the basis of conveyed information.

[1] states that traditional process of teaching and learning is based on formal mode of face to face instruction, where the teachers instruct the learners, and normally, the length of a teaching session moves around one to two hours or more. These sessions start in morning and ends in afternoon, and due to these long sessions, many times, it is challenging for the teachers to develop the detailed ideas of the topics, and to cover large quantity of instructional material; consequently, teachers try to revise these ideas at later phases that affects the learners' understanding, learning and detailed creation of the ideas; eventually impacts the overall learning outcomes.

Overall, female learners had been observed to be shyer as compared to male learners [2]. [3] states that generally, female learners face problems, when they initially come up in contact with ICT based technologies, due to their less exposure, whereas, generally male learners have better ideas and knowledge concerning the use of ICT based skills, and get the benefit, as compared to female learners, nonetheless, if the female learners get visible to the same knowledge and skills, their ideas and knowledge could become better than male learners. [4] claims that female students have encouraging and progressive approach towards the use of ICT.

[5] asserts that the use of a micro learning tool, towards the process of teaching and learning, in the form of information and communication technologies, produces encouraging results on the learning outcomes of female learners, as compared to male learners. [6] state that in general, linking the technology with education is a

demanding exercise, as it requires the implementation of course management system, faculty and leaners trainings, and many more, therefore, educational organizations have a nonstop requirement of new economical methodologies and easy practices to improve the teaching and learning expertise, and learning outcomes of the learners.

Dividing the contents of a course in small parts through the practice of micro learning helps the leaner to get better ideas, understanding and learning of the topics [1, 7, 8]. If traditional face to face method of teaching and learning gets an integration of ICT based practices, then the outcomes are very productive for the learners [2, 4, 9], and after using the ICT female learners get elevated results as compared to male students [5]. When information and communication technologies are linked with traditional face to face mode of teaching and learning, the outcomes are encouraging [10, 11].

Blended learning is an integration of any learning method with traditional mode of instruction that could help the learner to improve and advance the skills [12]. Blended learning is a method of teaching and learning that advances the learning skills and effectively helps the learning outcomes [13]. Educational experts are frequently integrating the ICT tools with traditional face to face method of instruction to enhance the instructional results [14].

Section 2 of this paper defines the ICT tool, and the method used for this research; grounded on the perspective of present literature. Section 3 illuminates the purpose of study, section 4 explains the used methodology in this research, section 5 provides the results, and section 6 tells about the conclusion and future work. If the results of this research are verified to be innovative and encouraging on the gender diversity; the effect would be substantial for the instructors, educational experts, industry and educational organizations; connected with the use of ICT based educational atmosphere for teaching and learning the male and female students.

2. WHAT IS MICRO LEARNING AND TWITTER?

Micro learning is a practice of instruction where small divisions are made to the contents of learning, and these small parts of learning contents are used in small steps, regarding the understanding and learning of course contents [2]. Micro learning is a mode of distributing the learning parts in to smaller pieces and its utilization in tiny breaks of time [15]. Micro learning is a method in educational field that supports in splitting the learning contents in tiny pieces, and is important for the development of skills and abilities [16]. When the learning information is based on small parts and conveyed through small steps, the output will be micro learning [17]. Micro learning is a novel method in the field of education, which offers promising results towards the better learning outcomes [1]. Micro learning is very useful in gaining higher marks in the exams [7].

Twitter is an electronic tool used for social interaction that links internet users from national or multinational backgrounds to communicate online; Twitter uses tweets as text, pictures, aural, or audio-visual arrangements [18, 19]. A tweet has maximum of 280 alphabets that confines the tweet to be brief and to the point [20].

3. PURPOSE OF STUDY

The purpose of this research is to evaluate the impact of Twitter as a micro learning tool on gender diversity (male vs female) by dividing the learning information of course contents in tiny parts and its usage for the revision of studied material through tweets, within a blended learning environment, through the integration of this tool with traditional mode of face to face study. Group “A” represents female learners, and group “B” signifies male learners.

4. METHODOLOGY

This research has evaluated the impact of Twitter as a micro learning tool on the examination results of the studied course unit of IT “Computer Fundamentals”. Total number of subjects for this study was twenty one (21); [1] has used fourteen subjects for a homogeneous research, and [21] has used twenty eight subjects in another matching research. For this study, there was a split of twenty one subjects into two groups “A” for female participants and “B” for male participants, respectively. Group “A” and “B” had studied the course unit within blended learning environment, where the participants were asked to read the tweets through Twitter, as a micro learning tool for revising the contents of studied unit, and were informed to read one tweet at a time, to gain the in-depth knowledge of micro content, and then the reading of next tweet after a minimum break of ten minutes. After the traditional way of instruction in the classroom, all the participants of both groups (“A” and “B”) had used their smart electronic gadgets, including mobile phones and tablets, to read the tweets.

Finally, both the groups had appeared in the exam of the studied course unit. This study has evaluated the impact of Twitter as a micro learning tool on groups “A” (female) vs “B” (male), respectively, and analyzed the outcomes of exam. Plain statistical analysis has been done to compare the exam results of groups “A” and “B” through group means of marks for the exam.

5. RESULTS

5.1 *Comparison of Exam Results (Group “A” vs Group “B”)*

The results of exam, taken for groups “A” and “B” are shown in Table 1. Outcomes of the examination evidently verify that group “A” linked with female participants have attained better results as compared to group “B” linked with male students. Mean value of group “A” is 9.98, as compared to Mean value of group “B”, which is 9.21. Hence, Mean results of group “A” minus Mean results of group “B” are equal to 0.77 out of fifteen (15) marks, and the difference is equivalent to 5.13%; therefore, each participant of group A (female participant) had achieved additional 5.13 marks, as compared to each participant of group “B” (male participant), if calculated out of 100 marks.

Table 1. Comparison of Exam Results (Group “A” vs “B”)

Exam Results: Out of Total 15 Marks	
Group “A” (female learners) Used Twitter as a micro learning tool within blended learning atmosphere along with formal face to face study for the revision of studied contents. *Outcomes of Exam Results (Group Mean of Group “A”)*	Group “B” (male learners) Used Twitter as a micro learning tool within blended learning atmosphere along with formal face to face study for the revision of studied contents. *Outcomes of Exam Results (Group Mean of Group “B”)*
9.98	9.21

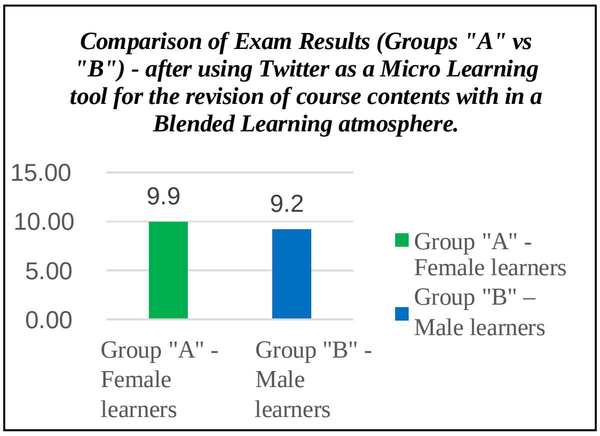

Figure 1. Comparison of Exam Results (Groups “A” vs “B”)

Following outcomes, shown in table 1 and figure 1 endorse the fact that Twitter as micro learning tool has helped more to group “A” (female participants) as compared to group “B” (male participants) in achieving higher grades in the examination.

6. CONCLUSION AND FUTURE WORK

The outcomes of this study declares that the use ofTwitter as a micro learning tool within in a blended learning environment certainly impacts the practice of learning in a positive way on the gender diversity, which helps the female learners in a better way, as compared to male learners, towards overall understanding and learning the course contents through in-depth discussion of ideas, consequently, getting higher grades in the exams.

Therefore, learning of course contents by teacher and supported with Twitter through the splitting of learning material in small pieces (maximum of 280 alphabets of text) and used in small steps (reading the tweets after a break of ten minutes) for the revisions of course contents, in the form of micro learning is surely useful, as the course material gets split in small pieces, contrasting the lengthy intervals of traditional face to face instruction, or course revisions, where several items are conversed or revised within a session, and as a result, detailed understanding, learning, and development of in-depth ideas of every item is challenging, and results in compromised outcomes.

Twitter is a famous and well known tool, and almost everyone has know-how about it; hence, while using the Twitter as a micro learning tool, there is no need to install any sort of course management system, and teachers and students do not need any kind of skill development of training for using the Twitter, therefore, this electronic communicational tool is without any cost, easy on the pocket, therefore, instructors have to include Twitter as a micro learning tool with in a blended learning atmosphere, due to its universal popularity.

The outcomes of this research are in agreement with [5] that the use of an ICT tool, utilized as micro learning with in a blended learning atmosphere certainly impacts on the gender diversity, and helps better to female learners, as compared to male learners, towards better understanding and learning the course material, development of in-depth ideas, and gaining higher marks in the exams.

The foundational possibility indicated in the beginning of this paper, regarding the optimistic impact of Twitter as micro learning tool within a blended learning atmosphere has turned to significant. Henceforth, this technique should be used by the instructors, along with traditional face to face instruction; as it has provided state of the art outcomes for the female learners, those were stated shyer as compared to the male learners, in the beginning of this study [2].

In view of limitations for this research; as all the learners had used their smart electronic gadgets including mobile phones and tablets to follow the tweets for reading, and replying through retweets, thus, some learners had old smart phones, and their batteries were older and weaker, and they had to recharge their batteries before reading or replying for the next tweet that was a trivial matter; overall, there were no limitations for this study. Therefore, this method is a positive addition to the field of education.

Valued educational specialists, instructors, educational organizations; a newfangled technique of using the Twitter as a micro learning tool within in a blended learning atmosphere, to support the female learners is in front of you, which is economical and easy to use; start using it from new and achieve outstanding results to help the female learners in gender diversity. Vlogs, blogs, and online chat sessions could be used as a micro learning tool for the future work.

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The 11th International Conference on eLearning (eLearning-2020),
24–25 September 2020, Belgrade, Serbia

E-ASSESSMENT FEEDBACK: STUDENTS' OPINIONS ON WHAT TO INCLUDE

DJORDJE M. KADIJEVICH
Institute for Educational Research, Belgrade, Serbia, djkadijevic@ipi.ac.rs

DANIJELA LJUBOJEVIC
Faculty of Information Technologies, Belgrade Metropolitan University, Belgrade, Serbia,
danijela.ljubojevic@metropolitan.ac.rs

Abstract: *By using a sample of 55 first-year undergraduate students at the Faculty of Information Technologies in Belgrade, this study aimed to explore different kinds of assessment feedback that are important to students. To this end, an online questionnaire with a list of different feedback techniques was used. For each of the stated techniques, students had to indicate the level of their agreement based on their experience with the e-learning platform they had used for their studies. Bearing in mind the importance of online help-seeking for e-learning success, this study also examined whether the kinds of feedback important to students were related to the types of online help they used. It was found that while the majority of students did not seek online help from the Internet or the instructor, many students did ask for online help from peers. Furthermore, two types of feedback listed in the questionnaire were endorsed by most students, namely: Next exam information (i.e. information about its date and content) and Exam answers comparison (i.e. comparison of one's own exam answers to the correct answers). Finally, the latter feedback was positively related to seeking online help from the Internet. Suggestions for further research are included.*

Keywords: *E-assessment, Feedback, Learning style*

1. INTRODUCTION

According to Hattie [1], feedback has one of the most powerful influences on learning and achievement. Giving instant feedback is also an important component in the learning process, which has become faster and easier within e-learning environments. Besides promptness and effectiveness, there are also different types of feedback identified as important to instructors (e.g., [2]). However, if we consider feedback as a vital part in learning, special attention should be given to sorts of feedback that are significant to learners (e.g., [3]), especially when it comes to e-assessment.

