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IMPROVED ALGORITHM FOR TAG-BASED COLLABORATIVE FILTERING

UDC: 519.254:[37.018.43:004
Professional Paper

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Abstract - Important aspect in the modern e-learning systems is selecting the most adequate learning materials based on learners' requirements, needs and knowledge goals. Recommender systems based on collaborative filtering contribute to overcoming the information overload in personalized learning environments. That's why there is imminent need of using systems that have the capability to detect the learners' needs and to recommend them the most adequate learning context. In recent years, it is common practice to use tags in the process of filtering the most useful learning materials. Through the tagging, learners can mark or highlight some learning materials and can contribute to organizing and retrieving useful learning materials.

Our previous researches were focused on tag-based collaborative filtering and learning style determination, the factors that affect the tag-based collaborative filtering, in order to suggest useful learning material in adequate format.

In this paper, we propose a new tag-based collaborative algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm, and suggest the learning materials based on posted tags rating and students rating.

The developed system was implemented at the Faculty of Law – Bitola, and the evaluation results are shown in this paper.

Keywords: tag-based collaborative filtering, algorithm, e-learning, learning materials

I. INTRODUCTION

Undoubtedly, the internet technology has an important role in the learning systems and, the volume of course-related information available to the learners is rapidly increasing. Searching for useful materials and sources in a large dataset without some tools for context filtering and recommendations leads to inefficient learning process.

Intelligent e-learning systems can improve, modernize and simplify the learning process by using tools for filtering the most adequate learning materials based on users' knowledge level, needs,

requirements and interests. In addition, the intelligent e-learning systems are going to motivate and support the learners to achieve the learning goals on efficient and effective way.

Recommender systems in e-learning environments utilize information about learners and learning activities and recommend items such as papers, web pages, courses, lessons and other learning objects. According to Drachler et al. [1], recommender systems have to meet the pedagogical rules and interests of learners. Because all learners have different characteristics, the effective recommender system in e-learning environments must take in consideration some learners' features like learning goals, knowledge level, learning characteristics, strategies, etc. The main goal of the recommender systems is to make predictions using user ratings and tags available for a given item.

Collaborative filtering is a widely used approach to recommend adequate items to users based on the assumption that similar minded people will have similar taste, requirements, needs or behaviors. According to Huizhi et al. [2], the collaborative filtering can help users organize, share and retrieve information in an easy and quick way.

With the increased use of the collaborative tagging systems, tags become useful information to enhance and optimize the algorithms for recommender systems. These systems can support learners by recommender learning resources and tags too. Collaborative tagging is a mechanism for describing items in large on-line collections. In other words, collaborative filtering approaches predict the rating of items for a specific user based on the ratings and tags from other users with similar interests. The same holds for tag suggestions. Tagging has recently become very popular and useful. At the same time it's an

effective way of classifying items and categorizing them in groups that contain items with similar characteristics. According to Wartena et al. [3], tags are assigned by users to describe and find back items. Based on Musto et al. [4] the use of tags, keywords freely chosen by users for annotating resources, offers a new way for organizing and retrieving web resources that closely reflect the users' mental model and also allow the use of evolving vocabularies.

Because different learners may set different tags for the same learning material and the learning material can be tagged with multiple tags, the learner profile should be profiled not only by the tags and used learning materials, but also by the relationship between the tags and tagged learning materials from the learner [5].

In our previous researches [6,7,8], we have implemented an intelligent e-learning system that was used in the educational process at the Faculty of Law in Bitola. It includes adaptation rules and ontology for knowledge representation and supports the learners by recommending learning materials, online learning activities based on their learning style, used tags, knowledge level and the browsing history of other students with similar characteristics. In other words, the system uses tag-based collaborative filtering in order to recommend the most adequate learning materials to the students. The students can add tags for the learning materials by using an interface and simply by entering one or more tags separated by commas in the free-text input text field. In our another research [9], we have identified the factors and parameters that impact a tag based collaborative filtering used for recommending the most adequate learning materials. In that content, we have identified the following factors: students rating, tags rating and learning materials rating.

In the scope of this paper, we review several tag-based collaborative filtering algorithms and propose a new algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm. Our approach determinates the similar profile with logged student, selects the adequate learning materials and forces the more important learning materials – materials that have tags with high rating set by the students with high rating.

II. RELATED WORKS

Liang et al. [2] proposed a tag-based collaborative filtering approach for recommending personalized items to the users. Based on the distinctive three dimensional relationships among the users, tags and items, they proposed a new similarity measuring method which generates the

neighborhood of users with similar tagging behavior instead of similar implicit ratings. Based on experimental result, the authors show that by using the tagging information, the proposed approach outperforms the standard user and item based collaborative filtering approaches. Carmagnola et al. [10] proposed a framework for improving recommender systems through exploiting the users tagging activity. They stress social annotation as a new and powerful kind of feedback and as a way to infer knowledge about users. Also, they investigated the role of tags in the definition of the user model and the impact of the tags on the accuracy of the recommendations. Yue et al. [11] proposed a novel algorithm for tag-based collaborative filtering, which exploits user-contributed tags that are common to multiple domains in order to establish the cross-domain links necessary for successful cross-domain collaborative filtering. The authors introduced a constraint involving tag-based similarities between pairs of users and pairs of items across domains. By using two publicly available collaborative filtering data sets as different domains, the authors experimentally demonstrated that the new algorithm substantially outperforms other state-of-the-art single domain collaborative filtering and cross-domain collaborative filtering approaches. Rong et al. [12] proposed a collaborative approach for expanding tag neighbors and investigate the spectral clustering algorithm to filter out noisy tag neighbors in order to get appropriate recommendation for the users. Based on the preliminary experiments that have been conducted on MovieLens dataset to compare the proposed approach with the traditional collaborative filtering recommendation approach and native tag neighbors expansion approach in terms of precision, the result demonstrates that the proposed approach could considerably improve the performance of the recommendations. Wartena et al. [3] focused on generating tag-based profiles for the users and then recommended new learning materials based on the generated profile. Also they introduced topic aware recommendation algorithm - first detect different interests in the user's profile and then generate recommendations for each of these interests. The authors in [13] present a tag recommender system which extends the collaborative filtering with a content-based approach able to extract tags directly from the textual content of HTML pages. Results of their experiments carried out on a large dataset gathered from Bibsonomy, where's shown that the use of content-based techniques improves the predictive accuracy of the tag recommender.

III. PROPOSED APPROACH

The proposed algorithm for tag-based collaborative filtering is a part of a larger adaptive e-learning system. Except recommendation, the system delivers the learning materials in format adequate to the learners' learning style.

All of the learners can describe learning materials with a set of tags, whereby the system creates a complex network of learners, learning materials and tags. To understand the main idea of the proposed algorithm, we need to consider that network as a three-dimensional relation: learner – learning material – tag. That structure allows determination of learners that set tags for specific learning material. In that manner, we can define the following sets:

$S = \{S_1, S_2, \dots, S_n\}$: set of learners (in our case students)

$L = \{L_1, L_2, \dots, L_n\}$: set of learning materials

$T = \{T_1, T_2, \dots, T_n\}$: set of tags posted from the students S for learning materials L

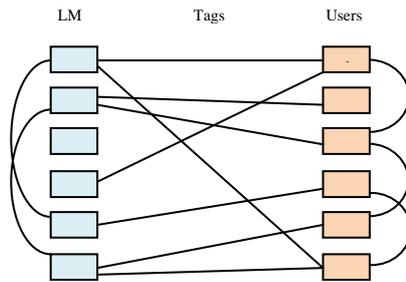


Figure 1. Conceptual model for collaborative tagging system

Additionally, learners and tags have their own rating. The learning material becomes important if it has been tagged with important tags (tags with high rating) from important learners (learners with high rating). For instance, one learning material could be tagged with important tags by important learner. Then, the tagged learning material can be considered as an important learning material and suggest it to the logged learner. The same holds for the learners and tags.

Undoubtedly, learners have different knowledge level and have different interest. To achieve greater efficiency in the educational process and in the process of recommendation, we group learners in few groups and subgroups named as virtual learning group. There, virtual learning group is a set of learners with the same knowledge level, the same learning interests and use the same course. For instance, learner A and learner B belongs to the same virtual learning group only if they have the same knowledge level and they have the same learning interests.

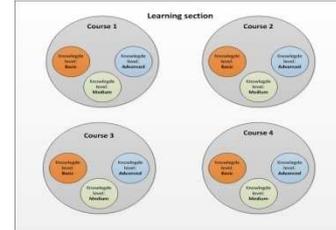


Figure 2. Virtual learning groups

The main idea of our paper is to suggest the most relevant learning materials to the learners using tag-based collaborative filtering, but also to take in consideration and the learners and learning materials rating. With other words, the suggested algorithm will force the more important learning materials – materials that have tags with high rating posted by learners with high rating.

To generate the suggested list, the system needs to complete the following steps: determine similar learners, select the most adequate learning materials and order the selected learning material by their rating.

The main goal of the first step is to determine similar learners with the logged learner and to generate a set of the top N most similar learners, ordered by their rating. In this step, system first selects all learners that belong to the same virtual group with the logged student (all students with the same knowledge level and learning interests) and students with higher knowledge level but with the same knowledge level. For instance, if logged user A has basic knowledge level and his learning interest is PHP programming language, then the algorithm will select all students with the same properties (basic knowledge level and interest in PHP programming language) and students with medium or advanced knowledge level that are interested for PHP programming language too.

Once the most similar learners are identified, the second step is to select the most adequate learning materials in order to be recommended to the logged learner. In that manner, the algorithm takes in consideration all materials which have been tagged from the similar learners generated in the previous step but not used from the logged learner. Important aspect in this step is the learning materials rating because the algorithm will force the learning materials with higher rating.

Within the first step, we use BM25, also known as Okapi BM25. Manning et al. [14] defined it is a non-binary probabilistic model used in information retrieval. The system takes into consideration a set of tags of each learner and make two analogies, comparing the tags of the logged learner with a query, and the set of tags of each similar profile as a document. It means that we performed

calculation of learners profile similarity based on the BM25 model and thus we generate a set with all the similar profiles to the logged learner. The BM25-based similarity model is taken from the calculation of the Retrieval Status Value of a document (RSV_d) of a collection of a given query [14]:

$$RSV_d = \sum_{t \in q} IDF * \frac{(t_1+1)tf_{td}}{k_1 \left((1-b) + b * \left(\frac{L_d}{L_{ave}} \right) \right) + tf_{td}} * \frac{(k_3+1)tf_{td}}{k_3 + tf_{td}}$$

RSV_d represents the similarity score between the logged learner (the terms of the query q) and one similar learner (the terms of the document d) from the same virtual group. This similarity is calculated as a sum over every tag t posted by the logged student. The similar learner n is represented as a set of tags with their frequencies. L_d is the sum of the frequencies of each tag of the similar learner n . L_{ave} is the average of the L_d of every similar learner. The term tf_{in} is the frequency of the tag t into the set of tags of the similar learner n , tf_{iq} represents the frequency of the tag t into the query - the set of tags of the logged user.

After calculating the similarity between the logged learner and each similar learner (learners from the same virtual learning group or learners with higher knowledge level but with the same learning interests), we choose the top N similar learners with the highest rating.

Within in the second step, the system uses cosine-based similarity to calculate the similarity between two learning materials – learning materials tagged from the logged learner and learning materials tagged from the similar learners. Then, the system will select top N materials with highest rating. To get the more reliable results for calculating the similarity between learning material a and learning material b , we need to isolate the students who have set tags to both of these items and then to apply a similarity computation technique to determine the similarity between learning material a and learning material b .

We use cosine-based similarity to calculate the similarity between two learning materials. In this case, the learning materials are thought of as two vectors in the m dimensional user space[15]. The similarity between the materials is measured by computing the cosine of the angle between these two vectors, based on following calculations:

$$Similarity(a,b) = \cos(\vec{a}, \vec{b}) = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\|_2 * \|\vec{b}\|_2}$$

Because the learners rating and the learning materials rating have an impact on the process of determining the relevant learning materials, we need to calculate them.

A. Student rating

In order to calculate the learners rating, the system uses two coefficients: knowledge level coefficient (C_{kl}) and student activity coefficient (C_{sa}).

Total student rating C_{kl} can be calculated as an average value of the two coefficients:

$$C_{kl} = \sum \left(\frac{P_n}{N_t} * K_{ln} \right)$$

P_n is a score from the test of knowledge level K_{ln} and N_t is the maximum number of test points.

The student activity coefficient (C_{sa}) can be calculated as:

$$C_{sa} = \frac{T_{su}}{T_r}$$

T_{su} is number of total tags posted from the student S , while T_r is total number of tags posted from the other learners for learning materials tagged by learner S .

Finally, learner rating S_{rat} can be calculating as:

$$S_{rat} = \frac{C_{kl} + C_{sa}}{2}$$

B. Learning material rating

Average material rating (LM_r) can be calculated as an average value of two coefficients: average rating posted from the learners (R_{av}) and learners' average rating that post rating to learning material (R_{sav}):

$$LM_r = \frac{R_{av} + R_{sav}}{2}$$

The Figure 3 shows the diagram of proposed approached.

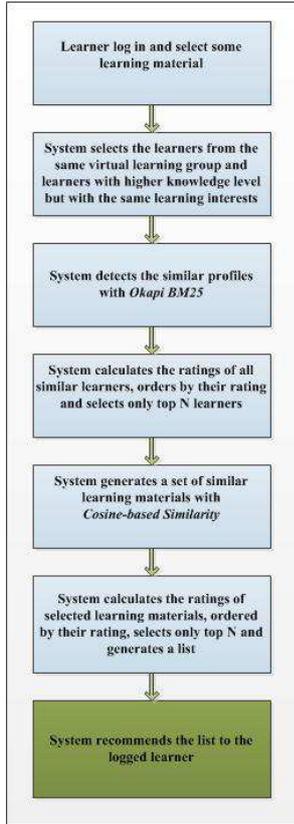


Figure 3. Process of learning materials recommendation

The implemented system uses following logics in the process of learning materials recommendation:

```

For each student S do
  If the student S belongs to the same virtual learning group with the logged student Sa
    If the student S has rating > rating_limit
      For each similar student to the logged student Sa (based on Okapi BM25) do
        For each tag on a learning material Lm of similar student Sa do
          For each commonly tagged learning material Lmk that Sa has with S do
            If the learning material Lmk has rating > rating_limit_material
              For each similar tag i
                Calculate the  $sim(T_{Sa \rightarrow Lmk[i]}, T_{Sa \rightarrow Lm[i]})$ 
                Add  $sim(T_{s1 \rightarrow Lmk[i]}, T_{Bmk \rightarrow k[i]}) + 1$  to student_temp_similarity
                Add_material_to_final_list()
              End for
            End if
          End for
        End for
      End if
    End if
  End for
End for

```

IV. RESULTS

The system was implemented at the Faculty of Law in Bitola. It was used in the period of 6 months by the students from the undergraduate studies. The survey was conducted on total 110 students, divided into two virtual learning groups: Computer Technology and Constitutional Law, which contains three sub virtual groups, based on student knowledge level: basic, medium and advanced knowledge level. Table I shows the number of students in virtual learning groups and sub-groups.

TABLE I. NUMBER OF STUDENTS IN VIRTUAL LEARNING GROUPS

		Knowledge level		
		Basic	Medium	Advanced
Courses	Computer Technology	22	24	12
	Constitutional law	18	21	13

We compared the results from our previously research and the current research. In our previously research, we were using simple collaborative filtering for learning materials recommendation, but we didn't take in consideration any additional factors that affect the collaborative filtering process. In the current research, we use BM25 probabilistic model for determination of similar students with the logged student and cosine-based similarity for selecting the most adequate learning materials. Additionally, in the scope of this paper we have taken in consideration learners rating and learning materials rating in order to check their impact on the process of determining the most relevant learning materials. Table II shows results differences.

TABLE II. COMPARISON OF THE RESULTS

Activity	The old research	The current research
Number of learning units	91	148
Number of students	110	110
Number of tags	739	1345
Average students rating (1-5)	/	3.89
Average learning materials rating (1-5)	/	4.12
Used learning materials from the suggested list (%)	74.6	83.8

According to the results in Table II, it's clear that the approach that takes in consideration learning materials and students rating bring to more effective process of tagging, but also and more valuable and useful recommendation. The Figure 4 shows the graph presentation of the results differences.

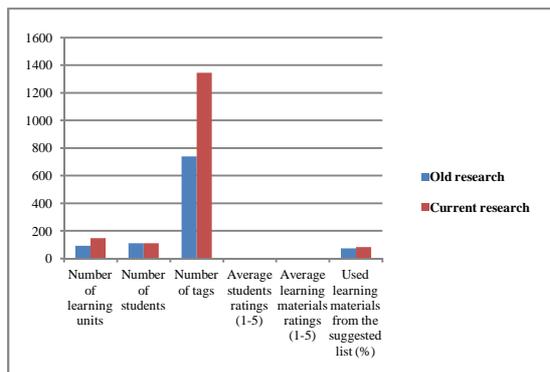


Figure 4: Graph presentation of the results differences

An e-survey was conducted as a last part of this research. The survey was conducted to the students after using the system and their answers are shown in Table III.

TABLE III. RESULTS FROM THE E-SURVEY

#	Question	Answers (1 - Strongly Disagree 5 - Strongly Agree)				
		1	2	3	4	5
1.	I found useful using learning materials with adequate complexity to my knowledge level and prior knowledge	5	9	22	25	49
2.	I found useful recommendations for learning materials	1	7	17	39	50
3.	The recommend learning materials are adequate to my needs	2	8	12	37	51
4.	The system was user-friendly and easy for using	3	8	14	29	56
5.	The approach of suggesting learning materials is useful and helpful in the educational process	4	11	26	30	39
6.	Learning materials with high rating are more valuable and helpful for me	7	15	22	30	36
7.	I want to use the learning materials which were used from the student with high rating	8	11	24	29	38

According to the answers, the students are satisfied with the quality of recommendation for the next learning materials, and they agree that the system is user-friendly and easy for using. Furthermore, they confirmed that the learning materials rating and student rating has important impact in the process of learning material recommendation.

V. CONCLUSION

The system's ability to select the most adequate learning content and deliver it in the adequate format to the users is very important aspect in adaptive e-learning systems. The main goal of our

system is to recommend the most appropriate materials to the students based on the tags they set for the learning materials. Additionally, we have taken in consideration students rating and learning material rating in the process of collaborative filtering.

In the scope of this paper we proposed a tag-based collaborative filtering algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm. Our approach determinates the similar profile with logged student, selects the adequate learning materials and forces the more important learning materials – materials that have tags with high rating set by students with high rating. The system calculates the rating of the learning materials and students first. Then, the system determinate the similar profiles to the logged learner based on the BM25 probabilistic model. Second, by using cosine-based similarity the system calculates the similarity between two learning materials – learning materials for which the logged learner has set tags and learning materials for which the similar learner has set tags. Then, the system will select top N materials with the highest rating.

After a period of using the system, we have compared the results obtained from the student's activities and we can conclude that the proposed algorithm for tag-based collaborative filtering that takes in consideration ratings of students and learning is more efficient that a standard collaborative filtering. It can be concludes based on the highest percentage of accepted items from the suggested list in the current research versus the percentage in the preview research.

The future researches could be focused on including lists with synonyms for the tags and cold star problem. in tag-based collaborative filtering process in order to be recommend more adequate learning materials.