In general, assessment is a fundamental part of education improving both learning and instruction (e.g., [4, 5]). To make the e-learning experience better, assessment needs to provide detailed feedback that students would actually benefit from [6]. Giving constructive feedback is a very challenging and demanding task for instructors. Having this in mind, the content of feedback should include assessment information that students perceive as meaningful, beneficial, and valuable for their learning (e.g., [3]). The content of feedback that students find useful may reflect key features of particular learning styles – the preferred ways in which they approach learning tasks (e.g., [7]). However, to facilitate genuine learning, only assessment feedback mirroring features of learning styles such as deep and strategic may be relevant and possibly added to e-learning platforms in use.

Having in mind the research context presented in the previous paragraphs, this study searched for kinds of assessment feedback that are significant to students. Therefore, students were given a list of different feedback techniques, mostly reflecting the key features of the two learning styles mentioned above. For example, when it comes to deep learning, two kinds of provided feedback dealt with (1) comparing given answers with correct answers, and (2) indicating insufficiently mastered areas that require additional learning. Regarding strategic learning, two kinds of feedback listed dealt with (1) various assessment statistics, and (2) details about next assessment to be undertaken. Bearing in mind the importance of online help-seeking to e-learning success [8], this study also examined whether the kinds of feedback important to students were related to the types of online help they used. Furthermore, students' gender and prior academic achievement were also taken into account.

2. METHOD

Sample

This study used a convenience sample comprising 55 first-year undergraduate students. The students attended the general English course NT112 English 2 as part of their studies at the Faculty of Informational Technologies in Belgrade. There were 202 students enrolled in this course, of whom 27.2% took part in this survey. This is an acceptable response rate, recalling that average response rate in online surveys is around 30% (e.g., [9]). The details on the sample regarding gender and the achievement in the previous exams (a 5–10 scale was used with 5 denoting failure) are given in Table 1.

Design and variables

This study used a frequentative design and a correlative design. The variables were:

- *Gender* (1-female, 2-male);
- *Achievement* (1-average achievement in the previous exams is between grades 9 and 10; 0-otherwise);
- *Internet help* (frequency of using it expressed on a five-point scale from 1-never to 5-very often);
- *Peer help* (frequency of using it expressed on this 1–5 scale);
- *Instructor help* (frequency of using it expressed on the 1–5 scale);
- *Basic exam statistics* – my previous exam scores and their average (a five-point scale, from 1-fully disagree to 5-fully agree, used to express agreement with having these statistics given);
- *Next exam information* – information about its date and content (using a 1–5 scale used to express agreement with having this information displayed);
- *Comparative score statistics* – my current exam score *vs* average exam scores of all students (the 1–5 scale used to express agreement with having these figures displayed);
- *Comparative rank statistics* – the rank of my current exam score compared to exam scores of all students (the 1–5 scale used to express agreement with having this rank provided);
- *Exam answers comparison* – my exam answers compared to correct exam answers (the 1–5 scale used to express agreement with having these answers displayed);
- *Exam areas comparison* – exam areas I've successfully mastered *vs* exams areas that require additional learning (the 1–5 scale used to express agreement with having these areas presented);
- *Learning materials suggestion* – materials I could use for mastering areas that require additional learning (the 1–5 scale used to express agreement with having this information given);
- *Peer help suggestion* – providing names of students, with current exam areas they have mastered, whom I could possibly ask for help in learning (the 1–5 scale used to express agreement with having these data displayed);
- *Instructor help suggestion* – current exam areas for which I could receive special learning assistance from a professor or assistant (the 1–5 scale used to express agreement with having this information displayed).

Instrument and procedure

The values of the variables used in this study were collected through an online survey using a questionnaire available at https://docs.google.com/forms/d/e/1FAIpQLSdHfK4Xac-aeFyIoOrBrhUIWXYiWVSgsSkWbUTOiwInatsCnw/formResponse

The students attending NT112 English 2 course, taught by the second author of this study, were invited by her to participate in the survey via e-mail and many of them did so. The survey was conducted in May 2020.

Data preparation and statistical analyses

To make data interpretation easier, dichotomous variables were only used. To this end, the participants' answers regarding frequency and agreement, expressed by numbers 4 and 5, were coded as 1s; other answers, expressed by numbers 1, 2 and 3, were coded as 0s. In other words, all variables were binary.

This study used two statistical tests. Pearson's Chi-square test was applied for comparison of proportions. Correlative analysis used Pearson's correlation coefficients – for dichotomous (binary) variables, these coefficients are equal to those of Kendall or Spearman – and their statistical difference from zero was examined by applying the *t*-test.

Table 1: Descriptive and inferential statistics for all variables applied

Variable	Descriptive and inferential statistics
Gender	1- female (47.3%) 2- male (52.7%)
Achievement	0- less than 9 (40%) 1- between 9 and 10 (60%)
Internet help	0 (64%) 1 (36%)*
Peer help	0 (43.6%) 1 (56.4%)
Instructor help	0 (76.4%) 1 (23.6%)**
Basic exam statistics	0 (45.5%) 1 (54.5%)
Next exam information	0 (32.7%) 1 (67.3%)*
Comparative score statistics	0 (43.6%) 1 (56.4%)
Comparative rank statistics	0 (65.5%) 1 (34.5%)*
Exam answers comparison	0 (21.8%) 1 (78.2%)**
Exam areas comparison	0 (43.6%) 1 (56.4%)
Learning materials suggestion	0 (47.3%) 1 (52.7%)
Peer help suggestion	0 (81.8%) 1 (18.2%)**
Instructor help suggestion	0 (45.5%) 1 (54.5%)

* $p < 0.05$ ** $p < 0.01$

3. RESULTS

Table 1 summarizes descriptive and inferential statistics for all variables used in this study. While the majority of students did not seek online help from the Internet or the instructor, many students did ask for online help from peers.

Regarding the students' answers about assessment feedback having statistical significance, *Next exam information* and *Exam answers comparison* were endorsed by most participants. The opposite applied for *Comparative rank statistics* and *Peer help suggestion*.

Although there were several statistically significant correlations among the variables used in this study, partial correlation analyses evidenced that only *Exam answers comparison* was related to *Internet help* (the initial correlation was 0.293, $p < 0.05$; the partial correlation controlling for *Achievement* was 0.273, $p < 0.05$). Note that the correlations among *Internet help*, *Peer help*, and *Instructor help* were equal to zero, statistically.

4. DISCUSSION

Three important findings have emerged from this study. Firstly, while the majority of students did not seek online help from the Internet or the instructor, many students did ask for online help from their peers. Secondly, while assessment feedback concerning *Next exam information* and *Exam answers comparison* were endorsed by the students, the opposite applied for feedback concerning *Comparative rank statistics* and *Peer help suggestion*. Thirdly, *Exam answers comparison* was positively related to *Internet help*.

The percentages of students who asked for online help from the Internet, peers, and instructors were 36%, 56.4%, 23.6%, respectively. A similar outcome, though favoring the Internet help as well, was reported for novice students in [8]; the corresponding means were 2.86, 2.55, and 2.03. As this applied for expert students too (see [8] for the outcome), it may be that online help seeking from course instructors may be preferred least by students in general. A positive relationship between *Instructor help* and *Achievement* found in our study ($r = 0.280$, $p < 0.05$) suggests that online help from instructors may only be sought by high-achieving students, who, because of their knowledge and skills, are willing slightly to risk compromising their high academic status through communications with course instructors.

Of nine assessment feedback given, only two were endorsed, namely: *Next exam information* (67.3%) and *Exam answers comparison* (78.2%). Most students chose not to support *Comparative rank statistics* (only 34.5%) and *Peer help suggestion* (only 18.2%). Having in mind the findings of Roberts et al. [3], the rejection of *Peer help suggestion* was possibly influenced by students' concern about privacy matters. The rejection of *Comparative rank statistics* was a surprising one because the participants in Roberts et al. [3] considerably endorsed the feature "My grades in comparison to my peers" (69.4%).

Although we expected that assessment feedback important to students were related to types of online help to which they applied, only *Exam answers comparison* was found to be positively related to *Internet help*. This was possibly because students could frequently use the Internet to compare the outcomes of their search terms as done by many of its (not only academic) users. It was found, for example, that *Exams areas comparison* was positively related to *Instructor help* ($r = 0.317$, $p < 0.05$) – an important finding regarding deep learning – but this relationship was cancelled out ($r = 0.248$, $p = 0.071$) when *Achievement* was controlled.

While the concept of learning styles has been criticized recently (e.g., [10]), it still cannot be underestimated when it comes to conceptualize approaches which students use in their learning. Moreover, this notion can be used to define assessment (learning) feedback through associating it with key features of particular learning styles, especially those that facilitate genuine learning such as deep and strategic learning. While deep learning characterizes relating ideas and using evidence, strategic learning characterizes study organization and intention to excel (e.g., [7]). Even though the main focus of this particular study was not on the students' learning styles, further research may do so through connecting learning styles students apply with e-assessment (e-learning) feedback they endorse. By establishing this connection students could benefit a lot: e-learning systems may adapt not only learning content and sequence (path) to student's learning style (e.g., [11]), but also learning feedback to that style, focusing on, whenever possible, facilitating genuine learning.

5. CONCLUSION

Focusing on learning styles that would facilitate genuine learning, this study explored what kinds of e-assessment feedback would be important to students. Most participants in the study endorsed two kinds of feedback, namely: *Next exam information* (i.e. information about its content and date) and *Exam answers comparison* (i.e. comparison of one's own exam answers to the correct answers), with the latter positively related to students' online help-seeking from the Internet. E-learning systems might use student's learning style to adapt not only what content to learn and path to follow, but also what kind of feedback to provide.

Acknowledgements. The authors wish to thank all students who participated in this study. The research done by the first author was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract No. 451-03-68/2020-14/200018).

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LAMBDA LEARNING AND CONSULTING PLATFORM

VALENTINA JANEV, DEJAN PAUNOVIĆ

University of Belgrade, Institute Mihajlo Pupin, valentina.janev@pupin.rs

EMANUEL SALLINGER

University of Oxford, Department of Computer Science, emanuel.sallinger@cs.ox.ac.uk

DAMIEN GRAUX

ADAPT SFI Centre, Trinity College Dublin, damien.graux@adaptcentre.ie

Abstract: *The potential behind the exploitation of data (Open, Linked and Big) to boost economies and growth is in the focus of many EU initiatives, the most recent of which is the European Strategy for Data. Many students and professionals are taking the online route to acquire knowledge on emerging technologies for Big Data. Therefore, in this paper, we introduce the LAMBDA Learning and Consulting platform that contains over 30 lectures related to topics such as challenges in processing Big Data, semantic and knowledge graphs-based tools for Big Data, Big Data architectures, Smart Data Analytics, Best Practices and Use Cases from different industries. The paper discusses the technical elements of the platform and the possibilities for adoption in different settings including vocational training.*

Keywords: *E-Learning, Big Data, Analytics, Open education, Platform, Lectures*

1. INTRODUCTION

The topics of Big Data, Linked Data, Open Data, Semantic technologies and Smart Analytics have spawned a tremendous amount of attention among scientists, industry leaders and decision makers in Europe, in the last decade. However, despite the strong scientific output and high public investment, Europe still lags behind the United States and China in high-tech industries. For instance, with the emergence of Big Data, the last decade also witnessed a technology boost for AI-driven technologies. From 2013 through 2016, external investment in AI technologies had a compound annual growth rate of almost 40 percent [1]. So far, external investment remains highly concentrated geographically, dominated by a few technology hubs in the United States and China, with Europe lagging far behind. In order to realize the EU vision of attractive, secure and dynamic data economy, and to implement the European Strategy for Data [2], which aims at creating a single market for data that will ensure Europe's global competitiveness and data sovereignty, different initiatives have been initiated such as

- investing in next generation tools and infrastructures to store and process data (see for instance the European Open Science Cloud) [3];
- pooling European data in key sectors, with common and interoperable data spaces, see for instance BDVA i-spaces [4].

With the aim of aligning the activities of research organizations from Serbia and the region with existing efforts across Europe, in July 2018 the Serbian R&D Institute Mihajlo Pupin started with the implementation of the EU project LAMBDA – **L**earning, **A**pplying, **M**ultiplying **B**ig **D**ata **A**nalytics (H2020, GA. 809965). In the last two years, the partners (Institute Mihajlo Pupin, Serbia; Fraunhofer Institute for Intelligent Analysis and Information Systems, Germany; Institute for Computer Science - University of Bonn, Germany; Department of Computer Science - University of Oxford, UK) studied many aspects related to Big Data and semantic technologies and proposed a training approach and established the infrastructure for collaborative work of LAMBDA teachers/trainers (see Figure 1, providers) with

PhD students and other interested parties (see Figure 1, Consumers). Activities are aligned also with the goals, strategies and recommendations defined by the European Big Data community in their work, see the *Strategic Research Innovation and Deployment Agenda for the AI, Data and Robotics* (SRIDA [5]).

Figure 1: LAMBDA Ecosystem

This paper describes the infrastructure that was established to reinforce organizational learning and capacity building at the Institute Mihajlo Pupin (PUPIN) and to facilitate teachers-trainees cooperation in the larger network of experts in the field of Big data, semantic technologies, Enterprise Knowledge Graphs (EKGs), Semantic Big Data Architectures (ARCH), and smart Big Data Analytics (BDA). The paper is structured as follows. Section 2 introduces the LAMBDA project and LAMBDA platform. Section 3 points to Big Data tools that were tested and evaluated in the LAMBDA framework. Section 4 provides an overview of the newly developed lectures on topics from the Big Data Analytics domain. Section 5 concludes the paper.

2. LAMBDA PLATFORM CUSTOMIZATION

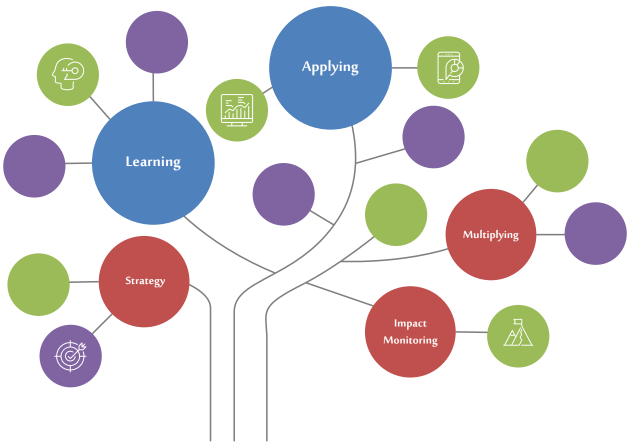

Figure 2: Main pillars of LAMBDA project

LAMBDA activities are structures around 3 main streams, as is presented in Figure 2:

- **Learning** – with the goal to establish and maintain a Knowledge repository as part of the LAMBDA Learning and Consulting Platform to facilitate spreading learning materials, as well as exchange of best practice;

- **Applying** – knowledge transfer and expertise exchange activities aimed at development of new prrof-of-concepts;

- **Multiplying -** raising awareness about future trends in Big Data, Emerging Tools and Technologies.

Hence, in order to support the transfer of institutional knowledge and expertise, but also to other relevant stakeholders in the region, the *LAMBDA Learning and Consulting Platform* was established using the Drupal content management system (CMS, https://www.drupal.org/). Since July 2018, it facilitates collaboration between consortium partners, e.g. joined paper and deliverable writing, information sharing, and stakeholders' data-base management. It is based on Drupal, the 3rd most popular Content Management System besides WordPress and Joomla. Some of the advantages of Drupal are related to the availability of different features / functionalities and customization, security and user experience i.e. Drupal is less resource-intensive and its pages typically load quicker and have faster response times than WordPress and Joomla. The architecture of Drupal CMS is modular and it consists of a few core modules and a plethora of plug-ins that can be switched on and off as required. In order to support the needs many different types of contents were defined, where each content type is described with a set of attributes, for instance, lecture is described with *category*, *contributor*, *format* (video, PPT, paper, book chapter). The platform provides access to the SlideWiki *open courseware* system, https://slidewiki.org/. The SlideWiki tool has the ability to import and export data from/into different data formats, thus SlideWiki users that use the SlideWiki presentation mode can merge and LAMBDA contents in their presentations.

3. OVERVIEW OF BIG DATA TECHNOLOGIES

Big Data refers to data sets which have large sizes and complex structures, while Big Data Analytics refers to the strategy of analysing large volumes of data that gathered from a wide variety of sources, including social networks, transaction records, videos, digital images and different kind of sensors. While more than 800,000 Petabyte (1 PB= 1015bytes) of data were stored in the year 2000, this volume will exceeds 175 zettabytes by 2025 as per International Data Corporation IDC expectations [6]. Some challenges related to the European ability to exploit the potential of Big Data are (1) fragmentation of the data ecosystem, due to different national policies, languages, and sectors involved; (2) fragmentation of data research efforts and lack of effective exchange of results; and (3) shortage of highly skilled persons for data-related jobs. Therefore, the LAMBDA research was devoted to **demystifying Big Data topics**, including the latest achievement in the **field of Knowledge Graphs** [7, 8, 9].

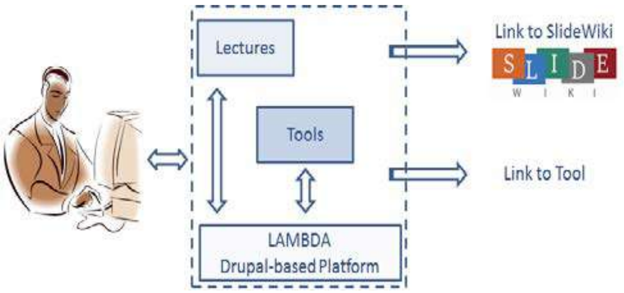

Figure 3: LAMBDA Platform - simplified illustration

Big Data Tools: One section of the LAMBDA Platform is devoted to tools and technologies. The tools have been categorized into twelve categories, see also Table 1 in the Annex: Cloud Marketplaces, Hadoop as a Web Service / Platform, Operational Database Management Systems, NoSQL/ Graph databases, Analytics Software / System / Platform, Data Analytics Languages, Optimization Library for Big Data, Library / API for Big Data, ML Library / API for Big Data, Visualization Software / System, and Distributed Messaging System.

Enterprise Knowledge Graphs (KGs) gained popularity in 2012 with the announcement of the Google Knowledge Graph as a representation of general world knowledge. KGs is a solution that allows to build a common understanding of heterogeneous, distributed data in organizations and value chains and thus to provide smart data for AI applications. However, many factors have prevented effective large-scale development and implementation of complex knowledge-based scenario because of inability to cope with the rising challenges coming from the Big Data applications; the rigidity of existing database management systems, inability to go beyond the standard requirements of query answering; and the lack of knowledge languages expressive enough to address real-world cases.

4. OVERVIEW OF LAMBDA LECTURES

One section of the LAMBDA Platform is devoted to open learning. Currently, the main providers of lectures are consortium partners and invited speakers at LAMBDA events relevant for LAMBDA are the University of Bonn (UBO), The University of Oxford (UOXF), the German National Library for Science and Technology (TIB) and the Institute Mihajlo Pupin:

- The *University of Bonn / Fraunhofer Institute* team works on the cutting edge technologies related to Big Data, Intelligent Analysis and Information Systems. The concerned team at the Smart Data Analytics (SDA) group is active in specializing applied research in intelligent data and knowledge analysis and teaching activities of the relevant topics. The *Fraunhofer* team is looking forward to applying the results of LAMBDA in different industrial domains.

- The *University of Oxford* team works on cutting edge technologies related to Big Data and analytics. The concerned team at the VADA ("Value Added Data Systems") group is active in research and teaching activities with regard to these topics. The *University of Oxford* team is looking forward to applying the results of LAMBDA in the financial domain, see for instance an example of adoption of LAMBDA lectures for vocational training, depicted in Figure 4.

- The *German National Library for Science and Technology* team is working on development of cutting edge technologies semantic data processing, knowledge engineering and information systems in different domains (including health).

- The *Institute Mihajlo Pupin* team is working on development of novel data analytics algorithms for different industrial domains, with main focus on the energy sector.

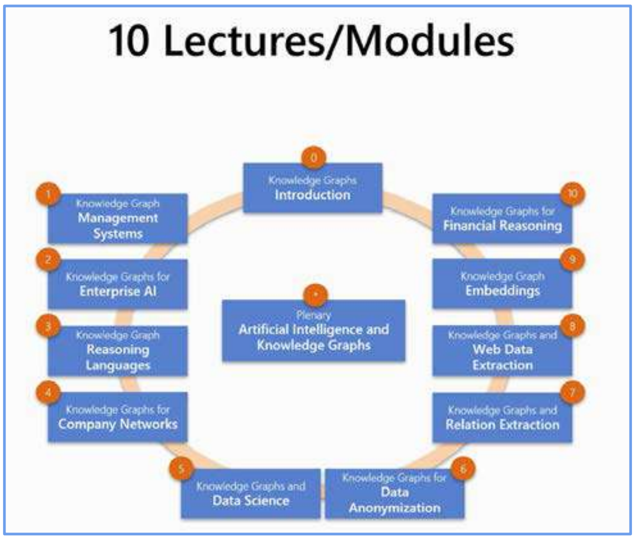

Figure 4: Adoption of LAMBDA lectures for finance domain (University of Oxford)

Since June 2020, the lectures have been categorized into eight modules, see also Table 2 in the Annex:

1. Artificial Intelligence (4 lectures),
2. Survey (3 lectures),
3. Foundations (3 lectures),
4. Enterprise Knowledge Graphs (4 lectures),
5. Semantic Big Data Architectures (7 lectures),
6. Big Data and Knowledge Graphs Tools (4 lecture),
7. Smart Data Analytics (5 lectures), and
8. Case Studies (5 lectures).

Key Performance Indicators (KPIs) for the self-evaluation of LAMBDA activities are given in Table 3 in the Appendix.

5. CONCLUSION

The potential behind the exploitation of data (Open, Linked and Big) to boost economies and growth has been in the focus of many EU initiatives, the most recent of which is the Digital Single Market, which highlights the need to make sense of Big Data, since this is considered to be a fertile ground for innovation in both technology and development. The EU funded project LAMBDA (Learning, Applying, Multiplying Big Data Analytics) addresses challenges related to Big Data Analytics and the semantics-based approach to processing data (Linked Data, Open Data, Big Data). The implemented activities in the LAMBDA framework (open education, research-industry collaboration) have strengthen the digital skills of professionals and improved the technologies and services of the involved stakeholders (PUPIN and other stakeholders from West Balkan), thus contributing to national and regional sustainable development. The LAMBDA researchers are currently involved in transfer of the knowledge and technologies to industry. To that aims, the LAMBDA Learning and Consulting Platform, https://project-lambda.org have been established that informes about the activities of the LAMBDA consortium and support the exchange of learning materials, tools, project results and best practice between the international leading organizations and research institutions and Industry from the West Balkan countries.