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CHANGING THE LECTURING STYLE – THE GOOD AND THE BAD OF MIXED-UP SCHEDULES

UDC: 378.4:371.311
Professional Paper

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Abstract - How does a teaching block impact on students, who are used to 13-week semester subjects? Do these students have better knowledge immediately (i.e. one week) after such a teaching block compared to the case of the usual setup, where they also wait one month until the exam? We had the chance to try out such a change in the course setting within one Software Quality and Project Management course at the Technical University of Kosice. The course is located in the last year of our Informatics and Applied Informatics Masters' degree study programs. This paper presents our teaching experiment focusing on the questions presented above, together with its results. First, we present details of the mixed-up semester and block schedules. Then, we analyze time constraints, relations to other subjects, various students' problems, workload on students and teachers, and grading issues. We also evaluate the collected data and opinions, and discuss students' feedback related to this specific course organization. The presented conclusion focuses on the future application of the teaching schedules used as well as on improvements of these schedules.

Keywords: simulation, mixed-up schedule, feedback

I. INTRODUCTION

Teaching at universities is always a big challenge. The bigger the challenge is the faster the development and innovation is in the given field. Software engineering is a characteristic example of such a field [1, 2]. In our setting,

We dedicate this paper to the memory of Ladislav Samuelis (1951-2013), the promoter of teaching software quality in Slovakia. Many thanks go to Elke Hochmüller from the Carinthia University of Applied Sciences in Klagenfurt for helping and supporting course implementation.

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software quality assurance and software project management represent such a teaching challenge.

Modern trends in teaching include, apart from the use of E-Learning systems and web-environments, the usage of examples [3], case studies [4], and simulations [5-8] for the following reasons:

1. Examples are one source of basic knowledge to be gained.
2. Case studies require more concentration than examples from the students to understand a process.
3. Simulations allow for the most complex type of knowledge transfer and interaction.

Instead being deductive as in the cases 1 and 2 above, simulations require predictive thinking. There is a significant positive property of teaching by using simulations: the knowledge stems from the students' own experiences. Additionally, the language used within simulation environments is less a problem, especially when compared to using foreign language teaching materials. Mária Šimková et al. argue that such materials have unwanted bad impact on native language skills of students [9]. Often, parts of these teaching materials come from industry or an inter-University cooperation, which implies also a jargon to be used – yielding another language problem and introducing inconsistencies in the used terms. Finally, experience at the Technical University of Košice (TUKE) also shows that some students still prefer cheating [10], and thrilling simulations can be seen as a chance to increase the interest in learning again.

Besides the teaching environment, the most important issue is the student himself/herself. In

our research, we aimed at measuring their results [12], and adopted teaching materials, as other authors [11-15] do, to consider the students' knowledge but also to provide the required level of new knowledge to them.

Further characteristics of a teaching environment include social and technical backgrounds and habits. Here, we consider e.g. lengths of teaching and examination periods, grading and evaluation requirements, learning material styles etc.

In this paper, we present the results of an experiment where we tried out a radical change in the setup of our teaching environment at TUKE. The main question was if there is an effect (and of which kind) when introducing a tight teaching block instead of following a traditional course setup on a weekly basis. We stated two hypotheses related to this question:

1. The teachers' and students' workload does not change when changing the implementation of the subject schedule from the 13-week semester model (lectures and labs) to a mixed-up model consisting of 13 weeks of lectures and a one-week long teaching block of intensive laboratory work.
2. The students' knowledge (measured by tests at the end) is higher (when compared to the past year's results) if they take place immediately in the week after the execution of the intensive teaching block.

In order to answer these questions, we examined changes in the students' behavior and workload as well as in the teachers' workload. The details on the environment changes will be presented in Section II of the paper. In Sec. III, we present and discuss selected problems with its implementation, while our student-behavior related experience is discussed in Sec. IV. In Sec. V, we evaluate our hypotheses and show further directions of our research.

II. LECTURES & LABS IN OUR EXPERIMENT

For our experiment, a course called Software Quality and Management was selected. This course takes place in the last year of our Informatics and Applied Informatics Masters' degree study programs. During our experiment, 148 students of the said specializations attended the course. In the year before our experiment, there have been 140 students attending the class. In the traditional 13-week semester setup, lectures and labs were taught by one teacher.

The theory required for the course is presented at lectures, while labs use a simulation tool for

practicing software project management. The theory is also accessible in a printed form as a textbook [16]. For the simulations, an environment called AMEISE (A Media Education Initiative for Software Engineering) [6-8] was used.

The basis for an AMEISE simulation run is a so-called simulation model. It contains the different simulation settings. In our course, we made use of a quality assurance model which focuses on quality aspects, requiring the trainee to manage a 200 AFP (Adjusted Function Point) project within 9 simulation months, a budget of 225.000 €, and strict requirements concerning the quality of the final product (in terms of a maximal number of errors allowed per 1000 lines of code and a minimum percentage of AFPs required to be implemented).

A. Structure of the 13-week semester subject

The "classical" semester TUKE students are familiar with lasts 13 weeks, followed by a 6 weeks examination period. The organization of a typical semester is as follows:

- Every week there is a lecture. There are 11 or 12 lectures depending on the actual year (as there could be a lecture cancelled due to a national holiday or a conference). This also means that the lecture content is adapted to the situation – in some cases the lecture is more condensed with a shorter time reserved for discussion. The length of a lecture is 90 minutes, i.e. two lecture hours.
- Every week a lab. There is the same number of labs and lectures that take place. Lab classes are only partially related to the actual week's lecture. The main focus of the labs is on practicing software project management skills. Basically, two simulations in the AMEISE environment have to be done by each student team. Such teams usually consist of two members; in the case of an uneven number of students, one team consists of three students. The duration of the labs is also 90 minutes, i.e. two lecture hours. As the duration of one AMEISE simulation run is more than a usual lab in the schedule, some parts of the simulations are to be completed at home (summing up to about 3 extra hours in total).

To conclude, the average workload of a student is 4 lecture hours per week (12 times), summing up to $48+3 = 51$ lecture hours per semester.

The lecturer has to work more, not only because of material preparation, but also because

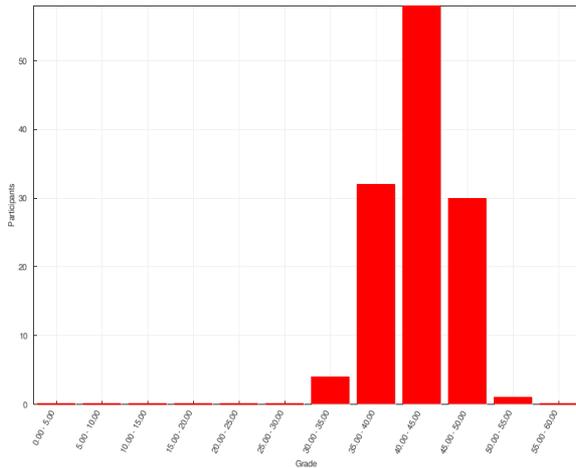


Figure 1. Course exam results from the 13-weeks variant

the students are from two fields of study. On average, it needs about 48 lecture-hours for preparation, giving the lecture and after-lecture work. Due to the high number of students in our experiment, 6 groups had to be formed in the lab classes. The lab workload for the teacher to be taken into account is thus 6 times 24 hours. It results in 12 lab-hours per week or 144 teaching hours per semester of workload for the teacher.

Grading is done at two stages: finishing an AMEISE simulation run successfully yields 6 ECTS credits and the exam result determines the final grade at our local A to FX scale. The weight distribution is 40% and 60%; obviously, 21% of 40% for the credits respectively 31% of 60% are needed to pass the exam and are thus the minimal requirements in the ECTS system of the subject.

The examination results for a typical 13-week semester subject are displayed in Fig. 1. It presents the results from the academic year 2012/2013 in the mentioned subject.

B. Structure of the mixed-up schedule

The mixed-up schedule combines the “classical” 13-week semester of lectures with a teaching block at the end of the semester. Due to the limitations in the organization of teaching subjects at our department, this combination had to be implemented at the beginning of the examination period – further details on problems and specific solutions will be presented in Sec. III.

The key point of the schedule is that labs are organized in a completely different way: they are scheduled in dense blocks. The lectures stay the same and the majority of them regularly takes place during the semester. Only those lectures (and parts of it) which are needed for successfully working in the labs are also shifted to the blocked week. The layout of the lectures is as follows:

1. The first four lectures are moderated guest lectures from the Testing headquarter at a big Company. Topics of these lectures include software and test-aware project management and software testing.
2. Next, three lectures on software metrics follow.
3. The remaining lectures focus on software quality management, on actual research results and challenges in all discussed fields of software engineering.

The above lecture organization is almost identical to the 13-week schedule. Therefore, we can provide nearly the same amount of effort:

- 24 hours per semester for students, and
- 48 hours per semester for a single teacher. However, the moderation of guest lectures might be of a lower workload than preparing for own presentations.

The introduction of a teaching block is something new at TUKE. The aim is to deepen the students’ knowledge intensively using simulations immediately after that lecture which introduces the simulation topic. How does it work? Well, we created the following schedule:

1. Intensive introductory lectures on software quality metrics and software project management,
2. Even more intensive lecture introducing the AMEISE simulation environment,
3. First simulation runs,
4. Feedback session on first simulations,
5. Second simulation runs,
6. Feedback session on second simulations.

To increase the students’ motivation, a best simulation award was defined for the first simulation runs.

The workload measurement results for the students partaking in the experiment can be summed up to 23 hours per block. The teachers’ workload considering 6 groups (as above) sums up to 83 teaching hours. This is a problem, because this would not fit into a normal one-week block. Therefore, we decided to involve 3 teachers (again, details will follow in Section III.C) in the lecture.

III. PROBLEMS & SOLUTIONS

Our final schedules looked like as presented in Fig. 2. However, it was a long way to create them. Our way was impeded by a lot of obstacles – which ones, we now present in the next subsections.

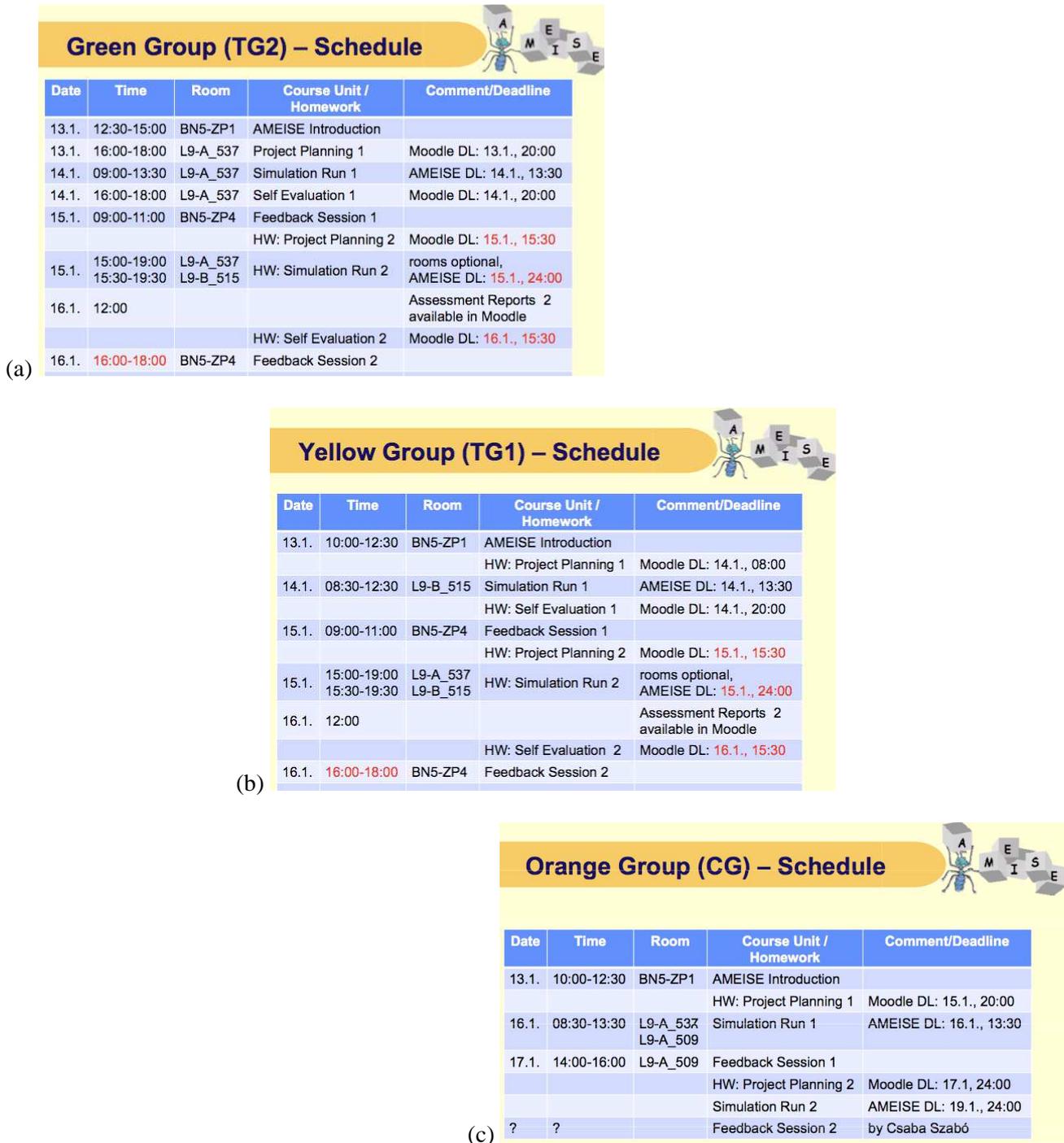


Figure 2. Final green (a), yellow (b) and orange (c) group schedules for the week with AMEISE

A. *In which week should the block be?*

This was (and still is) a very important question, also related to the workload of students and teachers.

The usual semester organization at TUKE (but also other Universities) prescribes that every student must have a lesson every week in every of his teaching subjects. This implies a huge complication when organizing a one-week teaching block. Students cannot be taken off from their usual schedule.

As a solution, we used the second week of the examination period for our block. However, with that, another problem appeared – there were possible collisions with exams in other subjects this time.

We solved the second problem by reorganizing students into larger groups: green, yellow and orange. This affected the schedule as well, but could decrease the number of teachers' hours due to a smaller number of groups.

B. How to grade the students?

Grading should be a transparent process in teaching. Fortunately, there are several attributes reported back as the result of a simulation run. In the simulation setting a software system had to be “produced”, and the following attributes (simulation goals) were used as a basis for the grading:

1. Duration of the project (in simulation time),
2. Costs (needed for delivering a product),
3. Number of Adjusted Function Point covered by the code,
4. Number of errors per 1000 lines of code,
5. Adjusted Function Point % covered by the manuals,
6. Number of errors per page in the manuals.

We defined lower limits of success, but as there have been two simulation runs, the most important factor was *how* the teams *improved* their simulation results. In order to pass this part of the lecture, we defined that at least in one of the above factors an improvement was required.

We used the reporting interface of the AMEISE server to retrieve all the relevant data. Then, we put these data into a Spreadsheet application, applied our limits, and summed up the results for each team separately.

To make it easier for the teams to improve, the first feedback session included personalized suggestions on how to do that.

C. How to decrease workload?

Our strategy in decreasing the workload was to reorganize groups and their schedule. From the first guessed value of 24 hours workload on students, the final organization using only three groups instead of six served with 23 hours workload. In the case of the experiment, the involved teachers managed to decrease the value from 83 to 40 teaching/lab hours.

D. In which week should be the exam?

According to the intensive block teaching, the question of the examination date was also important. Long-time memory and short-time memory effects play a major role in this case. And, the different learning styles of students also have to be considered. Results from brain-friendly teaching [17] indicate that using simulations (and other activities) in teaching already yields an optimal result and a lot of knowledge is moved from short to long-term memory. This means that the exams can be at the end of the block.

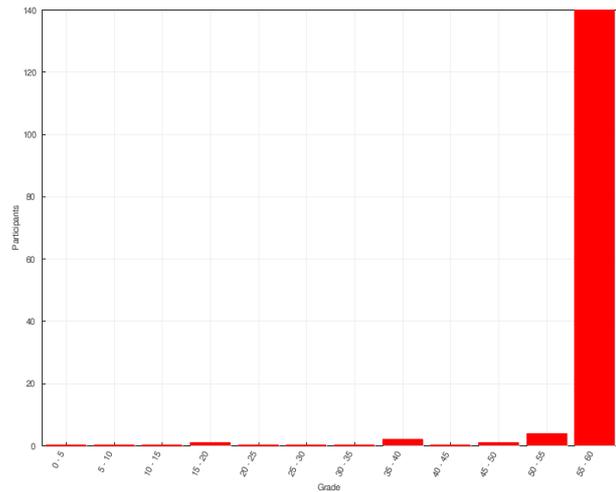


Figure 3. Course exam results from the intensive examination week after the mixed-up schedule

Additionally, the mixed-up schedule supports for both, short and long-term memory support. Almost every theoretical lecture took place one month (or longer) before, and then the simulation block repeats and demands the gained knowledge again.

In our case, we defined three examination days (with 9 exams) in the week after the lectures’ block. Another three exams were defined for the next three weeks of the examination period. But, with the exception of one student, all students passed the exams during the intensive week. The examination results for the intensive examination week are shown in Fig. 3.

E. Technical problems & solutions

As usual, technical problems also appeared. The most significant issue was the AMEISE server that was located at the Alpen-Adria University in Klagenfurt, Austria. The clients were connected to the server via the wireless computer network at TUKE and produced too much traffic. The bottleneck caused response time problems in all the clients. And, this unstable connectivity, as a consequence, also slowed down the AMEISE server and led to inconsistencies between the clients and the server. As a solution, we will use a local server in the future and improve/update the client software setting to limit unnecessary network traffic.

Another technical problem was the capacity of rooms available for the labs. Distributing the groups over several labs solved this problem, but also complicated the schedule (and the presence of the teacher) in several points.

IV. STUDENT FEEDBACK

We collected qualitative feedback from the students during the execution of the mixed-up schedule systematically using questionnaires.

Also, follow-up feedbacks were gathered, but in a less systematic way: students were allowed to report on their feelings about the schedule after the exams verbally, and, last but not least, indirect feedback was collected by reading student forums and by asking students (selected randomly) who were not enrolled to the subject.

A. *Immediate feedback*

As immediate feedback we consider feedback gained during the simulation sessions, i.e. before the end of the teaching block. This feedback was manifold; negative feedback is that several students had language or technical problem.

However, what can be seen as a great success: the vast majority of the students welcomed the new kind of organization and gave overall positive feedback on the system, guiding activities and amount of new knowledge gained during the blocked lecture.

B. *Delayed feedback*

Delayed feedback is given not later than two weeks after the teaching block finished. This includes feedback presented at the exams or informal feedback from several students.

The results of the evaluation show that there is mostly positive feedback again. One possible reason of missing negative feedback might be that we only asked students who already passed the exam positively. We know that these results are subjective, but the willingness of students to give a feedback is already an achievement, and to some extent a success of the teachers.

C. *Late feedback*

Late feedback is a feedback received later than two weeks after finishing the teaching subject. Here, no students were directly asked. But, by looking at students' forums, information was collected regarding to students' recommendations (to other students) on the Software Quality and Management course.

These types of recommendations are statistically incomplete, but as human factor evaluations, they reflect student satisfaction. We hope, this satisfaction remains and will not be teacher-related. The name AMEISE gained a positive meaning between our students, and in total 31 students had a very positive attitude to the course. But, we also know about 3 students who expressed a strong negative feeling about it. Other less negative feedback came from a very small group of students – about a size of 10 students.

V. RESULTS & CONCLUSION

The most significant lesson that we learned is that a mixed-up schedule implies a huge hidden workload on the organization, especially when it is un-natural to our teaching environments/settings. On the other hand, it represents a new and fresh point in a student's life – a change that electrifies him or her. This motivation is really needed in the all-days life.

A blocked schedule is, due to the facts presented in Section II.B, hard to improve. The strict and classical organization of lecture hours at most of the Universities yields problems in finding proper dates during the semester and the situation cannot be solved without changing local policies in Universities' teaching. One way out might be the organization of winter or summer schools for extra credits.

Finally, and based on our personal experience with the lack of space in small laboratories, the extension of the three-teacher team by additional members seems to help when running into a room capacity problem. In the case of the experiment, a fourth teacher would have been needed in order to ensure two guiding teachers per lab.

Looking at the findings above, our first hypothesis is not confirmed. The workload in such a un-natural setup is higher than in the case of a 13-week semester.

The evaluation of the second hypothesis is more difficult. The feedback sessions were obviously the most powerful sources of knowledge. Students were able to learn from their own mistakes as well as from the mistakes of the others. We claim that these sessions caused the positive feedback on the course organization at all.

The mixed-up schedule showed up as a very good solution regarding to the short-time and long-time memory of students. Our students had to use both types of their knowledge at the exam. The results suggest that it also increased their effectiveness in comparison to the previous year's results on the same question bank. Looking at Fig. 1 and Fig. 3, cheating might still be an issue, and an improvement of our question database might be needed.

So, if we do not consider possible cheating, then the results are amazing, and we can state that the hypothesis is proven to be true.

Another lesson learned is that language does really matter even in software engineering education – there are students who claim problems with English (e.g. one issue in the feedback is that a lecturer was speaking too fast). Probably, and due to the fact that the common teaching language

is Slovak, we will never have students with equal and very good English language skills at TUKE, but lectures given by external lecturers are one way in improving the situation a bit.

In the end, our results should encourage everyone to try out new settings. The way of learning is changing, and we also should think about changing our lecture style. Of course, one will run into good and bad issues, but at the end of the day increased knowledge and increased motivation is something we might harvest from it.

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INCREASING THE EFFECTIVENESS OF THE EDUCATIONAL PROCESS IN TECHNICAL SCIENCES BY MODERN INFORMATION TECHNOLOGIES

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Review Scientific Paper

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Abstract - This report examined and compared the methods related to evaluating students' knowledge by classical tests as well by the computer test system "UniTeSys". In order to verify the effectiveness of the evaluation by computer tests a series of experiments was conducted. Statistical processing of the results from the tests of students in the discipline Technical Documentation was made.

In conclusion it can be said that the objective of this work was achieved, namely to demonstrate the effectiveness of the assessment of students through computer tests in technical disciplines.

By choosing the computer test system "UniTeSys" the right choice of productive educational technology assessment was made, which increased the effectiveness of training and evaluating through the use of computer programs.

Keywords: Effectiveness, Evaluation, Computer test, Study, Experiment

I. INTRODUCTION

When planning the pedagogical experiment hypothesis was devised that includes the basic idea whose authenticity needs to be verified by conducting the experiment;

The hypothesis of the study is:

“The computer test system UniTeSys used for evaluating students' knowledge in engineering courses will lead to a greater efficiency of the evaluation on the one hand and to higher level of understanding the material on the other hand”.

II. RESEARCH PLAN

The stages for conducting the educational research are: a preparatory stage, a preliminary study, main study (natural and controlled experiment) and final experiment.

A. Preparatory stage

In the preparatory stage along with the study of the literature and the development of a concept is considered in what way the didactic experiment will be held, the key points in the methodology were marked.

The purpose of this stage is mainly gathering information about the suitability of the designated for the didactic experiment methods and tools. Purpose of the preparatory stage is also specification of the methodology and the organization of the work in the next stage.

B. Preliminary study

In this stage:

- the primary system (bank) of questions and problems was developed;
- pilot testing was conducted in which the assignments of the primary version of the test were tested;
- an analysis of the quality of questions;
- the difficulty of the assignments was analyzed;
- an analysis of the distractors was made;
- the test was tested and revised.

To establish the extent of conformity between the test assignments and the predetermined goal for the needs of the research an expert assessment was made.

The method of the expert assessment was applied twice. Once in defining the validity of the content of the compiled didactic tests and a second time in researching the experts opinion for establishing the conformity of the test assignments with certain parameters.

The expert assessment of the test assignments is an essential premise for creating tests regardless

of the level of application. Once the assignments are prepared their objectivity and their accuracy of the formulation should be checked. A task or a question can be considered objective or correctly formulated if the opinion of most experts match.

The analysis of the content validity of the test assignments by the expert assessment shows a high degree of conformity between the test assignment and the predetermined goal whose achievement it is intended to measure.

It is considered that the test is valid and it can be used to evaluate the students' knowledge. After examining and developing the test assignments and considering the results of the expertise it goes to the next stage of the test development: arranging the assignments and conducting their approbation.

According to the approbation results some of the assignments have been removed.

During the preliminary "trial" experiment, in order to appropate the methodological apparatus, the central tendencies and the standard deviation for the entire experimental group have been calculated. The results are shown in Table 1.

TABLE I CENTRAL TENDENCY

Statistics	Value
Arithmetic mean /Sr_ar_s/ \bar{X}	3,9793
Harmonic mean value /Sr_ha_s //Xh/	3,7327
Median /Med/ /Me/	3,9862
Mode / Mo/	4,00
Asymmetry coefficient in K.Pirsan / S_1 /	-0,0214
Asymmetry coefficient in Dzh.Yul / S_2 /	-0,0214
Excess /E/	-1,3439

The results of the test measurement in the prior study were calculated using the formulas

established in the testing by the test system "UniTeSys". [1]

The analysis of the results of the preliminary study gives a reason to conclude that the test system "UniTeSys" is suitable for the main experiment and with its help the goal will be achieved.

C. Natural experiment

During this study the initial natural experiment for the control and the experimental groups took place. This experiment was conducted by the pedagogical diagnostics through accepted indicators for measuring students' achievements in each of the two groups.

The aim of the natural experiment was to determine the effectiveness of the developed system.

In this stage following tasks were completed:

- A final selection of the assignments, the questions and the arrangement of test tasks was made;
- An experimental verification of the developed test assignments, methods of work organization of the students was conducted;
- The content of the used computer tests was analyzed;
- An experimental verification of the conformity between the electronic and the conventional tests in the education of students in technical disciplines was conducted;
- The results of the didactic experiment, support for the hypothesis, were summarized.

The results of the tests in the control and the experimental group are presented in figure.1.

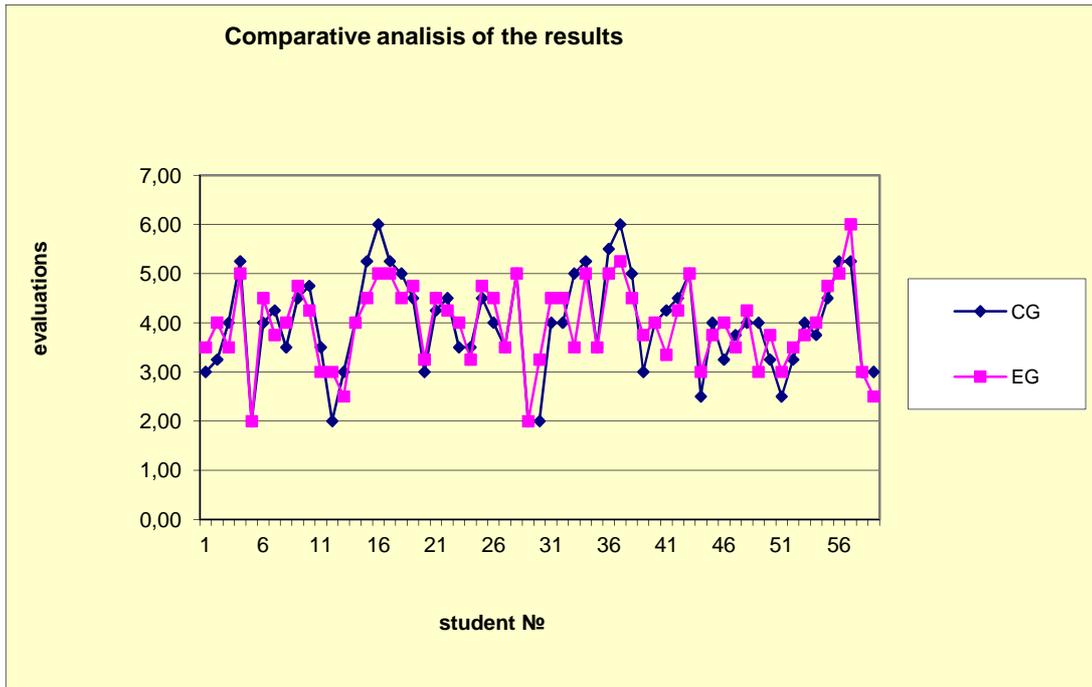


Figure 1. Results of the tests performed in the control and the experimental group

D. Testing the hypothesis

Testing the hypotheses implies estimation whether a predefined parameter value is plausible, i.e. concluding if the information obtained in the sample conforms to the expectations. In this way a decision whether to support or disprove the hypothesis can be made based on the results of the observations.

To solve the problem following hypotheses are formulated: $H_0: \mu_1 - \mu_2 = 0$ - Between the level of knowledge acquired in both groups there is no significant difference; $H_1: \mu_1 - \mu_2 > 0$ - Between the level of acquired knowledge in the two groups there is a significant difference; For finding the test statistic and its critical values with predetermined level of significance a t-Test was applied, the results of which are presented in Table 2.

TABLE II TWO-SAMPLE ASSUMING UNEQUAL VARIANCES

t-Test: Two-Sample Assuming Unequal Variances	Variable 1 /CG/	Variable 2 /EG/
Mean	3,983050	3,9762711
Variance	0,986776	0,7017548
Observations	59	59
Hypothesized Mean Difference	0	
Df	113	
t Stat	0,040075	
P(T<=t) one-tail	0,484051	
t Critical one-tail	1,658450	
P(T<=t) two-tail	0,968103	
t Critical two-tail	1,981180	

Conclusions:

- As shown by the test statistics results / t Stat = 0,04007554 / does not exceed the critical value for a one-sided test / t Critical two-tail = 0,9681 /, therefore the null hypothesis is not disproved. This means that it can be assumed that between the level of education of the students from both groups there is no statistically significant difference at the significance level of 0.05.
- The innovative electronic tests for verifying and evaluating the knowledge of the students in technical disciplines are equivalent and comparable to conventional methods
- The test is valid because it leads to results that are comparable with the results of a similar measurement method / have similar results /.
- The test is reliable because in the two groups of students with the same level of competence the results are similar.

E. Controlled experiment

As obtaining data on approximately equal performance of the experimental and control groups began forming experiment. It includes a special impact on certain qualities of the students. Quantitative and qualitative analysis of the results of the survey was made.

In this stage following assignments were accomplished:

- In the experimental group two intermediate tests were conducted;

- In the experimental and control group were conducted final tests;
- Surveys were conducted to measure the effectiveness of the evaluation of computer-based testing;
- A comparison between the results obtained from the tests in the study was made;
- An experimental verification of the effectiveness of the method of evaluating the computerized test system was made;
- The results of the research in the learning process were implemented.

In this phase of the study were used quantitative methods, in which parameters of the study experiments were set in advance before their implementation as well as qualitative methods, through which the parameters themselves were sought and interpreted [2].

The study used interviews and written questionnaires because of their wide applicability in the teaching practice.

An analysis and research of expert's and students' opinion was made on the effectiveness of computer-based test evaluation, on the quality of education, on the need to improve the learning

process including recommendations to the teaching, training and the teaching staff.

F. Final natural experiment

The purpose of the final natural experiment is:

- Accomplishing a series of final tests to measure the final results of the survey conducted in all groups of the study;
- Providing information on the results of the education, the methods that have been experimented under accordingly variable conditions;
- Comparison of the results by groups and variants derived from the preliminary, the intermediate and other tests during the study ;
- Experimental verification of the effectiveness of the method of operation or the suitability of the learning content.
- Implementation of the survey results

G. Conducting final tests and processing the results

The final test was conducted in the experimental and in the control groups. The results are shown in Figures: 2, 3 and 4.

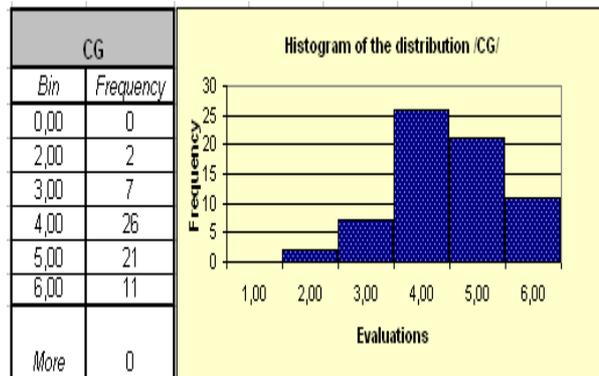


Figure 2. Frequency distribution and histogram of the results of the control group

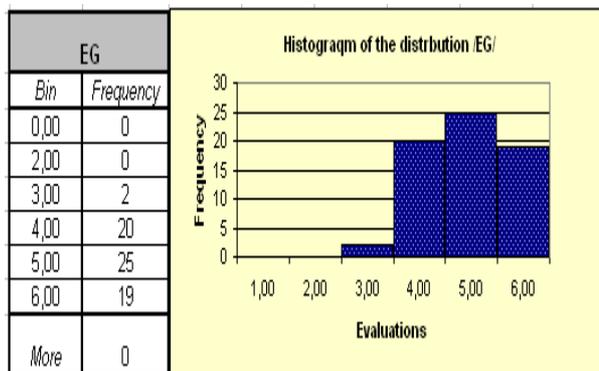


Figure 3. Frequency distribution and histogram of the results of the experimental group

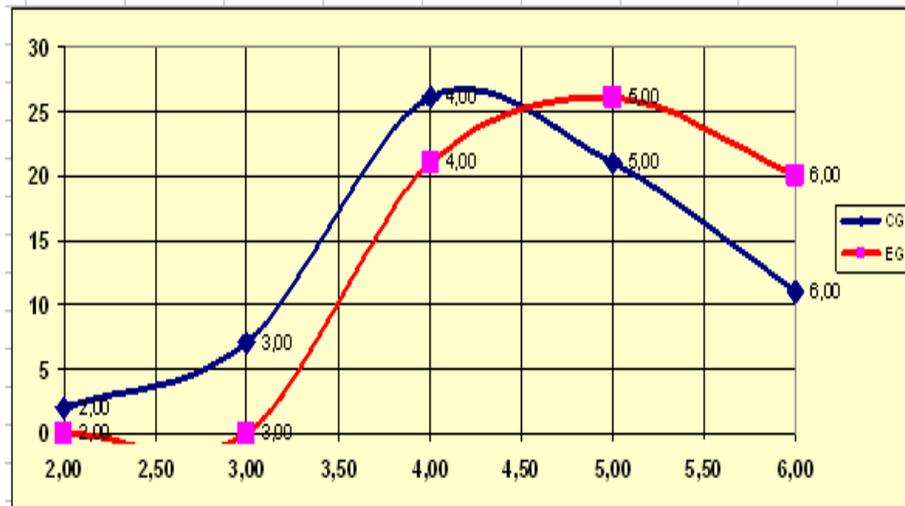


Figure 4. Distribution of the results of the control and experimental group

The results of the experimental group were statistically significantly better. In applying the method of parametric t-test to check the alternative hypothesis, the field of adoption is one-sided and the probability of error is estimated as: $\alpha = 0.05$. To find the test statistic and its critical values at a predetermined level of significance $P = 0,05$ t-Test is applied: Two-Sample Assuming Unequal Variances, whose results are indicated in Table 3.

TABLE III TWO-SAMPLE ASSUMING UNEQUAL VARIANCES

t-Test: Two-Sample Assuming Unequal Variances		
	Variable1 /CG/	Variable 2 /EG/
Mean / μ / \bar{X} /	4,018358209	4,48119403
Variance / σ^2 / S^2 /	0,852786658	0,40407431
Observations	67	67
Hypothesized Mean Difference	0	
df	117	
t Stat	-3,379253289	
P(T<=t) one-tail	0,000494038	
t Critical one-tail	1,657981659	
P(T<=t) two-tail	0,000988077	
t Critical two-tail	1,980447532	

Since $t \text{ Stat} = -3,379253289 < 1,980447532 / t \text{ Critical two-tail}$, then the test statistic is outside of the field of adoption and the null hypothesis H_0 is rejected in favor of the alternative. This is confirmed also by the probability: $P = 0.00099 < 0.05$.

As a result it can be concluded that the computer test is more effective for evaluating students in technical disciplines.

The results protocol which the "UniTeSys" system generates by teachers' request can be used for comparison of the results. The data from the survey can be used to evaluate the test subjects and

to conduct a further statistical analysis of the obtained results. The system offers the possibility to display the data in text, tables and graphs.

III. CONCLUSION AND IMPLICATIONS

In conclusion it can be said that the objective of this work, namely to demonstrate the effectiveness of evaluating students through computer tests in technical disciplines has been achieved.

By choosing the computer test system "UniTeSys" the right choice of productive educational assessment technology has been made, which increased the effectiveness of educating and evaluating through the use of computer programs.

Based on the implemented empirical research, from the qualitative and quantitative analysis of the results following conclusions and generalizations can be drawn:

1. The study content of technical disciplines offers great opportunities to build different versions of computer teaching tests and their use in individual and differentiated work with students.
2. Several tools allow to obtain reliable data on the actual level of knowledge and practical skills of the students surveyed.
3. Based on the comparative analysis of the results of the didactic study is reasonable to assume that the computer test system leads to a full and lasting understanding of the material, activates the students' cognitive and practical activity and increases their success rate.
4. Testing using computer based testing environment ensures a reliable, objective evaluation and application of the same criteria for testing each student.

5. Once created and standardized the computer tests can be reused, shared and / or exchanged between different teachers and e-courses.
6. Through generated electronic tests can be created and maintained dynamic test packages in multiple areas much faster (compared to traditional approaches)
7. Trainees receive faster assessments on the progress of their improvement in studying.
8. Computerized tests are an effective way to implement the vetting and evaluating activity as they show the degree of mastering the educational minimum of the educational content with maximum efficiency and minimum consumption of resources and time.

The introduction of computer-based testing methods for evaluating students in technical disciplines, developed for specific educational

content and theoretical and practical system of learning tasks, increases the efficiency of their activities in the acquisition of knowledge, skills and habits, and their creative application. The results of the study show that in the context of developing a system of classes and teaching model for acquiring knowledge the organized education of students contributes to improving the education of future professionals. [3]

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THE USE OF QR CODES IN EDUCATION

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Review Scientific Paper

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Abstract – Quick Response Codes (QR codes) are one of the features of smart phones that allow to connect the physical and virtual content for the user to get additional information. QR codes are already in use for various purposes in different areas, but there are not yet sufficiently applied in education.

The aim of this research is through the development of educational games that use QR codes, to popularize and expand the idea for their use in education as a support tool. For this research, various educational activities, for children of different ages were designed and tested. The results of the evaluation have shown that this type of learning is interesting and at the same time motivating and encourage collaborative learning.

Keywords: QR codes, education, collaborative learning.

I. INTRODUCTION

The possibilities of the computer technology and mobile devices with wide spectrum of additional functionalities became an everyday need in different areas of the modern living. Education is an area in which rapid development of information technology has a great impact and therefore the challenges for its use are vast. In order to use modern technologies in education some changes in the way of realization of education process are needed. Teachers should organized their lessons in a way that the students take active role during the classes.