ACKNOWLEDGEMENT

The research presented in this paper is partly financed by the Ministry of Science and Technological Development of the Republic of Serbia and partly by the H2020 project "Learning, Applying, Multiplying Big Data Analytics" (GA No. 809965).

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APPENDIX: TABLES

Table 1: Categorization of tools

Category	Tools
Cloud Marketplaces	ALIBABA CLOUD; IBM CLOUD; GOOGLE CLOUD PLATFORM; ORACLE CLOUD MARKETPLACE; CISCO MARKETPLACE; MICROSOFT AZURE MARKETPLACE; AWS MARKETPLACE
Hadoop as a Web Service / Platform	HDINSIGHT; IBM INFOSPHERE BIGINSIGHTS; MAPR; CLOUDERA CDH; AMAZON EMR
Operational Database Management Systems	IBM (DB2); SAP (SAP HANA) ; MICROSOFT (SQL SERVER) ; ORACLE (DATABASE)
NoSQL/ Graph databases	HADOOP DISTRIBUTED FILE SYSTEM (HDFS) ; AMAZON NEPTUNE NEO4J; TIGERGRAPH; MAPR DATABASE; ONTOTEXT GRAPHDB; ALEGROGRAPH; VIRTUOSO; APPACHE JENA; MARKLOGIC JANUSGRAPH; ORIENTDB; MICROSOFT AZZURE COSMOS DB; APACHE HBASE; APACHE CASSANDRA; MONGODB
Stream Processing Engines	APACHE FLUME; APACHE APEX; AMAZON KINESIS STREAMS; APACHE FLINK; APACHE SAMZA; APACHE STORM; APACHE SPARK
Analytics Software / System / Platform	SAS ANALYTICS SOFTWARE & SOLUTIONS; MATLAB; H2O.AI; ACCORD FRAMEWORK; APACHE HADOOP; CLOUDERA DATA PLATFORM; VADALOG SYSTEM; MATLAB; SEMANTIC ANALYTICS STACK (SANSA)
Data Analytics Languages	SCALA; JULIA; SPARQL; SQL; R; PYTHON PACKAGE INDEX (PYPI) ; PYTHON
Optimization Library for Big Data	FACEBOOK AX; HYPEROPT; IBM ILOG CPLEX OPTIMIZATION LIBRARY
Library / API for Big Data	TENSORFLOW SERVING; MLLIB; BIGML; GOOGLE PREDICTION API; AZURE MACHINE LEARNING; AMAZON MACHINE LEARNING API; IBM WATSON PROGRAMMING WITH BIG DATA IN R
ML Library / API for Big Data	CAFFE.AI; APPACHE MXNET; XGBOOST; PYTORCH; KERAS; TENSORFLOW
Visualization Software / System	ORACLE VISUAL ANALYZER; MICROSOFT POWER BI; DATAWRAPPER; QLIKVIEW; CANVAS.JS; HIGHCHARTS; FUSION CHART; D3; TABLEAU; GOOGLE CHART
Distributed Messaging System	APACHE KAFKA

Table 2: Overview of lectures

Category	Tools
Survey (3)	Survey on Big Data Tools; Overview and Comparison of Machine Learning Algorithms; Survey on Big Data Applications
Artificial Intelligence (4)	Data for AI: Foresight; AI and Knowledge Graphs; Conversational AI; The Revolution of AI
Foundations (3)	Big Data Ecosystem; Introduction to Knowledge Graphs; Big Data Outlook, Tools, and Architectures

Enterprise Knowledge Graphs (5)	What is Knowledge Graph? Introduction to Knowledge Graphs; Creation of Knowledge Graphs; Extraction for Knowledge Graphs; Swift Logic for Big Data and Knowledge Graphs
Semantic Big Data Architectures (5)	Reasoning in Knowledge Graphs; Introduction to Big Data Architecture; Big Data Solutions in Practical Use-cases; Distributed Big Data Frameworks; Data Lakes and Federated Query Processing
Big Data and Knowledge Graphs Tools (4)	Context-Based Entity Matching for Big Data; Vadalog System; Data Science with Spark and Hadoop; Spark using Scala
Smart Data Analytics (5)	Distributed Big Data Libraries; Distributed Semantic Analytics I; Distributed Semantic Analytics II; SANSA - Scalable Semantic Analytics Stack; Scalable Knowledge Graph Processing using SANSA
Case Studies (9)	Semantic Information Infrastructures from Business Information Delivery to Water Management; Soft computing for Transparent synthesis of Geo Big Data; Chronorobotics - Spatio-temporal models for social and service robots; IntelliSys: Intelligent System for Road Safety; Reasoning on Financial Knowledge Graphs: The Case of Company Networks; Embedding-based Recommendations on Scholarly Knowledge Graphs; Open and Big Data – Utilization Perspective; Data Analytics for Energy Sector; Predictive Analytics in Renewable Energy Systems

Table 3: Key Performance Indicators

Category	Success Indicator
STRATEGIES / RECOMMENDATIONS	number of strategic documents
BIG DATA ANALYTICS SCHOOL	number of events
	number of lectures (books, published, e.g. via ceur-ws.org)
	number of trained teachers / students
LAMBDA-NETWORK OF EXPERTS	number of organizations
	number of experts
CAPACITY BUILDING THROUGH THE LAMBDA LEARNING AND CONSULTING PLATFORM	number of tools integrated for experimentation
	number of visits / exchanges between partners and collaborators.
	number of university / organizations that have adopted the developed open lectures
DISSEMINATION AND OUTREACH (OTHER THAN BDA SCHOOL)	number of workshops, seminars and networking events organized
	number of brainstorming sessions on key society challenges
	number of joint scientific papers

TEACHING PHYSICS USING GOOGLE CLASSROOM AND DIGITAL SIMULATION

IVANA KRULJ

The Academy of Applied Technical and Preschool Studies, ivana.krulj@visokaskola.edu.rs

DRAGAN KRECULJ

The Academy of Applied Technical Studies Belgrade, Department of Computer-mechanical Engineering, kreculj7@gmail.com

NADA RATKOVIĆ KOVAČEVIĆ

The Academy of Applied Technical Studies Belgrade, Department of Computer-mechanical Engineering, nratkovicmf@gmail.com

VALENTINA TERZIĆ

Technical School Valjevo;
The Academy of Applied Technical Studies Belgrade, Department of Computer-mechanical Engineering, Higher Education Unit Valjevo, nterzicnn@gmail.com

OBREN VUJIĆ

Technical School Valjevo;
The Academy of Applied Technical Studies Belgrade, Department of Computer-mechanical Engineering, Higher Education Unit Valjevo, obren.vujic@gmail.com

Abstract: Nowadays ICTs have significant roles and variety of applications in teaching. Such innovative technologies are special platforms for online learning. Recently social distancing became mandatory due to Covid-19 pandemic. This had imposed and accelerated changes in education towards digitalization, virtualization and online learning. In the paper the use of Google Classroom in teaching physics for the 3rd grade in the grammar school was described. In addition to that both digital simulations and virtual labs were used. Google Classroom was also applied in teaching of two courses (Electrical Engineering with Electronics, and Sensors and Actuators), to the students of advanced vocational studies in mechanical engineering. Further it was used to disseminate educational materials to students, provide access to them and exchange of various files (messages) between teachers and students. The listed applications have proven to be valuable in communication and classroom activities, while students were quite engaged in lectures and practices.
Keywords: physics, electrical engineering, online learning; Google Classroom, simulation.

1. INTRODUCTION

Courses in Physics at higher education level are attended by students who have finished different types of High schools, with physics classes having various curricula and duration or credits. Regarding students who have graduated from high school, the general scope of learning physics is 7 years, covered by the common curriculum defined by the Ministry of Education, Science and Technology Development. Contemporary curriculums include as required activity - adopting knowledge on the content. However, concepts adoption checks regarding certain topics show very different levels of adoption. Therefore, it's safe to say that one of the challenges in higher education is the task to obtain necessary knowledge of physics in all students enrolled. This is to be used as a common ground to build upon in order to enhance the adoption of the concepts needed for further education in particular field. As learning physics is one of the crucial pillars of science and technological achievements, and also of STEM in education, we believe that the attention of academic, scientific and teaching communities should be directed towards more efficient strategies of learning physics. One possible way of wise planning in teaching physics can be based on detailed assessment of students preferred learning styles and also their cognitive skills. Obtained results indicate that teaching instructions demand task adequacy, preferred learning style compatibility and appreciation of the student's cognitive development at the time being.

Several studies have shown that the influence of learning styles may be significant for a conceptual understanding of physics [1]. Based on such experiences courses were developed with methodologies that promote active learning to enable scientific reasoning on the conceptual learning in some areas of physics. In [1] research was conducted showing that students had a high dependence on a verbal learning style, mainly associated to lectures and students with lack of active roles. The conceptual learning in [1] was assessed using the Force and Motion Conceptual Evaluation test (FMCE). The negative correlation between the Active-Reflective and the FMCE observed in [1] showed that students with a bigger preference for the active pole of this dimension have a better conceptual learning of physics.

There is not a unique attitude about the list of learning styles. The models of learning styles presented in literature are sometimes named after their authors: Myers-Briggs Felder-Silverman, Kolb, etc. The application of the revised version of Kolb's Learning Style Inventory (LSI-3) is frequent, primarily due to its validity and reliability. According to Kolb's model four learning styles were identified [2]: diverging, assimilating, converging, and accommodating. These four styles have being associated with different approaches to learning, combining one of two dialectically related modes of grasping experience (either abstract conceptualization or through concrete experience) with one out of two dialectically related modes of transforming experience (reflective observation or active experimentation) [2].

People with dominant diverging learning style have broad cultural interests, like to gather information, perform better in situations that call for generation of ideas, and tend to solve problems creatively - they score well in brainstorming sessions [2].

Subjects or students with predominantly assimilating learning style are best at understanding a wide range of information and putting it into concise, logical form, they are less focused on people and more interested in ideas and abstract concept, tend to approach problems systematically, and in formal learning situations, as stated in [2] people with this style prefer readings, attending lectures, exploring analytical models, and having time to think things through.

According to [2] people with predominantly converging learning style are best at finding practical uses for ideas and theories, have the ability to solve problems and make decisions based on finding solutions to questions or problems, prefer to deal with technical tasks and problems rather than with social and interpersonal issues, approach problems practically, prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications, and they often prefer simulations and experimentation.

Persons with predominantly accommodating learning style rely generally on other people to obtain information from and, therefore, prefer to work with others in teams or groups [2]. People with accommodating learning style have the ability to learn from primarily "hands-on" experience, enjoy carrying out plans and involving themselves in new and challenging experiences, may have tendency to act on "gut" feelings rather than on logical analysis. In solving problems, individuals with an accommodating learning style rely more heavily on people for information than on their own technical analysis [2]. In formal learning situations, people with the accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project. [2]

In [2] is stated that converging learning style is important for effectiveness in specialist and technology careers; the assimilative learning style is better for effectiveness in information and science career; accommodating learning style is well suited for effectiveness in action-oriented careers such as marketing or sales, while people with diverging learning style prefer to work in groups and tend to specialize in the arts. Other classifications of learning styles with up to nine classes with subtle transitions between these four major ones are presented in [2]. As the best learning style (and the ninth one), a balancing between feeling acting, reflecting, and thinking (or abstract conceptualization and concrete experience along with reflective observation and active experimentation) is suggested [2].

Learning spaces are described in [2] as well. In particular, in [2] is emphasized that negative emotions such as fear and anxiety can block learning, while positive feelings of attraction and interest may be essential for learning. Special attention is focused on promoting learning in higher education through institutional development [2].

2. E-LEARNING BY DIGITAL SIMULATION

The advantage of using digital simulations is that they can be observed with interruptions and repeating. In addition, they could be used to visualize variables in sizes and values that are otherwise inaccessible to our senses in real time. [3]

There are indications that in certain areas of physics learning in virtual laboratories can contribute more to better achievements of students when compared to learning in real environment. Virtual labs can be safer to use than real ones. The current circuit laboratory was modified to compare the effects of using computer simulations with the effects of implementation of real light bulbs, meters and wires. [4]

Some researches indicated that both learning style and formative assessment strategy significantly affect student achievement in web-based learning. It seems that the development of e-learning strategy designs for different learning styles may be enhanced by providing educational technology creators with access to information and training in the widest possible range of teaching techniques. [5]

Certain analyses show that students with moderate use of computers in school tend to have better achievements than those students who use them rare. However, students who often use computers at school have poorer achievements for most outcomes, even when their social and demographic factors get included in the analysis. Such results are explained by the fact that underlying deep conceptual understanding is enhanced by the intensive interaction of teachers and students. Technologies sometimes draw attention away from the above-mentioned and valuable human engagement. The second interpretation suggests that there is a discrepancy between the technology of the 21st century and the still present teaching style of the 20th century, and the danger of diminishing the efficiency of such teaching. [6]

If learning through simulations is not structured, students can find themselves in situations that they do not really learn due to a large number of possibilities. While on the other hand, highly structured use of simulations can limit their effects in a research-like approach. Scaffolding allows students to construct a structure of terms and understandings of particular phenomena but can be frustrating for them, while scripting creates interaction control but with the loss of open research values. [7]

On the other hand, simulation is the most appropriate method for restructuring existing knowledge and can help students overcome wrong concepts and adopt scientific and correct ones. [8]

Digital labs have even more significance in online teaching, because students can make their own researches and derive conclusions. In real labs tasks, the realization of working is often carried out upon finishing the topic, and the primary goal is to check students' knowledge of theory, followed by the practice in experimenting and processing results of experiments and its assessment. However digital labs offer free variables manipulation without any risk of the danger that real equipment might cause.

PhET Interactive Simulations are used widely in teaching physics. Special applications can be used in many different educational enviroments and settings, including giving lectures, offering individual or small group inquiry activities, homework, practices and lab. Students will explore virtual testing more productively, than with textbooks, and most valuable lab experiments would be done. [9]

Moreover, there are specific libraries on the web that contain interactive labs in physics for students of all ages (from primary school to high education level).

3. TEACHING APPROACH WITH THE GOOGLE CLASROOM PLATFORM

The benefit of using Google Classroom in education is to improve quality of both teaching and learning. Teachers and students are encouraged to use technology wisely, especially for learning process, saving time, being environmentally friendly, overcoming distance of residence, increasing collaboration among students, permanent communication, and also as a secure document storage. [10]

This teaching tool is user-friendly and is helping educators efficiently manage and assess progress, while enhancing connections with learners whether they are in school, at home, or somewhere else. Google Classroom is learning management system (LMS) aimed to simplify making, distributing and grading assignments for students in learning process online (Figure 1).

Figure 1. Google Classroom

One of the teaching approaches in Google Classroom is presenting the teaching material to students and requiring an assessment of the usage purpose. That approach is very important when digital labs are in use. The assumptions made about what can be determined, discovered, studied with digital equipment are valuable in the sense when students need to precisely understand not only why they are learning something, but also how they are learning.

The teacher assesses whether specific tasks be will set, or materials, questionnaires, etc. in the stream, so that the students can comment, follow, or will assign to the mentioned activities. In individually assigned tasks, the teacher can have a special dialogue with the student, directing his or her attention to the student’s individual characteristics. In this way, the teacher follows the course of learning and reasoning of an individual student. This approach is seemingly very demanding for the teacher, given a large number of students with whom the teacher communicates at the same time, but if the organization of work is such that the teacher communicates with one group of students in one part of the class, then quality communication with each student is realistically achievable. During classroom teaching, the teacher often has no insight into the flow of thoughts of a certain number of students

The idea that a teacher can be substituted by some technical devices can lead to some alternative conclusions or misconceptions. Actually, only knowing the content of a lesson, or if the student just retells what he or she reads by heart has not been considered as knowledge since long time ago. Very often this can happen with those students having deep misunderstanding of the real nature of some content, when a student made some alternative concepts that may pass unnoticed by teachers. The individual communication enables the teachers not only to detect incorrect alternative view or misconceptions, but also to direct the student in such a way that the student can see those concepts are wrong and to turn to the right direction in order to get the true concept of the things they learn.

4. EXAMPLES OF LEARNING ACTIVITIES

Activities that provide students with opportunities to think about several hypothesis, or use knowledge and information in new and different way will support their development of critical thinking. Skills like these are perceived as some of the main requirements in high education. Often critical thinking activities can stem out of other learning activities, after students have received feedback from the initial activities [11].

An overview of some of the many activities used in physics classes is given below. Special attention is paid to the topic of alternating electric currents. The principle of generating alternating current (AC) in teaching physics is not studied enough in high school education level in Serbia. Linked to this is the fact that in the third grade of grammar school the students make the first simple AC circuit analysis. Simulations from the two following web links were used to determine the principle of inducing alternating electric current:

- https://phet.colorado.edu/en/simulation/legacy/generator
- https://www.walter-fendt.de/html5/phsr/generator_sr.htm

Students need to answer several questions: What is observed in the simulation, what can be changed in it, and what are the effects? Students formulate a question regarding what they have observed in the simulation. The next step is to compare the formulated questions and discussions, and then list the concepts, phenomena and laws that can explain the phenomenon. This teaching approach encourages the development of competence for lifelong_learning - the student recognizes and produces arguments for a particular hypothesis.

The student is not exposed to the material, nor is given material for study, but is exposed to activities that require the engagement and use of prior knowledge, as well as thinking, reasoning and deducing; then coming to answers with arguments. As the physics experiments in the school laboratory were infeasible, digital laboratory provided valuable substitute for operating in real lab. Special challenge for teachers was the realization of laboratory exercises, which in this case had to be based on some type of digital laboratories. Instead of determining the impedance in the *RLC* circuit, a digital lab exercise producing *RLC* Frequency. Response was designed using the following applet:

- https://www.walter-fendt.de/html5/phen/combinationrlc_en.htm.

The task in this exercise was to adjust the set values of resistance, voltage and frequency in the *RLC* circuit, shown in Figure 2 and to record the measured values.

Current, voltage, and impedance in a *RLC* circuit are related by well-known Ohm's law (equation 1):

$$Z = U / I \tag{1}$$

The activity was supposed to lead to an answer on the question: What is the relation between frequency and impedance? The relevant relation is given by equation (2).

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \tag{2}$$

The student was experimenting independently in order to achieve resonance and explain when and if it occurred. Moreover, some alternative concepts have been identified and these have instructed the teachers to be careful about both the simulations and a challenge of conceptual change.

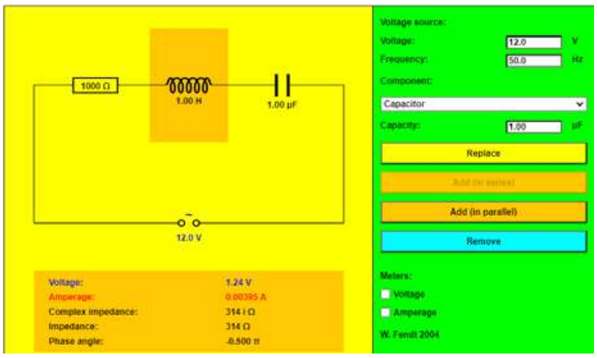

Figure 2. Screenshot of the simulation - Combination of elements in the series *RLC* circuit

One of the concepts in the simulation of the generator was the following: contact of water and the end of magnet bar is causing the magnet to rotate around its centre. If the centre is fixed, and such movement is possible, then the magnet is like the paddle on a water wheel of a mill, and this is the reason of changing current direction in the nearby coil (Figure 3).

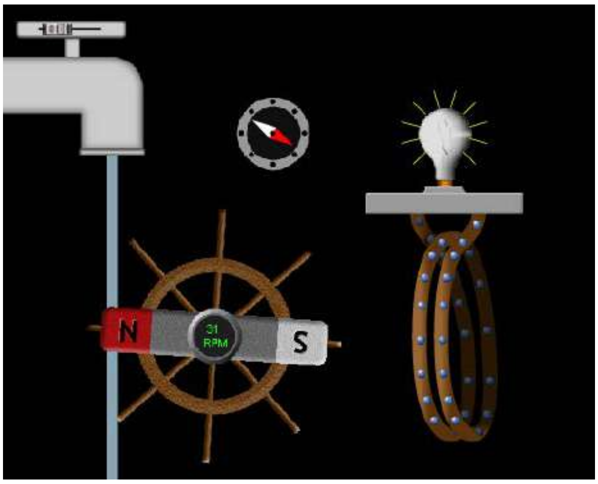

Figure 3. Screenshot of one moment in simulation AC Generator

An alternative simplified explanation of Faraday's law of electromagnetic induction was this: the interaction of the magnetic field with the electrons in the wire is causing electrons to move in ordered manner, creating current in the coil. The angle of collision determines drift velocity of electrons (see Figure 4).

Several students did not draw a conclusion to the end. One of the conclusions is that as the frequency of the current increases, the inductive reactance increases, and the capacitive reactance decreases (in absolute value). However, it is stated that the impedance increases with magnification of frequency. Since the difference of the two terms in (2) (reactance of the coil and reactance of the capacitor) is squared, its value is always nonnegative. The reference to the comparison of the values in certain columns led to the correct conclusion, however new difficulties arose in explaining this phenomenon.

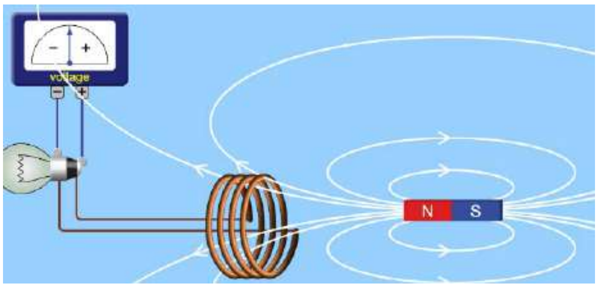

Figure 4. Screenshot from simulation of Faraday's law

5. STUDENTS OPINIONS ON E-LEARNING

Teaching physics was realized completely in online regime and in circumstances different than in classical classroom. Certain questions taken from the applied surveys were asked in different cases and are listed below.

Q1: It is considered that in order to have properly derived reasoning about some problems alongside with research of the same problem student needs to feel good. On the other hand, if a student is successful while learning it is expected that the student feels satisfied. Can you name some situation when you had the best feeling during online education and which content was in question?