The use of mobile phones in education, is often disputed. However number of studies indicate that the proper use of smart phones could increase student collaboration and engagement. Learning through playing games caused the large interest among students.

In this context we decided to use the QR (Quick Response) codes, for various educational activities, in order to explore the benefits and challenges of their use in education as a support tool. Evaluation was done with children of different ages. The results of evaluation are shown in this paper.

II. QR CODES

QR codes are 2D barcodes (matrix made of square black dots laid in a square scheme on white background). Designed for the first time in 1994 for the necessities in the automotive industry in Japan, in short time they have spread all over the world due to their quick readability, small printout size and immense capacity of storing information unlike the standard barcodes [1]. A useful way of thinking of QR codes is that they link the physical world with the virtual (electronic). This adds value through improving the potential of making access to information more efficient and effective.

QR codes can be generated with different 2D barcode generators, but previously we need to know what we want to be coded and choose the appropriate QR generator. The information that the QR codes carry could be read with the software-QR Reader that should be installed on computers or smart phones. Also the devices need to have a camera installed in order to read the QR codes [1], [2]. Various QR codes generator and reader exist in the market today, but their specifics are out of scope of this paper.

Speaking of where we can put the QR codes, we can freely say: everywhere. Printed QR codes can be placed in newspapers, magazines, brochures, books, flyers, different printed materials or business cards. They can be also put on products as labels, on billboards, in television commercial, or on web site [3]. By scanning the QR code user can get immediate access to the information that the code is carrying.



Figure 1. Using QR code for accessing information on Internet.

III. QR CODES IN EDUCATION

The study of QR codes in education can be placed in the context of mobile learning [4], [5], [6], [7].

The trend of the educational development is to focus more on student-centered education. Considering the characteristics and the opportunities that QR code offered, they really accords with this trend. QR code has a great potential for being integrated into the curriculum because they are incredibly simple and quick to use - a feature that makes them ideal for teaching and learning [8].

There are many reported examples of use of QR codes, in recent years. Rizzo [9] reported the use of QR codes during the chemistry class, where a periodic table with each chemical element represented by a QR code was designed. Chen & Choi [10] reported history learning with QR codes. Liu, Tan & Chu [11] designed QR codes to support language learning. Chaisatien & Akahori [12] used QR codes for classroom management. QR codes was also used in the library, associated each record on a library catalogue with a unique QR code [13].

IV. CASE STUDIES

For this research we introduce several specific examples of using QR codes in education. The survey was conducted among 62 eighth grade students and 64 sixth grade students, who expressed their attitude towards the implementation of the QR codes in regular classes. Before the survey, students were asked if they have seen or heard about QR code. Only minority of them (18.20%) revealed that they have heard about QR code, but only several of them have ever scanned a QR code. This fact encourage us even more to conduct this research.

The major disadvantage for using the QR codes was the fact that not all the students possess smart phones. This deficiency was overcome by creating groups where at least one of the students owned a smart phone. Each member of the group took an active participation in solving the final task.

A. Treasure Hunt game

This game is one of the most interesting and creative games which can be used in the process of learning. It encourage the students to participate actively during the class, increasing the mutual collaboration at the same time.

One of the version of the game is to create a map on which different positions are marked. On each position one QR code which represent one task is placed. To find all the QR codes, you only need to follow the map. Every task need to be solved, in order to reveal the final goal, the "hidden treasure".

QR codes for this game could be created in a few steps with the program QR Treasure Hunt generator. In the first step questions and answers for the game are entered, and in the second step the codes are created for every question. Next, the QR codes need to be printed and putted on the previously chosen positions.

The game Treasure Hunt was implemented during the Programming class. Every QR code carried a task which represent one command line of an actual program. The students need to reveal all the tasks in order to reassemble a program. The students work in groups and only one smart phone for a group was used.

B. Web Quest method

Web Quest is a research activity in which the students use Internet network as source for finding different types of information.

With this method instead of using URL addresses for searching specific information, students used QR codes that lead them to different information on Internet (videos, images or photographs). This method was especially useful for the younger students who have difficulties in writing the URL addresses in a given browser.

C. Self-assessment activities

Self-evaluation is an activity that is identified as an opportunity in including students in the process of evaluation. One of the most commonly used strategies of self-evaluation and mutual evaluation is comparing the tasks. The students get worksheets with the tasks that need to be solved and after solving them, they compare the results with already solved or partially solved model

saved as a QR code. In this way the students locate their mistakes and self-evaluate their work. QR codes can also be saved on mobile phones and can be used for solving tasks at home or as a link that could be forwarded to the students in the class.

D. Student portfolios

A student portfolio is a collection of projects or papers created by the student during the school year which are placed on the web. One of the goals of making a student portfolio is to present the student's projects to their parents and other students.

One part of the projects (an abstract) is displayed on the presentation board in the school, while the web location of the whole project is given as QR code. So, using the QR codes, the costs for the printed materials are reduced, and at the same time the way of presenting the projects is simplified. All the student have equal space for their presentations. Parents can also follow the work of their children from home and get familiarize with their projects and achievements.

E. Multicultural blogs

For solving the problems on various topics student blogs are created. These blogs provide information in different languages, depending on student nationality. For every post on the blog the students set a QR code in a prominent place at school. The rest of the students, as well as parents and teachers, can read these QR codes and actively participate in writing their suggestions and reviews. By using the QR codes students use common information space and have the free space on the blog to express themselves on their native language. In this way, regardless their nationality they are mutually closer and actualize their activities among all the students in school.

F. Homework

Some homework can be realized much easier and more efficient when given in form of QR codes. For example, when students have to answer questions from the content that is realized as videos, or questions whose answers should disclose the relevant web sites. Also, during the preparation of exercises that have different levels of difficulty, it is a good practice to use QR codes and to give them to each of the students, because in this way the individual work of the student is

increased while the opportunity to copy each other's homework is reduced.

G. Student technical support

Student team for technical support helps the teacher to maintain computers in school. Students use videos where all procedure for solving a given task is presented. Teacher can store these videos in a form of QR codes so the student support team can do their job regardless of teacher presence. In this way the student can also learn some advanced computer skills.

V. EVALUATION

During the research we received a positive feedback from the students about using QR codes in education. Students were asked whether they were satisfied with the use of QR codes for learning and their reasons for saying so. The majority were satisfied, explaining that the QR codes were easy to use, learning was fun and motivating, and that they would like to utilized QR codes more in education.

Near 70% of the students agreed that they learned new things about phone use, 85% agreed that QR codes are very useful for research activities, and 18% of the students somewhat agreed that they needed help with QR codes (this is mostly due to technical problems with the used smart phones).

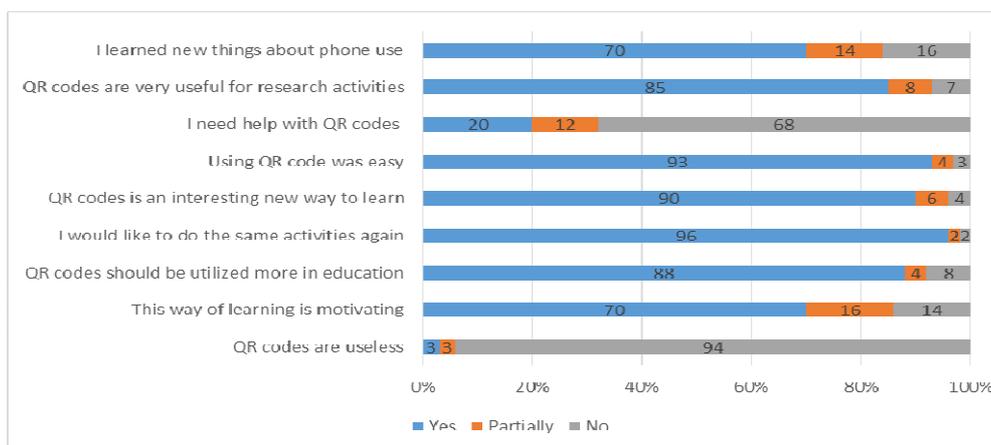
93% of the students agreed that it was easy to use QR codes, 90% of them agreed that using QR codes is an interesting new way to learn and near 96% of the students would like to do the same activities again.

88% of the students strongly agreed that QR codes should be utilized more in education. 70% of the students agreed that this new way of learning is motivating. Only 3% of the students thought that QR codes are useless.

The results of the evaluation are showed in Table I.

Interesting fact is that students have shown most interest in the first activity, The Hunting Game. This shows that the students are most motivated and active when learning through play.

TABLE I. RESULTS FROM EVALUATION



VI. CONCLUSION

The purpose of this paper is to determine students' level of awareness and acceptance of QR codes, at a same time exploring the benefits of its use as a support tool in education.

The activities conducted by using the QR codes have encouraged the collaborative learning and have a positive impact on student motivation and engagement in their learning process.

QR codes demonstrate a good potential for application and promotion in the area of education, especially when they are properly integrated into the education process. We can say that applying the QR codes in education, represents a step forward towards integration of a new technologies in learning process.

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EXPERIENCES WITH VIRTUAL REALITY IN EDUCATION PROCESS

UDC: 004.946:378
Professional Paper

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Abstract - This paper presents our experiences in education of virtual reality in both ways: as the subject of the study and also as the tool for the study. At the Department of Computers and Informatics, Faculty of Electrical Engineering and Informatics Technical university of Košice students can study virtual reality technologies and systems. This subject is relatively young. The study is focused on the acquirement of theoretical knowledge and practical experiences about 3D computer graphics, virtual reality and its technologies. On practical exercises students work in our laboratory (LIRKIS) with the latest virtual reality technologies (e.g. augmented/mixed reality, head-mounted displays, 3D scanning or 3D printing) and create content for them (such as 3D models or appropriate applications). For education purposes, it is also important to know what students know about the virtual reality and its technologies to correctly adjust lessons to the students' knowledge and to the needs of practice. Our newest findings about students' knowledge and their comparison with results from the previous survey are presented, too.

Keywords: virtual reality, augmented reality, human computer interaction

I. INTRODUCTION

New technologies in education are very important either as tools for the education or as subject of the study. At DCI FEEI TU of Košice (Department of computers and informatics, Faculty of Electrical Engineering and Informatics Technical university of Košice) we focus on both and our laboratory LIRKIS (Laboratory of Intelligent interFaces of Communication and Information Systems) is used as our educational support. LIRKIS is the excellent laboratory for research, development and teaching applications in area of parallel, distributed and network computing systems for solving computational processes in the processing of graphics data and virtual reality with a primary focus on information systems and visualization, intelligent interfaces a interaction human-computer (HCI), including the development of network communication environments, allowing searching and quality access to distributed

multimedia resources (knowledge stocks) and services and their use in creating and delivery of new knowledge and services including the development of online platforms to access to multimedia content.

Also, it is excellent laboratory for systems of scanning and visualization of input/output data for management of information systems in the context of communication human-computing system in its parallel, distributed or networked implementation environment. Special attention is devoted to research and development of new flexible and intelligent interfaces of systems based on virtual reality technologies designed to work in the following areas:

- systems for a scanning and a creation of input data (tracking systems, 3D scanning, modeling, simulation)
- visualization engines for rendering the outputs in various forms and controlled using higher level languages for easy handling of objects, including script handling
- parallel, distributed or network systems implementation environments
- human-computer interaction and virtual communication infrastructure and their use in educational practice

Generally, in the laboratory we (and also students) can work at all levels of virtualization sequence (Fig. 1) [1]. Modeling and visualization phase is improved by virtual reality (VR) technologies. Modeling phase is improved with 3D scanners and visualization phase with 3D displays and 3D printers.

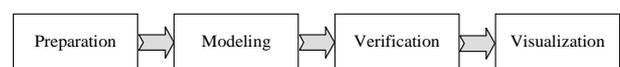


Figure 1. Virtualisation sequence

We also use VR technologies in the laboratory for the development of devices for the handicapped persons.

II. LABORATORY AND VIRTUAL-REALITY TECHNOLOGIES

Basic infrastructure in the laboratory is depicted in Fig. 4 and students can work with it during practices. Students can use the infrastructure for the development of the practical parts of their bachelor, diploma or PhD. theses, too. In addition to the depicted infrastructure other devices listed below are also available.

A. 3D Scanner

3D scanner is a device that analyzes a real-world object or environment to collect data on its shape and possibly its appearance (i.e. color). There are several types of 3D scanners, which differ in the technology used for obtaining a data. They can be divided into two main categories: contact and non-contact scanners. Contact scanners require a physical contact with the object being scanned. Non-contact scanners use radiation to acquire required information about objects. They are of two basic types: passive and active [2].

B. Augmented Reality

There are several definitions of augmented reality (AR) [1]. One was given by Ronald Azuma in 1997. Azuma's definition says that Augmented Reality combines real and virtual, is interactive in real time and is registered in 3D. Example of an AR system is shown in Fig. 2.

C. Head-Mounted Displays

A head-mounted display (HMD) is a display device, worn on the head (or as part of a helmet), that has small display optic in front of one (monocular HMD) or each eye (binocular HMD).

HMD are used in virtual reality and augmented reality applications. Another classification of HMDs is based on how the user sees real world. This classification divides HMDs into two categories: immersive and see-through. See-through HMDs have two subcategories: video see-through and optical see-through.

D. 3D/stereo Displays

3D displays use several technologies to create 3D image. Each technology has its advantages and disadvantages. There are several types of 3D displays [3]: holographic displays, volumetric displays (swept-volume and static volume displays) and stereoscopic displays (passive, active and autostereoscopic).

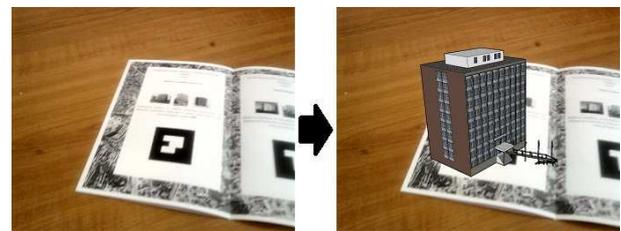


Figure 2. Catalogue without (left) and with augmented reality (right)

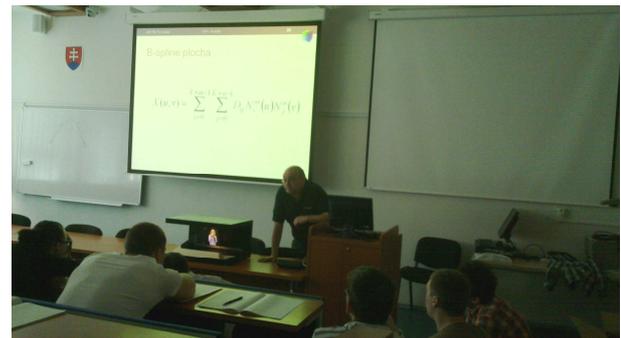


Figure 3. Holographic display presented during lecture

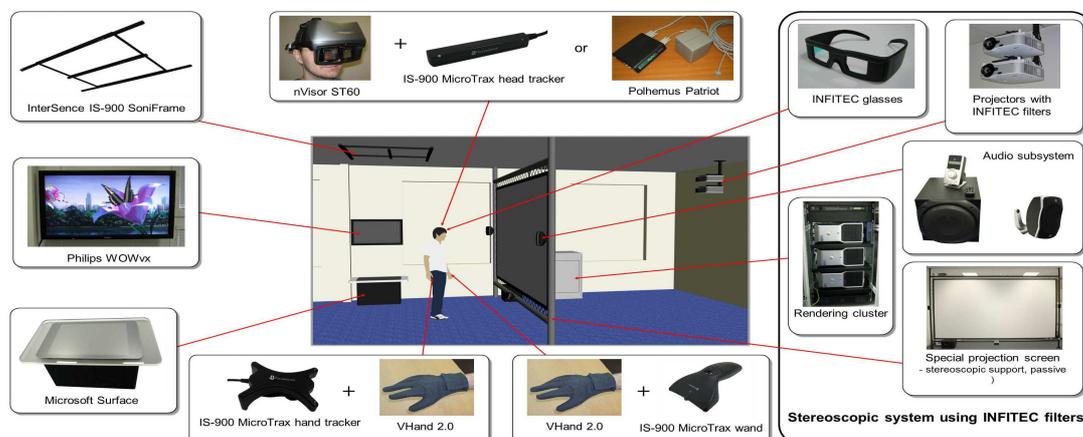


Figure 4. Basic infrastructure in the LIRKIS laboratory

E. 3D Printing

3D printing is a form of additive manufacturing technology where a three dimensional object (3D model) is created by laying down successive layers of material. 3D printers are generally faster, more affordable and easier to use than other manufacturing technologies. 3D printers offer developers the ability to print 3D models for visualization, testing or direct parts creation.

III. 3D MODELING AND VISUALIZATION EDUCATION WITH VR TECHNOLOGIES IN LIRKIS LABORATORY

Creation of a 3D model for visualization needs a lot of effort. Everything begins with the preparation phase, which consists from collection of information (e.g. photos or blueprints of a model which will be modeled) and their analysis (e.g. do we have photos from all directions?). When the data are prepared a 3D model creation begins (modeling phase). 3D modeling applications or 3D scanning can be used in the phase. A check of model for errors comes after 3D digital model creation (verification phase). The visualization of the final model is the last step. Students learn about each step on practical exercises, where they create and visualize 3D models. Also students learn how to work with virtual reality technologies and how to use them to improve 3D model creation and visualization process. Practical exercises (based on virtualization sequence shown in Fig. 1) are divided into four sections: 3D model creation, 3D scanning, 3D visualization and 3D printing.

A. 3D Model Creation

In this section students learn how to create 3D models, which are used later for 3D visualization and 3D printing. During practical exercises, students learn 3D modeling basics, how to create a 3D model using photos, sketches or blueprints, how to texture created 3D models and how to set up scene for rendering of single image or entire animation. SketchUp [4] and Blender [5] are utilized as 3D modeling applications. SketchUp is used for the creations of buildings (each one student creates one real building in Košice) and Blender is used for the creation of more complex models (e.g. game characters or cars).

B. 3D Scanning

In this section students learn how to manipulate and work with 3D scanner Leica ScanStation 2 [6] - e.g. finding the right scanning position, setting the best parameters for scanning or joining multiple point clouds together. Students also learn how to use scanned data to speedup their 3D model

creation. Students working with mentioned 3D scanner are shown in Fig. 3.



Figure 5. Students work with 3D scanner

C. Data processing - modeling

Data processing consists of several parts. First, the point cloud (from 3D scan) has to be meshed, i.e. the points have to be connected into a collection of triangles (called faces). The next step is to align the scans from various angles to create the whole object surface. The aligned scans then have to be merged into one continuous mesh, so that no overlapping parts occur. The merging process also involves filling the eventual “holes” (unscanned parts) in the model. Aligning and mesh creation step can be switched if it is required for data processing. Additionally, there is an optional step to simplify the mesh, which consists of reducing the number of triangles in order to save memory needed to visualize the final 3D model.

D. 3D Visualization

3D visualization section is divided into four subsections where students work with:

- anaglyph images – this subsection teaches students how to correctly create left and right image of selected real object (scene) for subsequent easy creation of anaglyph image.



Figure 6. Students work with anaglyph glasses and images

- autostereoscopic 3D display Philips WOWvx [7] – in this subsection students

learn which method this display use for 3D content displaying (2D-plus-depth) and how to create content for this autostereoscopic 3D display.

- virtual reality system – in this subsection students acquire theoretical and practical knowledge about 3D virtual reality system that combine together 3D displaying system (passive stereoscopic system using INFITEC technology [8]) and position tracking system (InterSense IS-900 SimTracker [9]) to create immersive VR environment (see also Fig. 2). Students also learn how to create content for this VR system with 3D modeling applications (SketchUp or Blender) and 3D scanning.



Figure 7. Student works with virtual-reality system

- augmented reality – this subsection teaches students how AR works and how to create content for AR applications. Fig. 7 shows student working with augmented reality system that use for displaying see-through HMD NVIS nVisor ST 60 [10]. Some results are used also for optimization of workplace in industry praxis [11].



Figure 8. Ph.D. students work with augmented reality system

E. 3D Printing

This section teaches students how 3D printing works and how to manipulate with 3D printer 3D

Systems ZPrinter 450 [12], how to prepare 3D models for printing and how to finalize printed models. Students use for printing their 3D models which were created in SketchUp or Blender.



Figure 9. Student works with 3D printer and printed model of university campus

IV. LABORATORY AND EDUCATION METHODS

It is important for us to know what students know about the issue of VR and what they think about VR education at the DCI FEEI TU of Košice. We started to watch this issue 3 years ago. Our first experiences were published in [13] and based on these results we improved our education process. This chapter shows our findings from the school year 2013/2014. 62 students of the Virtual reality systems course (in slovak: Systémy virtuálnej reality - SVR) participated in this survey.

A. Results of the survey

A questionnaire, given to the students at the end of the semester, was used for the survey. The questionnaire had three questions and its purpose was to determine students' satisfaction with the quality of the SVR course. The questionnaire also focused on the students' satisfaction with the VR systems and infrastructure with which they work during the semester. The questions in the questionnaire were:

- Q1: Rate VR systems and devices with which you have met in the LIRKIS laboratory. (4 – best, 0 – worst)
- Q2: How would you modify / improve VR systems and devices in the LIRKIS laboratory?
- Q3: What would you add, change or remove from SVR course?

Evaluation of the results obtained from the questionnaires:

Q1: The best rate was obtained by these VR systems (average rate bigger than 3): AR system with HMD (3.71), autostereoscopic 3D visualization system (3.22) and 3D printer (3.04). Worst average rate obtained MS Surface 1.0 (1.63) and stereoscopic displaying system using anaglyph technology (1.47).

Q2 and 3: Suggestions obtained from students were used for the improvement of SVR course and

created VR systems. Results obtained from the questionnaire are shown in the following tables (Tab. I and Tab. II). SWOT analysis was used for the evaluation of the results from the Q2 and Q3.

TABLE I. SWOT ANALYSIS OF THE ANSWERS TO THE QUESTION NUMBER 2

Strengths	Opportunities
<ul style="list-style-type: none"> new technologies intuitive and human oriented interaction with VR systems easy and simple visualization of 3D models and other data 	<ul style="list-style-type: none"> development of application that use 3D interfaces creation/modification of VR systems using students ideas simplification in the process of creation of new VR systems and devices (3D interfaces) possibility of usage for handicapped persons
Weaknesses	Threats
<ul style="list-style-type: none"> high complexity of software for development HMD needs to be connected to the PC with cables high price of 3D interfaces high price or insufficiency of material for 3D printing 	<ul style="list-style-type: none"> high price of the latest 3D interfaces insufficient funds for purchase of new 3D interfaces expansive repair of damaged hardware

TABLE II. SWOT ANALYSIS OF THE ANSWERS TO THE QUESTION NUMBER 3

Strengths	Opportunities
<ul style="list-style-type: none"> satisfaction with the teaching of VR and 3D interfaces large interest of the students in the problematic of VR (VR technologies) and 3D interfaces 	<ul style="list-style-type: none"> preparation of students for their future work with the VR technologies and 3D interfaces increase of the teaching hours building a stand workplaces for individual exercises
Weaknesses	Threats
<ul style="list-style-type: none"> fast interpretation of problematic dedicated to 3D modeling a few devices for massive education relatively small space of laboratory 	<ul style="list-style-type: none"> high price of the latest 3D interfaces decrease of the teaching hours a few qualified teachers or their leave

B. Comparison with previous results

This section shows comparison of the results presented in the previous section with the results obtained in the survey which was created two years ago (school year 2011/2012 – 64 participants).

Comparison of results to the question number 1 is shown in Tab. III. As can be seen, there are changes to average rates for individual VR systems and devices (increase in the rate for AR system with HMD and decrease in the other observed systems). Increase in AR system shows growing interest of students about advanced augmented / mixed reality technologies. Decrease in the other systems and devices shows that they become standard and affordable (e.g. 3D printers can be bought for as low as 400€) or their technology become obsolete (e.g. touch technology of MS

Surface 1.0 comparing to the newest smartphones and tablets).

TABLE III. COMPARISON OF RESULTS TO THE QUESTION NO. 1

VR systems and devices	Survey	
	Previous	Current
AR system with HMD	3.33	3.71
autostereoscopic 3D visualization system (Philips WOWvx)	3.68	3.22
3D printer (ZPrinter 450)	3.33	3.04
MS Surface 1.0	2.76	1.63
stereoscopic displaying system using anaglyph technology	1.58	1.47

Comparison of results to the question number 2 is shown in Tab. IV.

TABLE IV. COMPARISON - SWOT ANALYSIS OF THE ANSWERS TO THE QUESTION NUMBER 2

Comparison	
Previous survey	Current survey
Strengths	
<ul style="list-style-type: none"> easy and intuitive interaction with VR systems new technologies easy and simple visualization of 3D models and other data free VR engines and 3D modeling applications 	<ul style="list-style-type: none"> new technologies intuitive and human oriented interaction with VR systems easy and simple visualization of 3D models and other data
Opportunities	
<ul style="list-style-type: none"> creation and modification of VR systems using students ideas development of application that use 3D interfaces simplification in the process of creation of new VR systems and devices (3D interfaces) 	<ul style="list-style-type: none"> development of application that use 3D interfaces creation/modification of VR systems using students ideas simplification in the process of creation of new VR systems and devices possibility of usage for handicapped persons
Weaknesses	
<ul style="list-style-type: none"> high price of 3D interfaces HMD needs to be connected to the PC with cables VR systems needs high computational power 	<ul style="list-style-type: none"> high complexity of software for development HMD needs to be connected to the PC with cables high price of 3D interfaces high price or insufficiency of material for 3D printing
Threats	
<ul style="list-style-type: none"> insufficient funds for purchase of new 3D interfaces high price of the latest 3D interfaces expansive repair of damaged hardware 	<ul style="list-style-type: none"> high price of the latest 3D interfaces insufficient funds for purchase of new 3D interfaces expansive repair of damaged hardware

Comparison from the Tab. IV identified one new weakness: high price or insufficiency of material for 3D printing. The threat shows one problem of some 3D printers, their prices are low, but prices of materials are still relatively high. Another one interesting finding is that students do

not consider free VR engines and 3D modeling applications as strength.

Comparison of results to the question number 3 is shown in Tab. V.

TABLE V. COMPARISON - SWOT ANALYSIS OF THE ANSWERS TO THE QUESTION NUMBER 3

Comparison	
Previous survey	Current survey
Strengths	
<ul style="list-style-type: none"> • large interest of the students in the problematic of VR (VR technologies) and 3D interfaces • satisfaction with the teaching of VR and 3D interfaces 	<ul style="list-style-type: none"> • satisfaction with the teaching of VR and 3D interfaces • large interest of the students in the problematic of VR (VR technologies) and 3D interfaces
Opportunities	
<ul style="list-style-type: none"> • preparation of students for their future work with the VR technologies and 3D interfaces • increase of the teaching hours 	<ul style="list-style-type: none"> • preparation of students for their future work with the VR technologies and 3D interfaces • increase of the teaching hours • special workplaces for individual exercises
Weaknesses	
<ul style="list-style-type: none"> • fast interpretation of problematic dedicated to 3D modeling and Blender 	<ul style="list-style-type: none"> • fast interpretation of problematic dedicated to 3D modeling • a few devices for massive education • relatively small space of laboratory
Threats	
<ul style="list-style-type: none"> • high price of the latest 3D interfaces • decrease of the teaching hours 	<ul style="list-style-type: none"> • high price of the latest 3D interfaces • decrease of the teaching hours • a few qualified teachers or their leave

The comparison from Tab. V revealed several new SWOT characteristics: special workplaces for individual exercises (opportunity), few devices for massive education and relatively small space of laboratory (weaknesses) and few qualified teachers or their leave (threat). The identified opportunity, weaknesses and threat will be used for the improvement of the educational process in the next school year.

V. CONCLUSION

Virtual-reality technologies and similar technologies have the greatest progress in the present. These technologies allow the creation of systems which previously were impossible to create. These systems, especially their visualization subsystems and their interactivity, may shorten the process of interaction between human and

computers. They can also be used for visualization of formally developed software.

Our experiences say that the most of our students have met with touch screens (100%), 3D/stereo displays (98.9%) and position tracking devices (73.4%). Approximately 61% of students have met 3D/stereo cameras and 25% of students met with the mixed/augmented reality. Most of these students have met with 3D interfaces at a shop (53%). Worst percentage has previous school or education process (only 19%). As can be seen, there are still a lot of students which do not met with some 3D interfaces and technologies. This also shows need of the VR education at all levels of the educational process. Presented experiences and SWOT analyses can help other teachers to include this issue into their teaching process. Also, students' positive feedback confirms the correctness of placing of this subject into the education process at our department.

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FUNCTIONAL ADVANTAGES OF STUDENTS' TRAINING THROUGH THE *BLACKBOARD LEARN* E-PLATFORM

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Review Scientific Paper

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Abstract - Looking for possibilities to adapt the educational process in higher education to the requirements of the labor market requires bringing forward the use of electronic forms of distance learning. A good way to ensure quality education services in high schools is mixed (electronic and traditional) education which develops and incorporates the possibilities offered by information and communication technologies in traditional educational context. The broad understanding of mixed education refers to the integration of electronic and traditional learning, in which electronic environment is specially organized to have key functions in the overall educational process in higher education, namely by helping in achieving and supporting students' learning and the students' interaction with learning resources, other students and their teachers . This study presents the mixed (traditional and electronic) training of students as it has been applied in the Faculty of Pedagogy and the attitude of students towards it. It introduces the experience of teachers to work with the e-learning platform Blackboard Learn. An attempt has been made to display the accents on the requirements for educational content and its presentation in the electronic platform in the extracurricular activities of the students and the possibilities for the diagnosis and assessment of their academic achievement.

Keywords: blended education, e-learning, blackboard learn

I. BLENDED EDUCATION OF UNIVERSITY STUDENTS FROM THE PEDAGOGY MAJORS

The growing demands towards the preparation of the students with pedagogical majors and the need for continuous improvement of the quality of higher education have resulted in the search for new and more effective educational technologies and practices. The development of the information and communication technologies enables their successful integration within the framework of the university education at different levels. The e-learning environment allows students to determine their own pace of learning as well as the time, place and duration of the learning process. The e-learning platforms are extremely flexible and

adjust the learning process in accordance with the individual needs of each student and the specifics of the course of study. The platforms and the e-learning environment allow for the training of large groups, and at the same time provide individual assessment of the achievements. The informal communication between the teacher and the students via the electronic portal provides valuable feedback and assessment of the adequacy of the training and its usefulness as well as valuable guidance for its improvement. In turn, the student has the opportunity to get a quick, easy and timely access to the course content, the tools for testing and assessment, as well as the possibility of direct contact with other participants in the training or the trainer. Modern e-learning platforms allow for the presentation of the educational content in a more attractive way and thus adding a strong motivational aspect [3].

This possibility is explored through the blended education at university level and its context of understanding. Due to its broad continuum, the term "blended education" does not have a unified understanding and there is no consensus on its context of understanding, thus allowing for the syntagmas "blended education", "hybrid education", "mixed education" and "integrated education" to be used interchangeably in the literature, which at times is unfounded.

Some see "blended education" as a relatively new methodology and a system of teaching and learning that combines the inspiration and motivation of traditional teaching in the classroom with the fun and flexibility of e-learning to create courses that are accessible and motivating for today's adult students. This implies adequate distribution of hours spent in the classroom and online and the opportunity to find the best combination between the ability of teachers to correct students' work online, and the ability to

efficiently do group work, share experience, homework and last but not least adequate social communication with varying degrees of subordination.

This combination of face-to-face training and the online possibilities provided by electronic platforms and training resources varies depending on the educational content, motivation and needs of students; also on and teachers' opportunities to design and implement the blended education in an adequate educational environment.

Traditional teachers and trainers usually use different techniques to facilitate training. The idea for mixing approaches including lectures, group discussions in a different format, game elements, videos, various tasks and role-playing games is not a new one. Blended education has been present for many years, although the term has been extended and purposefully used in the technologically enriched learning and education. In this context, the term is used to describe an approach that combines the "traditional" education with the "e-education" [2].

Blended education suggests preserving the general principles of building of the traditional educational process. The idea for applying elements of asynchronous (occurring later in time) and synchronous (occurring in real time) distance learning in the blended education lies in the supposition that students learn a particular part of the courses in the traditional ways, and another part via the technologies of network training [1].

According to J. Hoehn & P. Rietsch blended education is the result of the convergence of two archetypal learning environments - the traditional face-to-face learning; on the one hand online training on the other. Although blended education can be seen in a variety of forms, the authors believe it is not a simple combination of online and offline (in person) training and education, not only because the media and education in the classroom should be combined, but also because forms of learning depend on the learning objectives [2]. According to the authors, the leading mechanisms for the implementation of blended education in universities are as follows:

- the need to enrich the face-to-face teaching and e-learning by increasing the degree of interactivity and thus enhancing the requirement for a significant commitment to training with self-direction;
- the need to increase the availability and flexibility of learning in the context of lifelong learning;
- the need to increase cost efficiency because universities are looking for ways to use

technology to achieve both improvement of the quality of education and reduction of costs [2].

The search for opportunities to fully design and implement blended education requires systematization of several of its main models, which play the role of conceptual frameworks. They enable its operationalization and technological realization in practice. Although the "patterns are abstract in their nature, they facilitate effective learning, which requires a specific understanding of the needs of learners, the educational content, the target groups and the organizational conditions and environment" [2].

The authors define seven basic models of blended education depending on the accents and ways of mixing the following context of understanding:

- **Mixing, which empowers** - focusing on the access to education and flexible learning, which in most cases is manifested by offering the same courses online and offline, and students are the ones to choose which type fits better their individual needs and at what point of time they are to use it;
- **Enrichment mixing** – it is characterized by the introduction of systems for learning management (LMS), through which teachers promptly enrich their courses with a specific level of technology by including traditional teaching in the classroom with additional online resources;
- **Transformation mixing** - it requires changes in the learning environment, in which students actively create knowledge through a dynamic interaction in the spirit of constructivism. The training is based on solving educational and cognitive tasks, which requires a new level of communication between the entities;
- **Blending of components** - all the components of the program are independent and each of them is fully applicable independently of the others - i.e., for each module there can be a set of independent components (the context of modular training);
- **Integrated mixing** - all components are integrated in the structure of the content and each component belongs to another or is based on other or others (context of the integrated education);
- **Mixing through cooperation** - a version of the integrated mixing, which has an additional collaborative environment (online conferences and discussions,

consumer groups and other social software).

- **Expensive mixing** – it involves formal education outside of the usual conditions [2].

These blended education models do not provide the whole range of options for its implementation, but represent a good basis for defining the features in accordance with the objectives, resources and opportunities for its practical implementation.

The implementation of the blended education through a specific e-learning platform and selection of appropriate media and design of the learning environment is in the context of Gane's theory, which outlines the following instructional events and the corresponding cognitive processes:

- attracting attention (reception)
- informing learners of the objective (expectations)
- stimulating the recall of prior learning (retrieval)
- presentation of the stimulus/a (selective perception)
- providing guidance on the education (semantic encoding)
- provoking action (response)
- providing feedback (reinforcement)
- assessment of the performance (recall)
- increasing the absorption and transfer (generalization).

These events must meet or provide the necessary conditions for learning and serve as a basis for designing the training and selection of appropriate media [4].

There are studies that characterize the blended (electronic and traditional) education from the perspective of students as its subjects and bring to the fore aspects such as:

- Blended education requires mechanical connection that has low social and scientific code;
- Blended education is a type of innovatory, but not innovative education, which deprives it of the real heuristic power and creativity, because not every novation is a guarantee for innovation;
- Blended education aims at changing the structure of the curricula, which is a component of the technology of education, but not a complete change of the learning and social interaction with students;
- Blended education requires informational environment and resources as a condition

for technologizing the process, but not the humanization of the educational environment and space;

- Blended education is impossible outside of the availability of resources, but only as a type of savings, not as investment of time, money, efforts as a condition for future educational investment;
- Blended education and its possible outcomes are an indicator of the level of awareness and the way of information, but they are certainly not to change the spiritual basis of communication with students [7].

The idea for the implementation of blended education is directly related to trends in higher education in the European educational area, or more specifically:

- making the learning environment more learner-centered in the spirit of constructivism;
- active learning based on social cooperation;
- access to educational materials anywhere and anytime;
- complementing the possibilities of classical education these of the electronic platforms and learning resources.

II. THE ELECTRONIC PLATFORM BLACKBOARD LEARN – POSSIBILITIES FOR BLENDED EDUCATION

The developing of software which can meet the requirements of the modern tendencies in education as well as the supplementary services allowing its successful installment and application for the purpose of life-long learning guarantees the quality of the educational environment and the quantity of the education product. Blackboard Learn is a web based platform for e-learning whose main goal is an integral solution for the improvement of students' achievements and their commitment in the educational process through the use of various tools for interactive teaching and assessment. The platform provides the educators with tools for the creating of effective and attractive courses and activities which encourage cooperation and improve the possibilities for a successful organization and realization of both curricular and extracurricular activities.

The platform effectively combines the possibilities of e-learning and provides faster learning for a smaller price, an increased access to education and a clear accountability for all participants in the process. Another advantage of e-learning is that teachers and students change their positions. The educator turns from an active part into a mediator who facilitates the process of

acquiring information and the forming of skills and competences in the students. Meanwhile the students also takes an active position.

Blackboard Learn for Academic Collaboration (Blackboard Learn) provides the possibility of managing courses online, a broader management of rights and roles on the platform, a centralized space for management of the content with maximum control over the content's elements, access, updates and links and integration of the platform to external sources. The platform is fully equipped with on-line trainings, video lessons on how to use the platform, i.e. how to access it or navigate your way through it, how to create, edit and delete courses, how to upload and use course content, how to manage an electronic journal, how to use the early notification system, etc. There are also the options of uploading photos, presentations and video content from various social networks without leaving the educational environment and without needing specific web programming knowledge. The system possesses modern and intuitive interface web 2.0, with an option for personalization of the view of the interface by the users through the changing of colours, fonts, designs and contents.