A: The feeling when you finish an exercise, you surrender your answer on time. It’s a nice feeling to be responsible. Somehow, this online teaching made us finish our obligations faster because we know that new ones will follow. During the 3rd laboratory exercise (since I didn't do the first two well from the first attempt), I was proud of myself when I successfully did the third exercise).

Q2: Are there any lessons or contents during the online education process that you did not feel confidently about and what were those lessons and contents? In other words, were there any materials that were learnt and you were frustrated by them?

Responses were negative except for a few that related to the non-functioning of the simulation.

Q3: If you were asked to name what was the thing that you learnt the best during online education process what would it be?

A: I learned how to draw conclusions; To pay attention to detail; How to learn from mistakes. Other answers relate to the same or similar content.

After the classes in the Google Classroom ended, the students answered the questions about the advantages and disadvantages of online learning. Their answers were:

- Learning in a Google Classroom is the same as in an actual classroom (76,67%);
- They have no objections to online learning activities but lack the work in group (18,33);
- Online classes teaching are complicated; they do not see any of its advantages over the work in the classroom (5%).

Majority of students (68,33%) observed that the teacher was more dedicated to each individual student in on-line learning.

6. CONCLUSION

Modern teaching takes place everywhere with implementation of innovative web applications and mobile devices. On-going Covid-19 Pandemic have imposed and increased adoption and implementation of both digital resources and distant communication in processes of teaching at all levels of education and study worldwide.

Google Classroom as affordable teaching platform provides active communication between educators and students. Students are feeling free to give responses (comments), and have the chance to select whether they post something to be visible to entire group, or they send inquires and demands to teacher only. Educators can make similar selection, choosing to disseminate materials and messages to all of the students, or to make confidentional one-to-one communications with individual students.

In absence of real laboratories and due to multiple savings posed on teaching activities, learning process could be varied in order to observe correlation between different physical and electrical variables and circuit parameters. New resources for that purpose are acquired such as affordable specialized platforms that have emerged recently and are able to simulate real experiments in physics. Computers, smart phones and additional equipments (e.g. for virtual or for augmented reality) have become important utilities that provide simulation of necessary experiments in teaching and learning. Digital labs offer relevant experiments and enable visualization of complex phenomena and concepts, making these simpler to understand.

Nowadays education can be perceived as service providing industry where services are offered to students, their parents, or their future employers. The group of students was polled to express what their experiences and impressions were on the new way of teaching physics. In general, both educators and students were satisfied with opportunities this innovative teaching approach allows in use of digital resources and remote communications.

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A CHANGE OF MIND

HANS HARTMANN

OBJENTIS Software Integration GmbH, hans.hartmann@objentis.com, Advisor

Abstract: *One year ago possible economic advantages and improved opportunities for students spoke for the use of e-learning. Since then, a new situation with restrictions that influenced all fields of our lives has made e-learning mandatory. Suddenly, it is not a choice of students, but compulsory. The experiences of teachers and students had already been extensively tested in the field. Now, after six months of living under unprecedented restrictions, we have much better insight into the weaknesses and strengths of remote learning. The guinea pigs were children between the ages of 6 and 18 and also students at university. For all, e-learning or remote learning were totally new adventures. The experience has revealed some positive impacts, as well as the challenges of insufficient technical infrastructure, e-mail overload for teachers and parental limitations on monitoring their children at home. This paper reports some grounded experiences in the period from March to August 2020.*

Keywords: *E-Learning, Distance learning, grounded experiences.*

1. INTRODUCTION

In a conference paper I delivered in August 2019 about e-Learning at Metropolitan University I emphasized why I prefer direct teaching to remote teaching. I did this in spite of my very favourable experiences with e-learning. Today, the common situation has changed tremendously. The question is not e-learning or not. We have to ask: how do we provide efficient e-learning for persons that have never been considered as the target group: students from elementary school, high school or conventional universities.

The Corona virus pandemic has had different consequences for various countries. However, all countries have imposed lock-downs of various durations, prohibiting dense gatherings of people. Different ways of teaching have been required.

2. GROUNDED EXPERIENCES

In the print media, the majority of education-related reports refer to:

A) How does remote learning – children at home – work?
B) When will classroom teaching start again?
C) What are the experiences of remote learning during the last few months?
D) What are the social consequences of children having to stay at home?
E) Problems with the technical infrastructure.

Topic E is a transitional one. The use of technical infrastructure may be a current problem but it will vanish soon. Already now, most of the children are more computer literate than their parents, however in twenty years all parents will be sufficiently able to help their children.

The case studies below address the questions A to D.

2.1 CASE 1

Both parents are teachers. He is retired, she teaches music, the children are between the ages of 6 and 18. In their music studies, the children are encouraged to make little videos (with the help of their parents if required). Some children show great enthusiasm in making their own production. Others do not want to deal with the technical details. How can home exercises be judged in an unbiased way? It has not been possible to perform in groups, such as singing in a chorus. Even professional artists have only just begun to find ways of performing together online.

Some teachers want direct contact with the children to inspire their interest, whilst others go no further than the technical interface. The father, who had taught natural sciences, is alert to this threat to learning.

"Teaching is a difficult job. You have to promote interest and teach the students the art of learning. Electronic media should help in raising interest, but some teachers fail by "omission". Instead of transporting contents by themselves, they are satisfied by showing a wonderful video presentation, while they sit back and relax." With reduced or no requirement for personal interaction, teachers have been less invested in inspiring their pupils.

2.2 CASE 2

She is a professional pianist, composer and music teacher. Her husband works in IT. The daughter is a gifted violinist of 14 years.

Their problem is a very typical one: the husband is required to work from home; the daughter has to do school exercises at home using a computer. The pianist provides lessons remotely using Skype and by assessing videos that the children have made of their own performance. They have only one computer.

Another problem for the piano teacher is that there is a very big difference between playing for a recording and playing in front of her. She finds that video interaction does not render a real result or progress. Without immediate presence, the nuance of musical interpretation is missed and progress decelerated.

2.3 CASE 3

In the university context, the experiences are mixed. Like the example of the music teacher, the immediacy of the real experience lessens the opportunity for learning. For example, students of forensic pathology have learned remotely the practice of dissection, where corpses are replaced by puppets. Like experiencing life via watching reality shows on television, the puppets cannot evoke the problems that a student might have when dealing directly with real organic "matter".

Another concern is the general absence of human interaction. Obviously, central to a university education is exchange with peers, e.g. impromptu debates in the hallways. As a 26-year-old medical student says, "you cannot replace the social dimension in academia with video conferences, as many as you might use".

Not all experience is diminished by having to learn online. A lecturer in law has had very positive experience by using online learning.

She reports of an exercise of a moot court, i.e. a simulated court hearing. Such an exercise depends on interaction and role playing. However, only one online session was available to execute this exercise.

The exercise lasted for four hours, as it would have done normally. Four different cases were handled. The teams of three to four students played the role of lawyers, one group for the plaintiffs, one for the accused. The briefs had been prepared during the previous semester and the topics discussed when classroom education was still possible.

The various teams were present on video and were very well prepared. The students dressed properly in front of their video cameras in the way they would before court. The discussions were lively and the legal questions could be discussed in depth. Between the handling of each case, a ten minute break was granted for relaxation and breakout sessions. During this time the teachers acted as judges and found their verdicts.

Did it work? The lecturer reports that it worked astonishingly well. The students reported afterwards that the session was very intensive and instructive.

One of factors behind the success of the online moot court was preparation. Though the briefs had been prepared and discussed in class beforehand, this preparation could have taken place also remotely. The students were also prepared for the moot setting. Another success factor was commitment: the students were extremely committed. Finally, a personal connection was decisive: the lecturer knew all the participants personally due to the earlier lectures and exercises. The intensive spark of the human relationship – as the piano teacher experienced and the retired teacher of the natural sciences observed in completely different contexts – was decisive to the success of the learning experience.

3. CONCLUSION

The Corona virus pandemic is pushing forward the transformation of learning from classroom to online. The experiences over the past 6 months have underscored previous lessons and have revealed new or intensified problems. The current troubles that will have to be solved include:

- insufficient technical infrastructure in people's homes
- insufficient privacy when several people are working from home, whether for school or business
- partial computer illiteracy.

E-learning can no longer be considered in a sandbox. The outside influences that affect education nowadays not only promote its use, but enforce its use. Much work needs to be done on improving its quality and efficiency now that we have societal experience worldwide with its opportunities and difficulties. The Corona virus may be with us for a long time, requiring further protective restrictions on direct personal contact. Where before, we had plenty of evidence of the advantages of e-learning in terms of the ease of supplying education to large groups, now we have experience that has crystallised its challenges.

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In two years from now there might exist references to scientific papers and results of research, including statistical values and conclusions about the best way of coping with the pandemic situation that exists right now. I have not found any information about the best way how to enact remote learning which is particular to a pandemic environment.

E-LEARNING AUTHORING TOOL - MOBILE APPLICATION FOR PRIMARY SCHOOL “OUR SCHOOL”

MAJA BAŠIĆ

Belgrade Metropolitan University, Belgrade, Serbia maja.basic.1518@metropolitan.ac.rs

SLOBODAN JOVANOVIĆ

(Corresponding author)

Metropolitan University, Belgrade, Serbia slobodan.jovanovic@metropolitan.ac.rs

Abstract: *We cannot imagine today's world without electronic devices. Children in such a world have become very skilled in using mobile applications and tablets by playing games. In specific so-called the "new" conditions of the pandemic, the development of online schooling has become increasingly important. Each country has its own standards and criteria regarding schooling, so for each of them it is necessary to develop a specific application that would fully meet the needs and enable children to have everything in one place. Guided by the previous conclusions, a mobile application was developed in this paper that would protect our youngest members of society from viruses and enable uninterrupted schooling during this or any other school dropout. Below, in text you can find the main advantages and disadvantages of the developed tool as well as a description of its use.*

Keywords: *Authoring tool, Mobile app, e-learning*

1. INTRODUCTION

An authoring tool [7] assists you in creating digital content. An e-learning authoring tool is a type of software that allows you to create digital training content, convert it into an e-learning format, and distribute it among learners via a learning management system, or on the web [1]. A user does not actually need any technical programming expertise to utilize the software. Instead, e-learning authoring tools are generally pre-programmed and offer a ready-to-use interface complete with templates, media, tools, interactions, and tests that the user can easily arrange and manipulate [2]. A mobile application, also referred to as a mobile app or simply an app, is a computer program or software application designed to run on a mobile device such as a phone, tablet, or watch [3]. What You See Is What You Get (WYSIWYG) [8] is a system where editing software allows content to be edited in a form that resembles its appearance when printed or displayed as a finished product such as a printed document, web page, or slide presentation [4] .

A mobile application was developed in this paper that would protect our youngest members of society from viruses and enable uninterrupted schooling during this or any other school dropout. Below, in text you can find the main advantages and disadvantages of the developed tool as well as a description of its use.

The app that was developed here was developed in an Android studio using a Java and SQLite database [10].

2. SIMILAR WORKS

The mobile application that was developed in this work is based on the Web authoring tool [5] that is displayed within the X e-learning conference at Metropolitan University, the basis of which comes from the Zone Administrator tool, which is intended for Word adaptive documents [6]. Although the idea came from these already developed tools, this new e-learning tool also has a new development path that has been adjusted for today's generations. A variety of mobile applications can be found online and they can be applied in today's schooling as an auxiliary tool, whereas to meet the needs of the our education you need to adjust application and use two or more applications.

3. A NEW E-LEARNING MOBILE TOOL FOR PRIMARY SCHOOLS IN SERBIA

The tool described here belongs to a group of e-learning authoring tools and has certain content that is visible on the internet and for its formation used primarily Android studio [9] with Java [5]. Within this application, partial settings from previously developed Web authoring tools have been used within Android studios because today's Generation easily manages tablets and mobile phones from a young age rather than computers.

The basic characteristics of this tool:

- Enter a new document
- Mark document parts related to user errors
- Ability to comment, evaluate and correction of documents
- Solving tasks

4. TOOL OPTIONS

As the tool was developed with the aim of using the youngest age groups in education, it is designed to make it as easy as possible to use the so-called user-frendly and to enable very easily any additional expansion.

The tool was developed for specific conditions of education during the pandemic, and its role is to meet the needs of pupils when working from home. Tool users are two target categories: teachers, i.e. administrators in charge of creating writing and project tasks, and student solves tasks set by administrators.

It is also possible to mark errors when reviewing and commenting on the works.

At any time, the administrator can go back to the home list or exit the application.

Note:

All documents used in this tool are blank on the first time you use them. For the purposes of displaying certain functionality, certain documents are pre-filled with the appropriate data. Selecting the appropriate documents is done according to the student's data as it is in real life. In case of an error, an error notification is also displayed. In this, it is important to note that the tool is adjusted to real conditions and each document has the appearance of reality.

Since this is a large area in this mobile application, written tasks from Serbian language and mathematics have been processed, as well as project development, all other school obligations are very easy to upgrade to an already existing tool.

5. VIEW FUNCTIONS

Since the tool is intended for two types of users, primarily professors and students, these are two basic views depending on the user roled in.

5.1 COMMON FUNCTIONS – LOGGING

The user initially enters their basic data with the name and the password Image 1.

5.1.1 ADMINISTRATOR FUNCTIONS – TEACHER

After logging, the option to select from the drop-down list appears Image 2. In this way, the teacher chooses the appropriate subject and the ability to regulate the necessary functioning of the given parties.

In the image shown, Image 3 can be seen a list of all possible functions related to the teacher. The two buttons at the bottom allow you to return to the given "Back" list and return to the "Start" logo and exist on each side of the administrator as long as the student has it until the task begins.

5.1.2 ENTRY OF CLASSES AND DEPARTMENTS

At the start of the school year it is necessary to enter the required classes and departments Image 4. In this case, if an existing class-department is entered, a notification appears as in the case of existing data entry

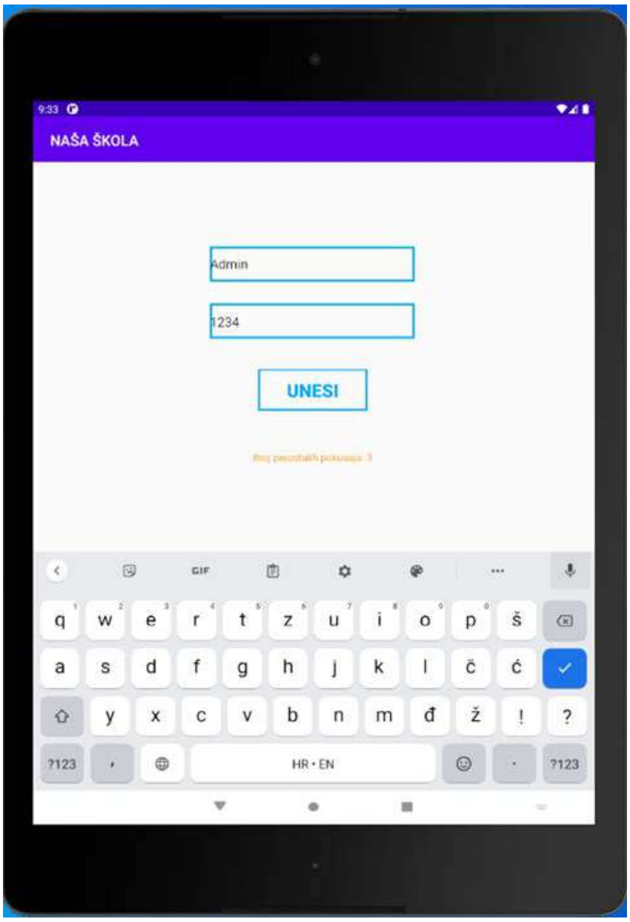

Image 1 Logging user

Image 2 Function list

5.1.3 ENTERING THE NECESSARY STUDENT INFORMATION

Along with the entry of classes and departments, it is necessary to define the students within the given classes. When selecting the appropriate class and the department on the right is a list of pupils who can be scrolling and easily searched if there is any doubt that a student has already entered Image 5. All notifications related to successful or unsuccessful intake are clearly stated.

5.1.4 ENTER TOPICS FOR SERBIAN, PROJECT, AND MATH TASKS

This option allows the teacher to enter the necessary materials for, say, Serbian and project, by choosing a class, department and literacy number. This displays a list of already entered themes for such selected parameters IImage 6. Like all other previews in this app, this list can be scrolling.

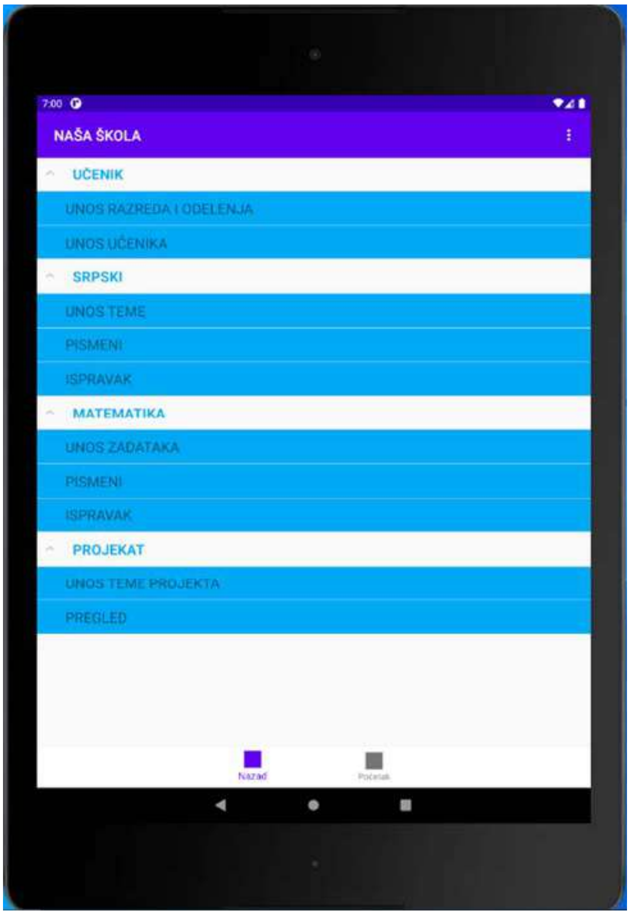

Image 3 Complete list

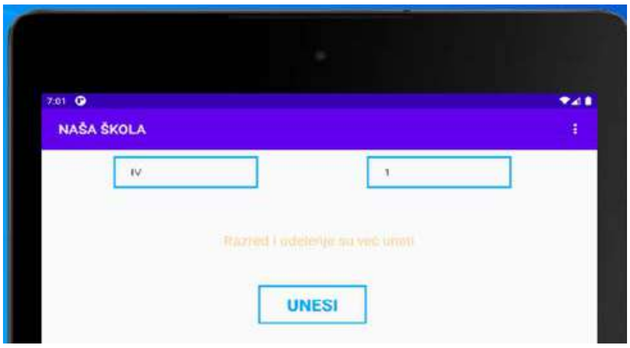

Image 4 Input class and department

Image 5 Input new student

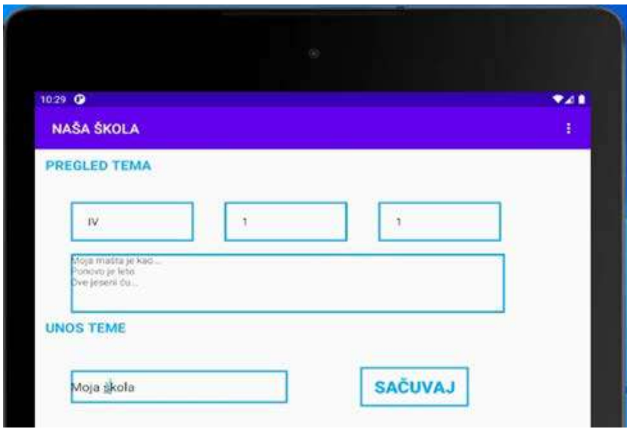

Image 6 Input topic

Image 7 Input task

In the case of math by selecting a math card and the appropriate task intake, a new page opens up regarding the input of tasks for a particular literacy according to certain parameters. Selecting a class and department as well as a literacy number will show if there is a list of tasks for that literacy in a separate field that can be scrolling Image 7.

Image 8 Incomplete entry

At any time, it can be given up by pressing the button back that returns to the drop-down list for selection or exits the app entirely. Notifications related to incomplete or misleading input are clearly emphasized Image 8.

5.1.5 OVERVIEW OF WRITTEN AND PROJECTED

This one, as well as the previous possibility, combines the presentation of Serbian and mathematics, in relation to the written tasks and the project. The selection of students is made on the basis of the selection of certain parameters Image 9, Image 10. Incomplete selection gives clear notice.

Image 9 Student selection

When one of the students is chosen, there is an opportunity to review his work, comment and give a mark. Commenting can also include selecting certain parts of the text that can be transferred to the comment box by pressing the Mark button Image 11. In this, comments and mark are red because in real-life they are red also.

Image 10 Student selection1

Image 11 Work in maths

For the purpose of displaying the work, only data from Serbian has been fully filled in Image 12.

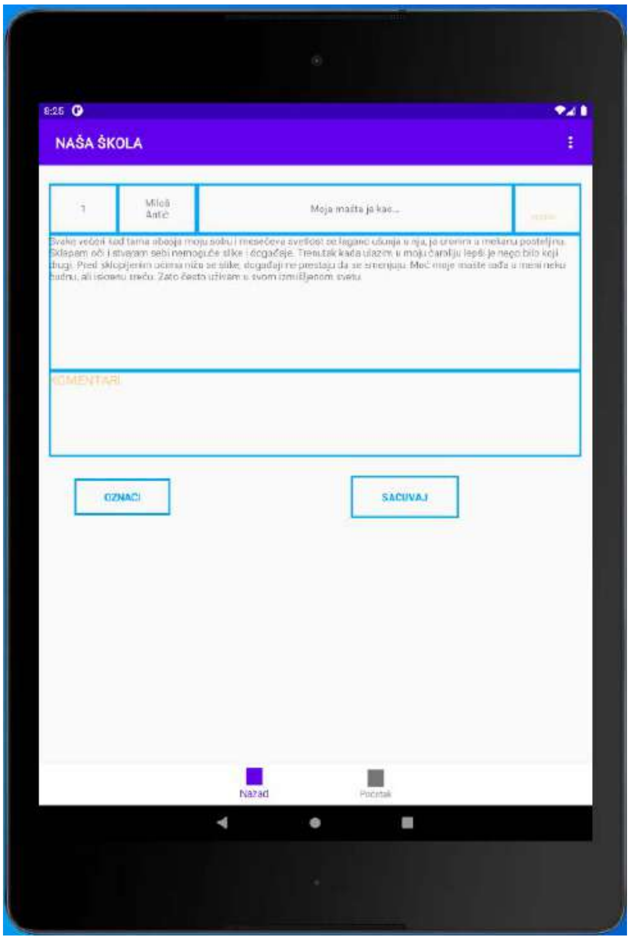

Image 12 Work in Serbian

The picture shows what the work the teacher received before his examination by the same looks like Image 13. Text and comment fields can scrolls because writing can be very long.