In general, **Blackboard Learn** provides the options for:

- creating of catalogues of courses, searching for courses and visibility of courses according to priorly set roles and rights for the individual users of the system as well as a change in the settings of the course, accesibility or inaccessibility to certain tools and contents set by time and date;
 - uploading of public information related to the teacher or the course;
 - uploading of updates accessible to all students through the setting of certain rights;
 - uploading of examination topic lists for students who have certain access rights;
 - creating, editing and designing educational content even without the possessing of a specific web-programming knowledge;
 - creating a number of section within a course;
 - setting the order in which certain educational content is accessed and determining the sequence of its acquisition;
 - providing a plan for a lecture or a seminar with a detailed description, guiding lines and assessment criteria provided by the professor;
- individual orientation through the options of accessibility to differentiated content based on the performance and advance of each student;
 - automatic notification of the users for new activities, uploads, homework, examinations, tests or changes in the course schedule or content;
 - verification and statistics of users' activities and access to the system along with option for them to be personalized;
 - communication and interaction, including calendar, notifications and messages, email, tasks, chat, groups (allow control of membership, rights and accessibility to various tools);
 - setting homework, doing test and exams on-line;

test assessment made easy by the multiple options for creating of test questions and tasks which can also be defined by additional descriptive information (meta data); this allows their grouping by certain criteria in order for them to be further used in tests, quizzes, or in order for the question to be given a particular weigh when the course grade is formed; the platform also provides options for reviewing and correcting a grade, assessing the work of the professors, doing tests multiple times, self-evaluation, creating a questionnaire date base, etc.

III. FUNCTIONAL PROFILE OF THE PLATFORM

As the platform has been designed to provide a communication channel between the main subjects of education in higher educational institutions, it is to be viewed as a complex electronic didactic means whose functional definition has two sides: **technological and didactic**.

The technological functions derive from the options provided by the platform's software. It allows quick access and achievement of high levels of interaction between the main subjects in the educational process- the professors and the students.

The university server provides the option for the creating of a personal account for both students and professors. The procedure requires logging in Blackboard Learn by copying the URL address in the browser, registration of a user name and password [5] In this way **the identification** of the subjects of the training is carried out which defines them as participants with certain roles and not simply users (which is commonly made mistake in the attempts at blended education processes we have observed).

The next function is related to the orientation of the subjects of teaching and the subjects of learning in the modules which contain the tool for the organization of information and the links related to the particular courses. For example, the module 'My course' contains the section 'My institution' where the students can view the courses which they have been enrolled in and the professors can view a list of the courses they teach. The full range of the orientation function is carried out through the modules 'My notifications', 'My calendar', 'My tasks' which allow access to up-to-date information for the courses, the upcoming events and the tasks assigned.

When accessing the panel of global navigation, the subjects of the educational process are granted access to the User Menu and My Blackboard, which are in fact the 'personalized view of the educational environment'.

The User Menu provides access to the educational courses and certain other links and also provides the options for changes in personal settings related to text volume or personal information, for example.

My Blackboard shows the connections between the different courses as well as the set deadlines for the various tasks, the way they are assessed, etc. Bearing in mind that this section has all the complex information from the whole platform and the students can use different tools to view the activities in a certain course, look through events, grades, etc, this function of the platform can be therefore defined as an **integrating** one. And since it is space where access is provided to all new elements on the platform we can say that it also has two more important functions: **communicative and coordinating**.

The basic details related to the stages of designing and manifestation of the technological functions of the platform are as follows:

- Profile – identification of the subjects in the education process;
- Bb beginning – an overview of the activities in the various courses;
- Posts/ uploads – reviewing the latest post of the students;
- Actualization – reviewing all the notifications for all the courses, sorting and choosing the types of notifications the user wants to receive;
- My grades – each student can see the grades for the tasks/activities/tests s/he has accomplished and the arguments that stand behind them;

- Calendar – the section allows viewing of all events and deadlines;
- Messages – the section allow sending messages out of the environment of a particular course;
- People – the section allows interaction among a broader circle of students and professors in the academic network of Blackboard;
- Places – allows the creating of places or groups for studying or team work on projects (as a part of the extracurricular activities)

IV. DIDACTIC FUNCTIONS

It is necessary to define the didactic functions of the platform Blackboard Learn within the conceptual framework of the model of blended education. The difficulties in this respect are based on the fact that there is a blending of elements of various education methods which have already been mentioned above. The preliminary suppositions are that the introduction of the platform would lead to some of the didactic functions of the traditional model being transferred to some of the technological functions. This, however, is a small deception because the electronic platform is a means of supporting the educational process in a particular educational subject that helps both students and professors and this means has been previously defined in the syllabus of any possible course which syllabus suggests a number of educational means including electronic ones. As far as the tools which the platform provides are concerned, optimizing of the didactic functions can be mentioned i.e. there is a greater efficiency in the educational interaction as teaching and learning form an uninterrupted continuum.

The foundation of the existing multitude of theoretical generalizations about the didactic functions of the educational environment can, in this case, be modified as follows:

- Informational-related to the preparation, providing and acquisition of educational information defined by the curriculum;
- Systemizing–connects logically the contents' components in the curriculum and ensures the transition from a lower to a higher degree of education;
- Differentiating–related to the possibility to differ among the personal achievements and advance of the students in both curricular and extracurricular activities;
- Assessment and self-assessment– meant to sustain the objectivity in the assessment of

knowledge, skills and competences of the students, as well as the procedures of students' self-assessment;

- Stimulation – related to the encouraging of media literacy in both students and teachers and the stimulation of the so called 'double unlocking' i.e. the educational contents is unlocked for students and students are unlocked, stimulated to learn [6].

V. PREFERRED FUNCTIONALITIES OF THE PLATFORM BLACKBOARD LEARN AND MOTIVATION OF THE STUDENTS IN THE CONDITION OF BLENDED (MIXED) LEARNING

The main components of the methodology of the empirical study are directly linked with its **design** and realization. **The object** of the study is *the training of the students from the pedagogical specialties and their preferred e-platform functionalities for blended learning (traditional and e-learning).*

The aim of the study is *to diagnose the preferences of the students regarding the functionalities of the Blackboard learn platform in the process of blended learning.*

TABLE I.

№	Functionality	Factor Weight
1	easy access to the learning content	0,89
2	variety of learning resources	0,86
3	timely notification on pending tasks (tests, homework, etc.)	0,74
4	good organization of the out-of-class activities	0,75
5	fast evaluation and self-evaluation of students' achievements	0,78
6	good communication with the lecturer/ teacher	0,62
7	timely feedback	0,78
8	membership in groups determined by the assignment of rights to certain tools	0,65
9	distribution of different weight to automatically evaluated tasks and the possibility for a partial marking	0,85

The results draw the attention mainly towards an easier and better communication with the lecturers/teachers; easy access to information about out-of-class activities and their thorough realization; timely access to the requirements for midterm and final exams and test; the possibility to create an e-portfolio to help students prepare for their exams.

Experimenting with educational techniques and technologies in higher education is directly linked to the implementation of new information and communication networks. The principle we use when we choose which ones to apply will be determined by the possibility to not just use an e-platform, resources and different types of activities

The **empirical study** was conducted in the period between September 2013 and February 2014 with **93 students**.

The tools for the conducting of the empirical study include an *Observation Chart* and a *Survey Card* regarding the students' preferences about the functionalities of the system Blackboard Learn.

The factor analysis made, allows the transformation of the sufficient amount of correlated data into a new set of non-correlated artificial variables or factors which describe the biggest possible portion of the input data and thus the number of the input variables is reduced by the grouping of those which correlate into a common factor and the separation of those which do not correlate into different factors.

The preferences of the students from the pedagogy specialties and the Physical Education and Sports specialty were analyzed with respect to the functionalities of the platform and the factor analysis showed their distribution with regard to their factor weight to be as it follows in Table 1.

but mainly by the inner expectations and attitudes of the students viewed through their motives for goal-oriented learning.

The result of the study allows evaluation of the dynamics of the educational activities with respect to the functionalities of the e-platform. In this sense, blended education is a new possibility to create priorities for research related to the idea of innovation models of cooperation between classic learning and e-learning in order to stimulate motivation-based behavior models of the learners through the functionalities of the e-platform used.

Such studies can serve as a foundation for the development of functionality diagrams based on the conceptual modeling when designing e-

courses, which allows the quantity evaluation of the degree of variation within an e-course and among all e-courses on an e-platform. This is a prerequisite for the optimization of the design of e-courses as well as an opportunity to evaluate their qualities through certain quantity criteria. This will further allow the designers of e-learning courses and platforms to provide learning objects and functionalities in order to guarantee a higher degree of variability and thus a better quality of the educational product.

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Assoc. Prof. Nikolay Tsankov, PhD – Part I, II, V.

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E-LEARNING THROUGH KHAN'S EIGHT-DIMENSIONAL FRAMEWORK

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Review Scientific Paper

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Abstract - Electronic learning or e-learning is a relatively new concept and is still differently defined in literature sources, especially in pedagogical practice. Letter "e" is accepted as a prefix for activities based on electronic infrastructure, giving them a modern technological meaning. General educational needs of digital society, concept and dimensions of e-learning can be considered through 8 dimensions according to framework established by Badrul Khan. This paper will address the key questions of e-learning through the framework of Khan, with the goal to create support to teachers and other factors included in educational process in Serbia, while taking into consideration educational, technological and other specificity of this area.

Keywords: e-learning, teaching methods, ICT, Moodle

I. INTRODUCTION

E-learning presents innovation in teaching, not only for the students, but also for the teachers, principals, instructors, trainers, administrators, technical and support staff, that is the whole educational institutions. It indicates a metaphor for belonging to the age of information and communication technologies (ICT), so the expressions such as e-government, e-health, e-learning, are becoming accepted in Serbian language as well.

Children, now pupils of elementary, secondary schools and faculties are often called "the digital generation". They were born after the informational evolution. They grew up, formed habits, learned, built an attitude in the era of high speed, multimedia and non-linear information, 3D interface, touch displays, virtual reality environment, parallel worlds. It can be said that the teachers are "guests" in their era, and for them it is much harder to adapt. Teaching limited to school benches, walls and frontal teacher position is in complete contradiction to things children find interesting and where they can find motivational trigger for class work, so they slowly alienate from school and fail to understand the value of real learning and knowledge.

Enormous motivational potential, metaphorically contained in one letter "e" is the power that teacher and school can turn to "their benefit". Implementation of e-learning is no longer a question of "wanting", but becomes a pedagogical duty, because it can lead to another threat that brings uncontrolled use of new technologies and that is misapprehension. Children who spend countless hours in front of computer often uncritically adopt content from the Internet as truthful and lose connection with the real world. Typical examples are aggressive computer games where children, especially at younger age, lose consciousness about danger, cruelty and injury level. This is exactly where maybe the most powerful argument is, about necessity of strong teacher influence on guiding students towards teaching content and educational development, by changing teaching methodology, accepting and integrating e-learning in everyday teaching process.

II. ICT IN SERBIA

Intensity of computer use with children is shown in many researches. According to data from Statistical Office of the Republic of Serbia for 2013 [1], on the sample of 2400 households in Serbia, 75,7% owns a computer (Belgrade 67,1%, Vojvodina 64%, central Serbia 55,1%). Number of Internet connections has increased from 18,5% in 2006 to 55,8% in 2013. According to this data, progress is huge, but we are still at the bottom among european countries. 84% of participants said they use computer every day; among them, users aged 16 to 24 are the most intense with 96%. Intention to use Internet in educational purposes was present with 66,5% participants.

These results clearly indicate that Internet has cleared its path in the last 7 years, and its use and exploitation is widely accepted with people, especially younger population. Research worldwide show the same trends and it is useful

considering them on micro levels. According to Oblinger's research [2], teenagers spend approximately 3,5 hours a day in front of computer, and 94% of them use it for learning and research and believes it helps them in school. One of the statements of participants stands out, and is motivation for this paper, answering on question how seriously he takes ICT with: "It's a part of my world."

In the research conducted in 2014 on Technical faculty "Mihajlo Pupin" in Zrenjanin about habits of Serbian adolescents with informal computer use, following results were gathered: based on acquired data, the structure of informal computer use was formed; only 12,89% participants spends less than an hour a day in front of computer, and 23,91% spends more than 3 hours. Most of them, 178 or 76,47% stays awake until midnight on working days, a 5,39% even then after 2 a.m. On weekends, 78,3% stays awake after midnight.

Activities they perform are: listening to music 84.47%, playing games 43.17%, watching movies 64.6%, looking at pictures 54.35%, visiting social networks 87.89%, and other 21.74%. Without clear goal 21,74% surfs the Internet, and 54,66% stated that they surf to study. When it comes to social networks, most of the participants stated that they prefer Facebook, 97,8%, then Twitter with 28,93%, Instagram 29,87%, Ask.fm with 14,47% and other 20,44%. Communication services they chose are: Facebook 88.05%, e-mail 74.85%, Skype 61.64%, Messenger 31.33%, Viber 32.39% and other 15.09%. Answer to question whether they surf during classes on mobile phones indicates that 50,94% do not, but the other 49,06% use phone "under the table".

III. E-LEARNING

E-learning is present in teaching practice for over two decades, and it relates to learning with use of ICT. At this technological point e-learning is leaning on computer with additional devices, digital television, laptop, tablet computers, mobile phones, wireless connection, interactive boards and other. Communication means servicing users through e-mail, social networks, android application, systems for collaborative learning. E-learning also means distance learning, through intranet and can be considered as component of flexible learning. When learning is in real time, it is called on-line learning. When distributed on mobile devices such as mobile phones, laptops and tablets, it is called m-learning. Mobile learning and learning through web are two subcategories of e-learning [3].

Methodically speaking, e-learning includes numerous strategies, actions and techniques that

support process of multimedia learning, where individual exchange of information and acquiring knowledge are happening. This learning is enriched with electronic technology, carried out with adjusted methodical actions, realized in a way to enable acquiring skills and knowledge for modern working environments.

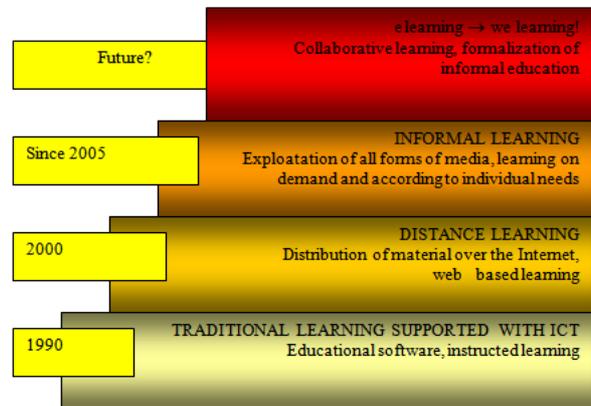


Figure 1. Evolution of e-learning [3]

E-learning is an innovative approach in distribution of open, flexible, well designed, multimedia, towards student oriented, without limitations in time or geographical position, interactive and easier educational environment, with ICT resources.

E-learning does not deny existing ways of learning, but complement and enriches them, while also improves importance of teacher role.

E-learning is not a new kind of learning, but new approach to methods of learning.

E-learning has coverage in psychology and pedagogy, and is possible to determine its didactical, logical and methodical foundation. Priority goal in e-learning is accomplishing educational outcomes by satisfying individual needs.

IV. DIMENSIONS OF E-LEARNING

One of the authors of e-learning theories, Badrul Khan [3], defined an 8-dimensional framework which does not give model of concrete solution, but indicates important technological and sociological factors responsible for efficiency of every system. Every dimension represents different factors of e-learning. Framework offers practical and detailed list of elements which should serve as instruments in self-evaluation of educational institutions' readiness for e-learning.

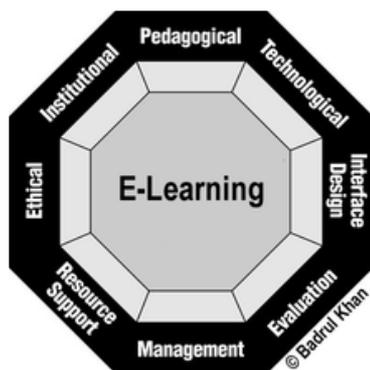


Figure 2. 8 dimensions of e-learning, Khan [3]

Khan says that e-learning can be described through 8 dimensions:

TABLE I. DIMENSIONS OF E-LEARNING DERIVED FROM KHAN [3]

Dimension of e-learning	Description
Institutional	Institutional dimension is related to legal and administrative framework, or regulatory support to e-learning system.
Ethical	Ethical considerations of e-learning relate to social and political influence, cultural, geographic and demographic differences of students.
Pedagogical	Pedagogical dimension of e-learning relates to teaching and learning. It deals with questions considering content analysis, goals of teaching, didactical and methodical questions, organization and learning strategies.
Design of teaching resources	Interface design, site design, content design, navigation, intuitiveness, accessibility.
Forms of e-learning	Dimension of form of application of teaching resources of e-learning, structure, types and forms of e-learning.
Technology	Tehnological dimension of e-learning consideres questions of technological infrastructure in e-environments. This includes planning of infrastrucutre, hardware and software.
Management	Management of e-learning relates to systems for learning management - LMS.
Evaluation	Evaluation of system through summary and formative evaluation. Evaluation of students' achievements.

Institutional dimension processes questions of legal and administrative regulation. Legal questions are regulated with legislations, strategic orientation and legal foundation based on whole of educational system, as a discourse of state educational policy and mechanisms for maintaining teaching quality. In order to establish this dimension of e-learning, legislative and strategic acts of Republic of Serbia were analyzed, which have direct or indirect connection with e-learning. Law on the foundations of the education system [4] says that realization of general outcomes of education and discipline is provided with total educational process on all levels of education, through all forms, ways and work contents. In Strategy of education until 2020 [5],

one of the main preference regarding quality of teaching and learning process is use of advantages of ICT and different forms in on-line environment (electronic conferences, course blogs, discussion debates, electronic testing etc.); also, possibilities and conditions of some forms of distance education should be tested.

Within National strategy for young in Republic of Serbia adopted by Serbian Government in 2008 [5], young are recognized as active participants of social flows, so their education is set as a priority task of the state. In the same document, accent is put on necessity for development of mechanisms for increasing information literacy level of young people. Information literacy means knowing basics of computer operations and conformity in using already developed applications. Imperative if this strategy is integration of Serbian educational system in European educational environment. New generations of students, so called “net-generation”, requires new approach to learning focused on the student. It is more than just adapting to different learning styles and giving commands of learning itself in the hands of students. This learning is characterized not only with greater autonomy of students, but also with active learning, processes of creation, communicational and participation, with different teacher roles that the difference between teacher and student is fully erased.

Ethical dimension is dealing with questions related to social influence, differences, biases, different levels of digital literacy, information availability, information culture, questions of privacy and copyright. Ethics is a philosophical category which deals with theories of values. It considers values of certain concepts and procedures, and arguments them. Ethics in education presents discipline with the goal to evaluate resolutions in educational processes according to moral principles, and to be directed towards ethical strengthening of students in different phases of life [7]. Considering that ICT use in teaching has strong motivational power on student actions, it shapes his attitudes and actions to a large degree. It is significant that many previous barriers in teaching were overcome: linguistic, cultural, geographical, social, and that alone has great ethical values. Also, learning is now much more available, sources of knowledge at students' fingertips, that is alone ethical. Worldwide, great efforts are being made on establishing ethical principles and norms adopted on e-learning level and internet action in general.

Pedagogical dimension is dealing with sub dimensions such as modern learning theories and teaching, pedagogical questions, design of e-learning content, e-didactics, efficient strategies, principles and methods of e-teaching. Basic

meaning of this dimension is shaping the system pedagogically. Dimension also relates to electronic methods of delivering teaching contents for achieving wanted learning outcomes. Aspect of pedagogical validity of e-learning use is complex and is moving from psychological assumptions, through learning styles, to concrete didactical and methodical actions and solutions.

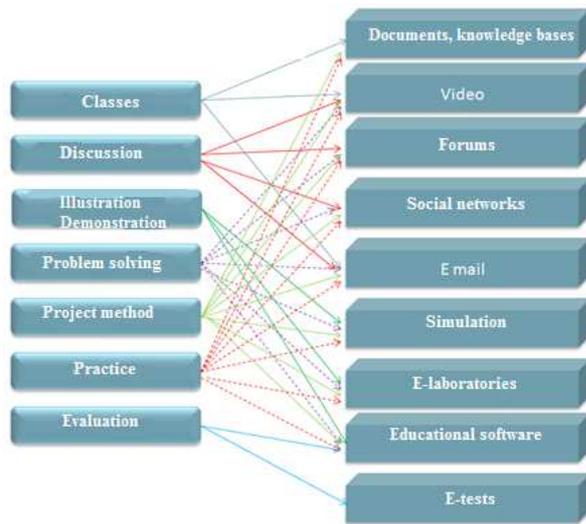


Figure 3. Methods in e-teaching, derived from [9]

Dimension of technology estimates questions related to hardware, software and planning of infrastructure. It also deals with questions considering the choice of the most suitable software for learning and ICT resources management. It processes sub dimension of infrastructure, meaning efficient servers, bandwidth and capacity, security, backup mechanisms and other questions. All technological resources are put in service of successful communication in teaching. Communication in electronic teaching as a first imperative has acquiring interactivity. Text or content publishing on web, as well as shows on radio and television, without contact with recipients, are examples of one-way communication. That depletes the prefix “e”. Meaning of electronic communication is two-way synchronized communication, dialog or timely feedback to teacher.

Focus of design dimension is on user interface quality, aesthetic look of site, respecting of intuitiveness principles, ease of navigation, usage and other questions. Instructional design is a pedagogical-didactical-technological-art interdisciplinary activity with the goal of efficient design of educational materials to facilitate desired outcomes of learning. In practice it is also called “interactive media design” and is defined as products and services of computer systems that respond to users’ actions, presenting content such as text, graphics, animation, video, audio, games

etc. Interactive media design is area of fine arts that deals with aesthetic and functional aspects of interactive media use.

Dimension of management deals with defining standards of design, functioning and maintenance of learning environment. It deals with questions of quality control and security. SCORM (Sharable Content Object Reference Model) is currently one of the most recognizable and dominant standards on the market. It is a model for multiple use of teaching content for learning with computer, as well as for online learning. It is the most accepted standard that has every significant guidelines needed for design and implementation of e-education system [6]. It defines technical framework for creation of online teaching material.

Dimension of teaching resources considers all technical and educational resources that are exploited with the goal of creating meaningful and successful e-learning environment. Examples of support services are digital cooperation, computer and web supported learning. Arguments, whose validity is proven through series of scientific research for use of computers in teaching, surely lie in the fact that it is only resource that can contribute to visualization and simulation of real processes. Also, very significant argument is high level of motivation that computer itself has on young people. When it is said computer in teaching it is surely meant on educational software designed and licensed for that purpose. For example, very popular technology currently is video on-demand. It means broadcasting previously prepared video. Cameras of high resolution record video signal from Smart blackboard that allows transfer of digital pen mark to digital form. With synchronized recording of video and audio material with writing in digital form gives multimedia content that represents individual learning with the help of a tutor. Students can hear the voice of a teacher and follow the way of solving the task. Advantage of digital writing is that there is no visual obstruction with the hand or “the text is writing itself”. Web 2.0 tools, known as platform of collective intelligence, enable student and teacher participation in creating the content of Web. It implies interactive two way communication between user and computer as well as with other users. Student has the role of active subject in teaching. Philosophy of Web 2.0 is to put the student in the centre of learning as an active participant, through network services (blogs, forums, portals, video services, photo galleries, web encyclopedias etc.).

Dimension of evaluation relates to estimation of complete environment of e-learning system quality, assessing development processes and

contents, as well as mechanisms to measure student achievement. The term learning management system is adopted worldwide as an acronym from Learning Management System - LMS. There are many terms with the same or similar meaning. According to Alias, LMS can be defined as a software application or web based technology used for planning, implementation and evaluation of specific learning process. The most widely used LMS is a free Moodle educational environment. It has become very popular with teachers and according to research is on 9th place out of 100 most used tools in education. It is interesting that before Moodle is Twitter (on the first place!), Facebook, You tube, PowerPoint, Skype, Wikipedia [8]. In the category of LMS, Moodle is far from all others, because of its technical and educational-technological characteristic, as well as because its development is directed at new educational theories and methodologies.

V. CONCLUSION

Design of open, flexible, distributed e-learning system is a challenge, with new barriers and uncertainties for teachers. Key questions of e-learning through 8 dimensions of Khan's framework are significant in the phase of planning the institutional long-term development and action

plan for informatization and modernization of education in Serbia. Surely it is significant from the aspect of teacher support and other factors included in educational process as well. When analyzing e-learning through all 8 dimensions, specific contexts of educational system, demographic and other characteristics of educational reality in Serbia were acknowledged.

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WEB APPLICATION FOR PROJECT MANAGEMENT SUPPORT IN INFORMATION SYSTEMS HIGHER EDUCATION

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Professional Paper

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Abstract – This paper presents research results on application of project management in higher education. Particularly it presents a developed prototype of web application for project management support in higher education in the field of information systems.

Keywords: Project management, prototype web applications

I. INTRODUCTION

Project could be defined as "complex and unique set of activities that is to be done in certain period of time in aim to fulfill a goal in specified time frame and with specified resources and costs" [1]

Project Management Institute conducted a research [2] with a large number of companies from different working areas in aim to determine the value and impact of project management to finalizing projects and quality of business processess, through measurable and non-measurable performance indicators. Components influencing value of project management are:

a) Context (economic, people, culture, projects, organizational attributes, strategic);

b) Implementation (training, tools, people, motivation, organization).

They influence value determined as: satisfaction, alignment, consistent practices, process outcomes, business outcomes, benefits realized.

In research [2] has been shown that tools used in project management have very important role. „Without information system, that gathers data about starting planned data about realization of project and timely gathered information about the

state of project during project realization, it is not possible to start any managerial activities, i.e. not possible to permanently monitor and control and manage project. " [1]

This paper presents part of results from Ljubica Kazi's PhD thesis research, conducted at University of Novi Sad, Technical faculty „Mihajlo Pupin“ Zrenjanin, Serbia. Results presented in this research briefly show a prototype web application made in aim to improve project management in information systems higher education, i.e. to enable better insight in progress and quality of students' information systems related projects. The prototype application is available at URL:www.it-project.rs. It consist of administrative (teacher's) and user (student's) part of application.

II. THEORETICAL BACKGROUND

According to Project Management Institute's Book (Body) of knowledge (i.e. PMBOK [3]), „project management is considered as directing and coordination of human and material resources in aim to finalize project within planned time-frame, with planned quality and with planned costs“. PMBOK defines project life cycle with phases [4]: a) Project initialization, b) Project planning, c) Project implementation / execution, d) Project monitoring and control, e) Project closing.

Project management is performed within systematic activities in nine basic functional areas, i.e. knowledge areas [3], as presented at Figure 1.

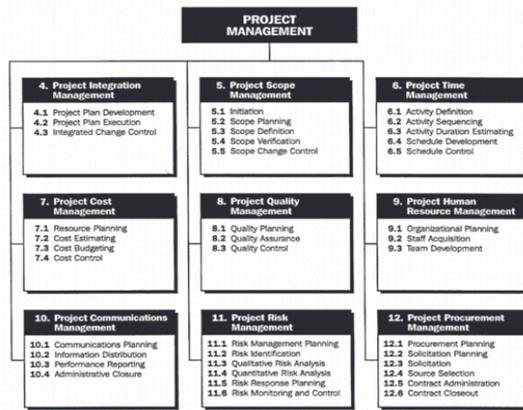


Figure 1. Project management functional areas [3]

These nine areas include: Project integration management, Project scope management, Project time management, Project cost management, Project quality management, Project human resources management, Project communications management, Project Risk management, Project procurement management.

III. PROJECT MANAGEMENT IN HIGHER EDUCATION

Application of project management in higher institutions has different perspectives.

One of the perspectives is related to establishing project management organizational units (i.e. PMO – Project Management Office) to support all project management activities, such as development and improvement of integrated information system [5].

Second perspective is inclusion of project management as a subject, i.e. course in higher education institutions curriculum. Subject could be generally named “Project Management”, but mostly it is related to specific application of project management, such as IT project management [6, 7] or project management in education [8].

Third perspective is establishing project management methods within teaching process. Within this perspective, one of the educational approaches is engagement of students in projects. Particular consideration in research is focused on the role of tutor in project-based learning [9]. When teamwork projects are considered [10], some research results are related to the problem of assessment of individual’s contribution to a group project [11].

Fourth research perspective is related to software tools and technologies to be used within project management of students’ projects. Web environments are considered as appropriate environments for tools that support group-based projects in higher education [12].

IV. TOOLS FOR PROJECT MANAGEMENT OF INFORMATION SYSTEMS DEVELOPMENT

The study of use of project management tools has been conducted among 1000 project managers (members of Project Management Institute) and the necessity of using project management supporting software tools in project management and satisfaction with particular available tools has been presented in [13]. In the information technology industry, Gartner Research estimates that 75% of large IT projects managed with the support of a project management information system (PMIS) will succeed, while 75% of projects without such support will fail [14, 15].

It has been shown in professional practice that tools for project management support should be integrated with the tools that produce results of these projects [15]. Projects in the field of information systems development include variety of tools such as CASE tools (Computer Aided Software Engineering), DBMS (Database management systems) and programming IDEs (Integrated Development Environments).

Particularly important is collaboration for the success of projects. CASE tools’ modules for collaborative work are particularly developed for the support of collaboration in systems analysis and design phase [16, 17]. Since programming is one of the crucial activities in information systems development, research and practical results in enhancement of programming IDEs with collaboration tools are presented in [18].

V. WEB-BASED PROJECT MANAGEMENT SOFTWARE SYSTEMS

Among many available solutions of software tools, generally they could be categorized as desktop (single computer), client/server (desktop + remote database) and web solutions.

Web based solutions are developed and available in recent years. Web-based project management software systems are named as “Project web sites” [19] or “Web-based project management systems” [20].

Experiences of constructing and using such web sites are presented in research [19] and [20]. Research [20] shows that small sector of construction industry (which was a focused type of industry) implemented web based project management systems and determines the reasons. Research [19] determines the key issues in implementing and using project management web sites, which could be considered “first generation” of such software systems. The key finding [19] is that web sites for project management support should be:

- Better integrated with particular job activities,
- Enable adaptation to different types of users, working roles and personality, i.e. “one size fits all team members” approach does not enable using all the advantages of this technology.

VI. PROPOSED SOLUTION

A. Research objective

Aim of this section is to present the prototype of a web application that is created for support of project management of students projects at University of Novi Sad, Technical faculty “Mihajlo Pupin” Zrenjanin, Serbia. This prototype web application is available at www.it-project.rs (Figure 2).

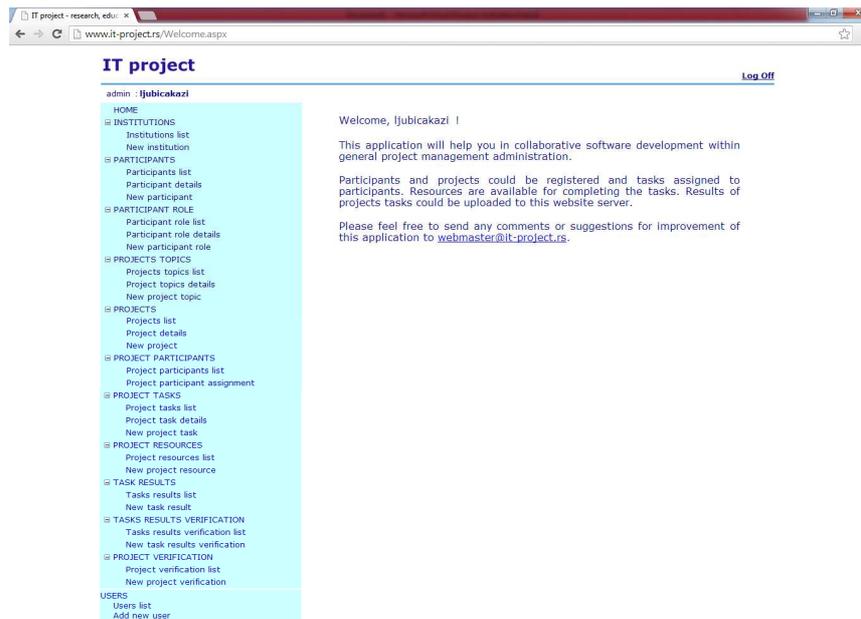


Figure 2. Wellcome screen of web application www.it-project.rs for project management support (detailed approach)

The web application is developed to meet challenges of previous key findings on issues about using web-based project management systems:

1. Integration with job activities:
 - a. Support to all crucial general project management activities (Figure 3.)
 - b. Particular focus on Information systems development projects (Figure 9)
2. User – centric approach and different working roles and styles:
 - a. Detailed approach – each phase has separate detailed page (Figure 3, Figure 4, Figure 5, Figure 6)
 - b. Unified approach – data about all activities are centrally documented at a project records page (Figure 12)

Illustration of the specified approaches and results within a prototype web application is presented at following figures.

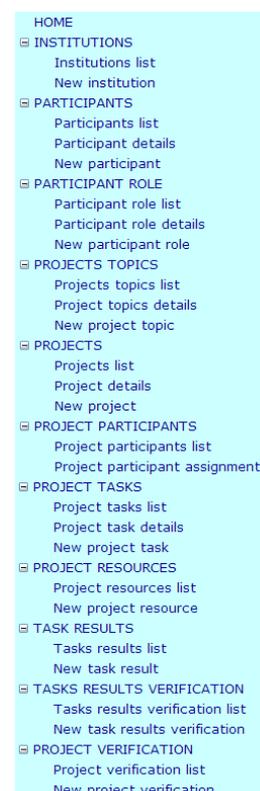


Figure 3. Main menu of detailed approach in web application
www.it-project.rs

NEW PROJECT TASK

Project: choose...

Participant:

Part. proj. assignment:

Task short description:

Task description:

Date assigned: (dd / mm / yyyy)

Assigned duration: (days)

Figure 4. Form for adding a task in detailed approach

NEW TASK RESULT

Project: choose...

Participant assigned to task:

Part. proj. assignment:

Task short description:

Task No:

Task description:

Date assigned: (dd/mm/yyyy)

Assigned duration: (days)

File Upload: No file chosen

Participant implemented result:

Submission date: (dd/mm/yyyy)

Result type: choose...

Result description:

Figure 5. Form for adding a task result in detailed approach

NEW TASK RESULTS VERIFICATION

Project: choose...

Participant:

Part. proj. assignment:

Unfinished Task:

Participant's Task No:

Task description:

Date assigned: (dd/mm/yyyy)

Assigned duration: (days)

List of task results:

Finished: Yes No

Date verified: (dd/mm/yyyy)

Finish grade: / 5

Project participant verified:

Figure 6. Form for result verification in detailed approach

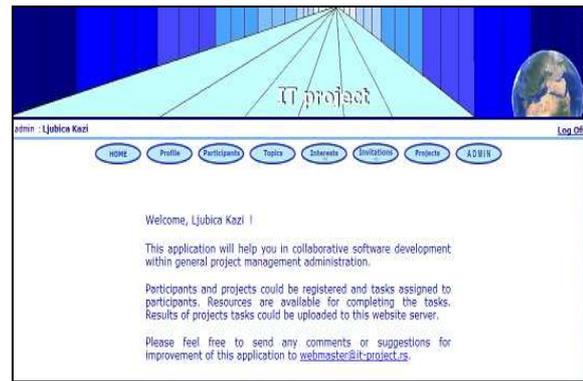


Figure 7. Wellcome screen for www.it-project.rs (unified approach)



Figure 8. Profile page with data about logged participant

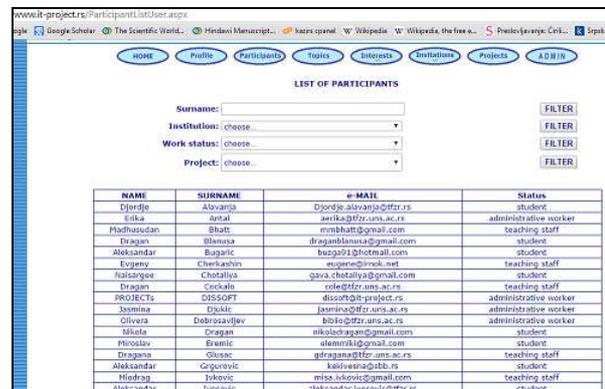


Figure 9. List of participants

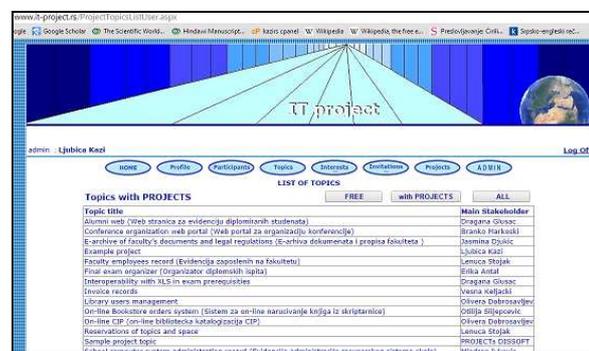


Figure 10. List of topics – free, with projects, all

SELECT ID	Project title	Proj. start date	Duration (months)	MY ASSIGNMENT
Select 6	Alumni record 1.0	March 15, 2014	3	Consultant
Select 11	Computer system administration record 1.0	March 15, 2014	3	Consultant
Select 19	Conference organizer 1.0	March 15, 2014	3	Consultant
Select 23	E-mail stud info 1.0	April 2, 2014	3	Consultant
Select 10	Faculty employees record 1.0	March 15, 2014	3	Consultant
Select 7	First exam organizer 1.0	March 15, 2014	3	Consultant
Select 18	Forum 1.0	March 15, 2014	3	Consultant
Select 23	Interop M.S	April 3, 2014	3	Consultant
Select 15	Legal documents 1.0	March 15, 2014	3	Consultant
Select 20	Library users 1.0	April 1, 2014	2	Consultant
Select 14	Online Bookstore 1.0	March 15, 2014	3	Consultant
Select 8	On-line ZIP records 1.0	March 15, 2014	3	Consultant
Select 21	Org Conf 2.0	April 1, 2014	3	Consultant
Select 17	Pre-exam archive 1.0	March 15, 2014	3	Consultant
Select 9	SCI fund record 1.0	March 15, 2014	3	Consultant
Select 16	Sessions archive 1.0	March 15, 2014	3	Consultant
Select 12	Web evaluation of teaching 1.0	March 15, 2014	3	Consultant
Select 13	Work organizer 1.0	March 15, 2014	3	Consultant

Figure 11. List of projects for active user (unified approach)

ID	Date	FROM	Title	Segment	Artifact	Phase	Attachments
View 120	April 18, 2014	Kazi Ljubica	Izmena statickog sajta	result	source code	programming	0
View 90	April 9, 2014	Kazi Ljubica	Postavljen stabicki na sajt	result	source code	user interface	0
View 89	April 3, 2014	Kazi Ljubica	Odgovor - stabicki html	task	information	programming	0
View 87	April 2, 2014	Ljubica	Verifikacija - Dragana Glasac	verification	information	requirements	0
View 80	April 1, 2014	Simic Milos	Konstiricki interfejs - licno	result	source code	user interface	0
View 22	March 25, 2014	Kazi Ljubica	Use case - Licne konsultacije	result	model	use case	0
View 4	March 25, 2014	Kazi Ljubica	Licne konsultacije	result	model	data model	0

Figure 12. Project records list for particular project, related to Information systems development (unified approach)

ADD NEW RECORD

Date: 27 April 2014

Title: [text input]

Description: [text area]

Segment: choose...