Image 13 Enter comments

5.2 FUNCTIONS OF STUDENTS

After logging, the student has the option as well as the teacher of the choice of the appropriate subjects and functions related to them. From the displayed drop-down list, all possible selections of can be easily selected Image 14.

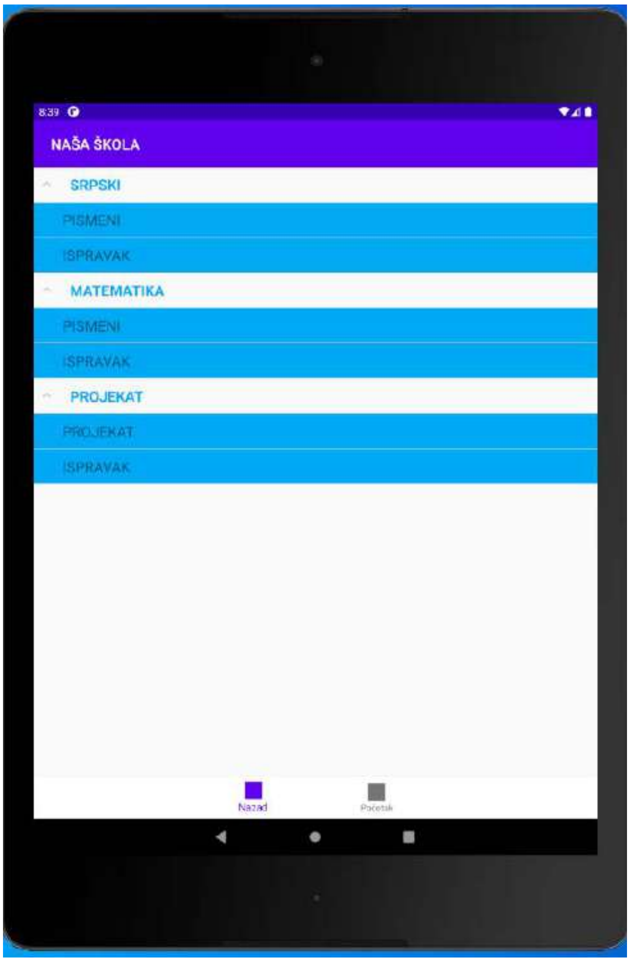

Image 14 Complete list1

5.2.1 PREPARATION OF WRITTEN TASKS AND PROJECTS

To start making Serbian language literacy, the student selects the theme Image 15. It passes through the buttons back and forth.

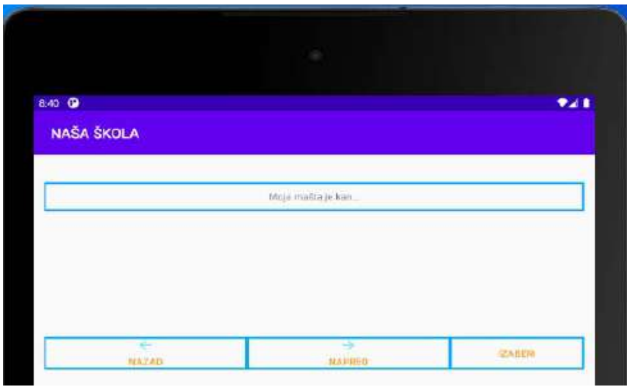

Image 15 Topic selection

After this choice, a new look opens, which allows the student to write appropriate work from the Serbian language Image 16. In the course of the work, there is no possibility of returning to the home list, i.e. interruption of the composition. Only when the composition is preserved can the student choose one of the options.

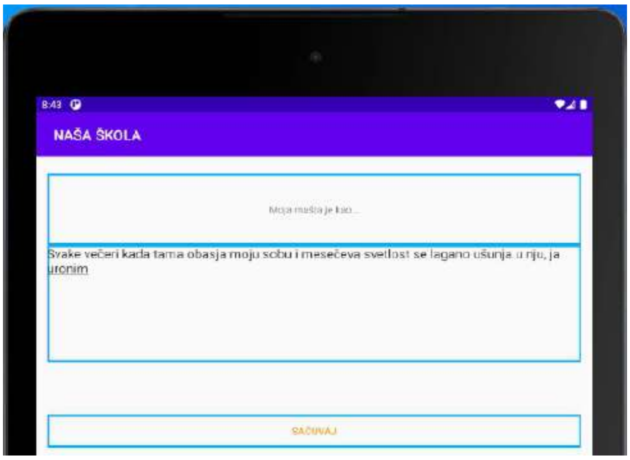

Image 16 Writing

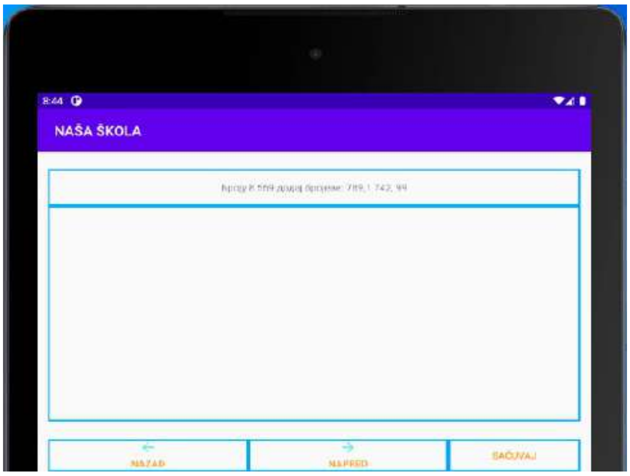

Image 17 Solving tasks

Selecting a math-written card opens up an environment for task-making, with tasks being passed through the forward and back arrows Image 17. In the framework of project creation, you can choose the picture and enter the appropriate text Image 18.

The theme of the work is given by the teacher, who in the same way later reviews the work done as he does in Serbian and mathematics. Text field can scroll.

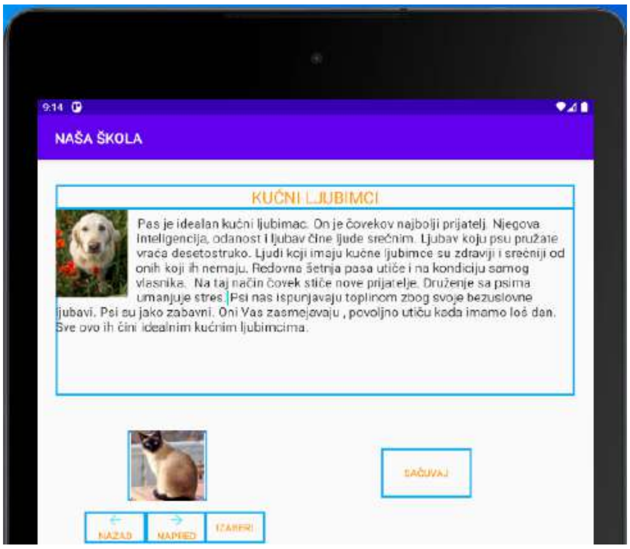

Image 18 Project development

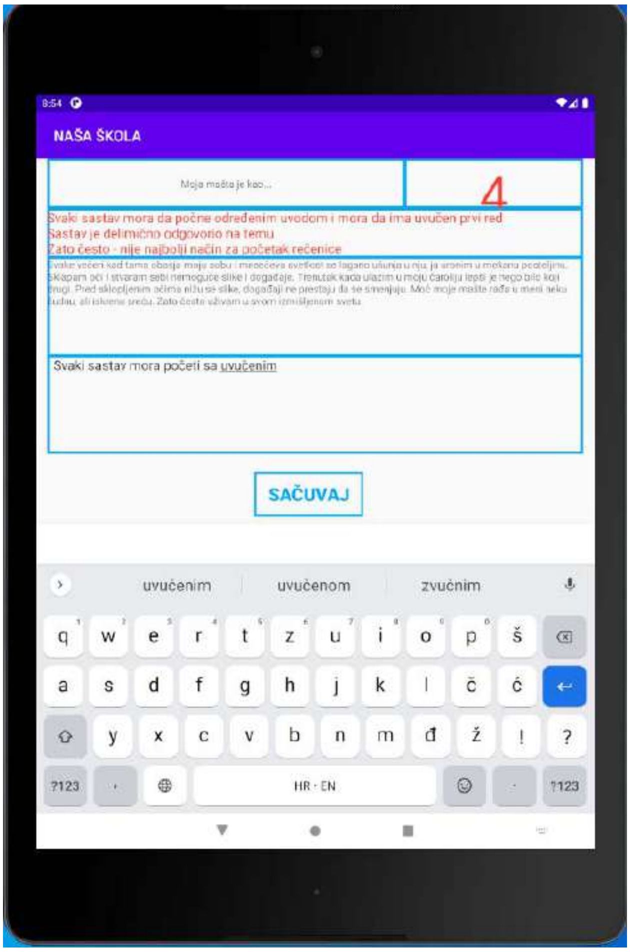

Image 19 Correction of written

Possible photos are passed through arrows back and forth. After the work has begun, the student is unable to exit the work box until he has finished working by clicking the save button.

5.2.2 CORRECTION OF THE WRITTEN AND PROJECT

The student is also able to correct the work done on the basis of the rated work by the teacher, as he did in real life

Image 19. Fields related to text and comments can be scrolled. Mark and comments are in red like in real life.

6. CONCLUSION

A large amount of mobile applications can be found online, but none fully meet the needs of domestic education. As schooling during the pandemic was very difficult and every trip to school was considered an additional risk to employees, children, their parents and relatives, we sought to create tools to satisfy the need for children to continue online and all written and tests at home. The tool is made in accordance with the requirements of domestic education and includes the development of literacy tasks in Serbian and Mathematics as well as the development of projects. When making tools, it is hand-in-hand that each item has the same look as those used in real life.

Given the development of the new reality and the general adjustment of the needs for further development of e-learning tools, it will not diminish in any way, but the tendency for its increasing development is clearly visible development. During the analysis of previous online classes, it was concluded that students and teachers are limited to existing Viber, Zoom applications, which are quite overloaded due to the huge number of users, and papers are sent using email, this tool is designed to facilitate the creation of basic elements of knowledge testing within today's schooling.

As part of this work, written in Serbian and mathematics were processed, where patterns applied to languages, physics and chemistry and many other subjects. If possible, more testing should be added to satisfy the needs of checking children's knowledge at various levels in the conditions of online teaching. Projects should also be added to create a larger group of children for their socialization, which would be particularly interesting to them since they often play different games together.

As the possible emergence of a growing number of pandemics has been pointed out, developing these types of applications should be a priority.

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37.018.43:004.738.5(082)
371::004(082)
37.02(082)

INTERNATIONAL Conference on e-Learning (11 ; 2020 ; Beograd)
E-Learning 2020 : proceedings / The Eleventh Internacional Conference on E-Learning, Belgrade, 24-25 September 2020. ; [editors Bojana Trebinjac, Slobodan Jovanović]. - Belgrade : Metropolitan University, 2021 (Belgrade : Copy Print Plus). - 107 str. : ilustr. ; 30 cm

Tiraž 70. - Bibliografija uz svaki rad.

ISBN 978-86-89755-19-0

а) Учење на даљину -- Зборници б) Образовна технологија -- Зборници в) Информациона технологија -- Образовање -- Зборници г) Електронско учење -- Зборници

COBISS.SR-ID 42161417