Artifact: choose...

Phase: choose...

ATTACHMENT:

File (ZIP): Choose File: No file chosen

File description: [text input]

Submit Cancel

Figure 13. Form for adding a new record in project's records (unified approach)

In unified approach, after successful login, an active user is faced with a welcome screen (Figure 7), where he can use options:

- Profile - for changing personal data, if needed (Figure 8),
- Participants - for list of participants in projects (Figure 9),
- Topics - for list of projects topics that are available or all projects topics, i.e. projects (Figure 10)
- Interests (for adding new project proposals) or Invitations (to see if some project manager has invited an active user to participate in certain project)

- Projects (starts page with list of active projects of an active user) (Figure 11).
- ADMIN (if active user is administrator, this option enables using DETAILED part of web application).

After an active user loads page with list of projects, project records about the particular project is presented as list of all events and activities in grid below, as well as current state of each phase of information system development (Figure 12). Phases of information system development are presented at Figure 18 and are presented as markers at the top of page for project records (Figure 14). They are: requirements, data model, use case, database, user interface, programming, testing.

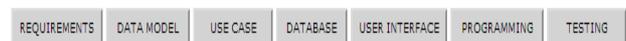


Figure 14. Markers for phases of information system development – inactive for a particular project

For each phase that there are results submitted, the appropriate button at the top of the project records page will be 'enlighted', i.e. coloured "yellow" meaning – "active" (Figure 15).



Figure 15. Markers with active phases in information system development for a particular project

If there are no results for some phase, it will remain gray coloured, meaning – "not active" (all inactive as at Figure 14).

Within a records list page, if an active user starts a page for adding a new record, the page for adding new item in project records list will appear (Figure 13). Within the page for adding an item to project record, an active user could enter submission date, title, description, segment, artifact, phase, upload a file and enter a file description.

Segment is related to general project activities in project and could be: task, resource, result, question, verification, information (Figure 16).

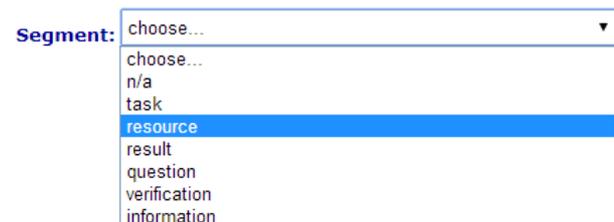


Figure 16. Items of segment combo box

Artifact in information systems project could be: document, information, model, database, source code (Figure 17).

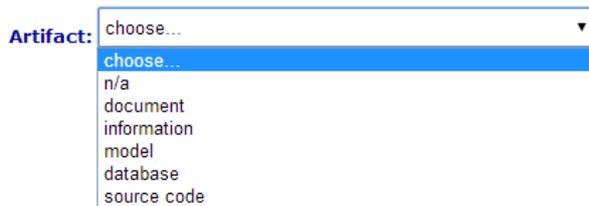


Figure 17. Items of artifact combo box

Phase in information system development could be: requirements, data modeling, use case creation, user interface design, programming, database implementation, software testing, documenting (Figure 18).

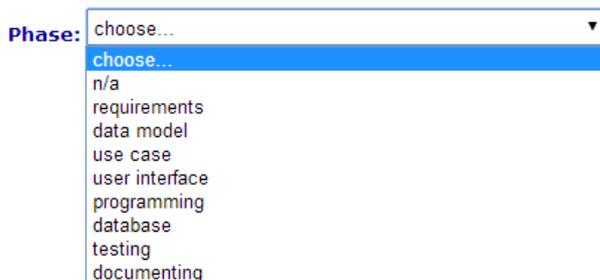


Figure 18. Phases in information systems development

Mapping an entry of project records item with phases will result in “switching on”, i.e. colouring “yellow” appropriate button at the top of the project records list.

VII. CONCLUSION

Aim of this paper was to present current state in the field of web-based project management systems and to show the necessity for development of specialized web sites for project management support. Specialization is oriented to particular working domain, such as information systems development. In this field, the contribution of this paper is related to the development of specialized web application for project management support to information systems projects in higher education.

Another aim of this paper was to present the necessity of user-centric approach in constructing web sites for project management. Therefore, two development approaches are presented for the developed prototype of the web application: detailed approach with separate detailed page for each development and project management phase or activity type and unified approach, with central project records.

This way, both crucial issues in using web-based project management systems are resolved.

Future plans for the developed web application is to be tested with more students' projects (currently is tested by 15 student's projects). The developed system is planned to be deployed at the official website of Technical faculty “Mihajlo

Pupin” in Zrenjanin, in aim to enable using within regular classes in information systems courses. It is also planned to include using this application within an international cooperation with other IT students from universities from other countries.

Existing solution should be extended with support to business process modeling as separate development phase. It could be also transformed to support other types of software to be administered in project management context. These other types of software could include educational software, multimedia etc.

Further development will also be directed towards application of models for evaluation of success of teamwork students' projects.

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CODE HUNT-AN EDUCATIONAL WEB GAME FOR LEARNING PROGRAMMING

UDC: 004.42
Professional Paper

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Abstract - Programming is a major subject in Computer Science (CS) departments. However, students often face difficulties on the basic programming courses due to several factors that cause these difficulties. The most important reason may be the lack of problem solving abilities that many students show. Learning to code can be made more effective and sustainable if it is perceived as fun by the learner. Code Hunt uses puzzles that players have to explore by means of clues presented as test cases. Players iteratively modify their code to match the functional behavior of secret solutions.

Keywords: Code Hunt, visualization

I. INTRODUCTION

Programming is a complex mental activity that is defined as an abstract process. Understanding and visualizing abstract processes poses a considerable problem for students when learning programming, as well as other fields with similar characteristics.

Linn and Dalbey [1], [2], define an ideal chain of the learning process of learning programming and suggest it as a standard for comparing programming teaching methods. The three links of the chain are:

- characteristics of the programming language – in order to log the programming solution of the problem with the given language, the student needs to understand the syntax, semantics, and expressive possibilities of the language.
- the skill of forming the program is the knowledge to use a bundle of techniques which, applied and combined, are used to solve the given problem. The skill is based on the knowledge of stereotypical code samples which combine different characteristics of the language. The models implement complex functions, such as sorting, finding the lowest common denominator of two numbers, counting words in a given text, etc. Programmers design the language and model characteristics to be

combined, problems to be decomposed into parts, solving every part independently, then linking the partial solutions into a unique unit – the program. At the end of the program writing process its correctness is checked by testing.

- the general problem solving skills come to light during learning new formal systems and this is set as the goal to be achieved by studying programming. The same models and procedural skills are common to many, or even all formal systems. Therefore, this approach is used to learn models of logging with one formal system and the rules of transfer to the new one, the subject of the learning process, so it results in mental learning and activation of pre-existing knowledge.

Lemut et al. [3] explain the difficulty of learning programming by the need for implementing complex activities that have to be mastered even by beginners simultaneously. For example, the program is tested by executing it, using carefully selected input marginal values that will result in checking all program paths. The choice of the marginal values requires the knowledge of semantic program instructions. Opposed to this, the beginner programmer learns instructions, so they find it very difficult to choose such inputs on their own. Du Boulay [4] finds that the sources of difficulties are the following:

Orientation – the general idea of students about programming and the program.

Abstract engine – understanding the computing model that defines the program language.

Notation – syntax and semantics of the language.

Structures – knowledge of programming constructions as a composition of instructions with which certain program requirements are met.

Pragmatics – skills implemented in creating the correct program (planning, decomposition, coding, testing, detecting and fixing errors).

Learning to code can be made more effective and sustainable if it is perceived as fun by the learner. Gamification [5] is the use of game - play mechanics for non game applications.

The following arguments can be brought in support of gamifying education:

- Higher level of interactivity and rewards – The aim is not only to have the student read a given text, but to have them interacting with the contents
- Raising the level of awareness – Placing the student into situation that trigger actions and deeper comprehension which would not occur in regular computer based training
- Link challenging to reward systems – Make the students’ efforts to hand in tasks on deadline or completing given tasks ‘worthwhile’ by offering rewards

The table below presents the points of divergence regarding an actual game and gamification [6]:

TABLE I. DIFFERENCE BETWEEN GAMES AND GAMIFICATION

Game	Gamification
Games have defined rules & objectives	May just be a collection of tasks with points or some form of reward
There is a possibility of losing	Losing may or may not be possible because the point is to motivate people to take some action and do something.
Sometimes just playing the game is intrinsically rewarding	Being intrinsically rewarding is optional.
Games are usually hard and expensive to build	Gamification is usually easier and cheaper
Content is usually morphed to fit the story and scenes of the game	Usually game like features are added without making too many changes to your content

Usually one finds four categories of players.

- Those who constantly face the urge of being at the top of the ranking – the Achievers
- Those who enjoy the process of discovering something new – the Explorers
- Those who feel the need for interaction with others – the Socializers
- Those who play with a strong desire to destroy or eliminate other characters – the Killers

In terms of education-based games, the main target groups are the players belonging to either the category of Achievers or Explorers. The mindset of the Achiever drives them to complete the course, it does not matter at what cost. The Explorer is most

likely to discover all aspects of the game, which in turn leads them to covering the whole course. On the other hand, the Socializer is bound to apply the help of other plays, yet they are less likely to complete the course. An education-based game will hardly contain something challenging for the Killer type to complete it. Taken into consideration the above-described, as well as the research by Heeter et al. [7], it can be stated that only the categories of Achievers and Explorers are to be considered as target groups for educational games.

The player will play a social game given the following defined player lifecycle.

- Newbie – These players have just started the game. They need some time to acclimatize to the game, thus levels in the early stages of the game ought to be easy so that players can familiarize themselves with the game.
- Regular – This is the phase when players should become ‘hooked’ on the game The subsequent levels should present the players with satisfaction no matter what player type.
- Enthusiast – most of what can be learnt as to how to play the game - these players know it all, but now they require challenges to keep them ‘hooked’

The player lifecycle will differ somewhat with an educational game.

- Newbie – These players have just started the game. They need some time to acclimatize to the game, thus levels in the early stages of the game ought to be easy so that players can familiarize themselves with the game.
- Regular – This is the phase when players should become ‘hooked’ on the game and aim at completing the course.

II. BACKGROUND-PEX FOR FUN

Code Hunt uses puzzles that players have to explore by means of clues presented as test cases. Code Hunt is based on the test/clue generation of Pex, a white-box test generation tool that uses dynamic symbolic execution.

Pex [8] is an automatic white-box test generation tool for .NET, based on dynamic symbolic execution. This tool is integrated into Microsoft Visual Studio in the form of an add-in. It can generate test inputs which are combined with different unit testing frameworks [9]. They have implemented Pex in classroom teaching at various universities (for example North Carolina State University, University of Illinois at Urbana-Champaign, and University of Texas at Arlington), and also in a variety of tutorials both within Microsoft (such as internal training of Microsoft

developers) and outside Microsoft (such as invited tutorials at .NET user groups). Further, they have created numerous open source research extensions upon Pex [10].

One of the most important methodologies that Pex supports is called parameterized unit testing, which broadens the scope of today's industry practice which prefers closed, traditional unit tests (i.e., unit test methods without input parameters) [9].

There are useful characteristics that Pex offers to support for testing. Primarily, there is the option of exploring code and suggesting the tests that should be done. Secondly, assuming that it is a parameterized test, Pex can determine the combination of parameters that has to be tested so as to provide all feasible versions. Lastly, once Code Contracts is being used, Pex uses that information to fine-tune the unit tests that are offered or generated for the user [11].

Code Digger is the first extension from the Pex team at Microsoft Research for Visual Studio 2012 and 2013 and analyzes possible execution paths through .NET code. The result is a table where each row shows a unique behavior of code. The table helps user understand the behavior of the code, and it may also uncover hidden bugs [15].

Under the hood, Code Digger uses the Pex engine and Microsoft Research's Z3 constraint solver to systematically analyze all branches in the code, trying to generate a test suite that achieves high code coverage [15].

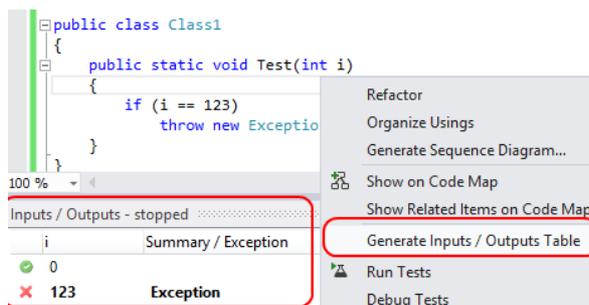


Figure 1. The user interface of applying Code Digger in Visual Studio [15]

In software testing especially unit testing, it is often desirable to test individual units (such as classes) in isolation. To address the issue, the Pex team developed a lightweight framework called Moles [16]. The Moles framework allows replacing any .NET method with a delegate. In the context of unit testing, you can use Moles to isolate from environment dependencies such as time, file system, database, and so on, even when those dependencies are hard-coded through static method or sealed types [17]. With Moles, you can detour any .NET method to user-defined delegates. Moles

can be used to isolate any .NET application. Microsoft Moles can run as a standalone tool.

III. CODE HUNT, AN OVERVIEW

Code Hunt is an educational coding game. The play scenario is the following: the student will impersonate the code player, whose task is to detect the missing code fragments. Points are gained by completed level, while extra points are granted for elegant solutions. The game can be implemented for either C# or Java. During the game, the player will make their way to specific sectors and gain knowledge about arithmetic operators, conditional statements, loops, strings, search algorithms and more. The entire gaming experience has an underlying automated grading engine based on dynamic symbolic execution. The grading engine automatically analyzes the user code and the secret code so that the result table is generated. Most modern browsers including Internet Explorer 9, 10, 11 and recent versions of Chrome and Firefox are suitable for running Code Hunt [12].



Figure 2. The start screen of Code Hunt

Code Hunt resembles most games in the sense that there are sectors and levels. Code is written in an editor window by the player, they use either C# or Java as the programming language. The task is for the code to implement a given formula or algorithm – indicated by a top-level function, the “Puzzle”. The function presents input parameters, then provides a result. The player needs to test if their task was successful, i.e. if the target algorithm was in fact appropriately implemented. This is done by hitting the enormous “CAPTURE CODE” button. This button will trigger a chain of events [12]:

1. The code is sent to a server in the cloud.
2. The server compiles the code (including an optional Java-to-C# conversion, as described in Section 3)
3. The server starts an in-depth analysis of the code, it is compared with the goal algorithm.
4. The player will then be presented with the results (Figure 3).

The result will be either a compilation error, with information in the bottom pane, or some

mismatches or agreements with the goal algorithm. The code is presented left in Figure 3, while on the right there are the mismatches (red crosses) and agreements (yellow checkmarks). The player has completed this level successfully if the code has compiled and no mismatches were found, only agreements with the goal algorithm. In the game this is described as the player having “CAPTURED!” the code, here seen in Figure 4.



Figure 3. The Code Hunt showing test results



Figure 4. After solving the puzzle, the player gets a score

As a follow-up, the each mismatch and agreement with the goal algorithm is returned in the form of a tuple (input, actual result, expected result). In the case when the player’s code is in agreement with the goal algorithm, the actual and expected results are identical, while, if a mismatch has occurred, they are different. The player is given a chance to examine the mismatches and figure out how to modify and improve the code so a greater resemblance is achieved with the goal algorithm [12].

Upon the completion of a given level, the player will be prompted to choose a somewhat more difficult level, so as to keep up the flow. Also, all sectors bar the first one are locked as their default setup. Only when the player has completed a satisfactory number of levels in a certain sector does the next sector become unlocked (Figure 5).



Figure 5. The game’s sector

IV. CONCLUSION

Games are an integral component of people’s daily lives. Over \$20.5 billion were spent on video games by Americans in 2013 [13]. While the games’ primary aim is to present entertainment, given how universally applicable they are, games have long-since outgrown their entertainment role. Games are implemented not only to provide entertainment, but also in the fields of defense, education, scientific exploration, health care, emergency management, city planning, engineering, religion, and politics. Apart from entertainment games there are also the so-called serious games whose primary goal is to train, investigate, or advertise.

The term gamification does not refer to the creation of a game from scratch. Instead, the term indicates the process of transforming education into a fun process, showing students it can be engaging, yet maintaining credibility. Gamification is an aide for increasing student motivation, leading them to increase their coding skills, ultimately they will be stimulated to learn. Gamification can act have a boosting effect leading them to study/read more [14].

Code Hunt is a highly effective educational gaming platform that internally leverages fitness values so as to guide the user to successful test/clue generation furthermore, it also externally provides its users with an entertaining learning experiences where search-based test generation is manually emulated. Code Hunt is a new attempt to create a game using serious search-based testing, make it available for a huge group of users, including coders, and especially learning coders [12]. The test cases are constantly changing, since they are built on the mined data, thus players will enjoy a new experience every time. Learning to code can become increasingly efficient and sustainable if the learner sees it as ‘fun’ as opposed to ‘learning to code’.

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ADVANCED TRAINING OF TEACHERS OF TECHNICAL EDUCATION AND COMPUTER SCIENCE

UDC: 371.13
Professional Paper

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Abstract - This paper presents the importance, reasons and opportunities for advanced training and professional development of teachers of technical education and computer science in the country and the region. In addition to this, the ways and forms of advanced training of the teachers are defined, with particular emphasis given to the professional development of teachers in order to achieve better effects during the teaching process.

Keywords: Technical education, Computer science

I. INTRODUCTION

Technical education and computer science as a subject that is taught in primary schools in the Republic of Serbia has its evolutionary development from manual labor when it was considered as a skill, to modern computerised classes with elements of modeling and simulation. As part of this course, areas such as transport, graphic communications, information technology, constructor modeling, technology of the material, energy, architecture, civil engineering, mechanical engineering, robotics, electronics, electrical engineering, etc. are taught.

Practical and theoretical part of the course is not lost, but takes on the form of modular teaching where students, depending on their abilities, desires and interests, create the different models and prototypes bringing together their theoretical knowledge and practical work. All of this proves the fact that the subject of technical education and computer science is multidisciplinary in its character and accordingly, the teachers who teach this course must prepare properly for the classes by following novelties and innovations which are inevitable in the modern world.

Teachers of technical education and computer science are involved with their students, not only in the competitions organized by the Ministry of

Education of the Republic of Serbia, but also in the international competitions. A leading role is often taken in projects such as the one held in Zrenjanin, called „European Village“. It is not only tourist, but an educational event as well, that involves exhibition of students' works on the topic of some of the European countries. Then, there is a review called Robo-int invent, of interdistrict character, in which primary and secondary school students, as well as technical faculty students, radio and modeling clubs exhibit their works on the subject of robotics and interface, dealing with innovations and thus developing students' interest for new technologies. Then there is the participation in the European project „Researchers' Night“, as well as at the Festival of Science where the students, together with their teachers, also participate actively, promoting in this way both themselves and their knowledge as well as the subject of technical education and computer science. The Olympics of technical creativity of the South East European countries where the representatives of our country participate actively means a lot in terms of the exchange of the ideas and new knowledge in the field of technics and technology, presenting their innovative work and developing creative and inquiring spirit of the young generation. In the area of transport, the teachers of technical education and computer science in cooperation with the traffic police and the Serbian Automobile Association, organize not only school, but municipal, district and national competitions also, after which the best students, representatives of our country, take part in European competitions.

Engineering, technology and computer science are prone to rapid change that can not be taught unless the teacher professionally trains themselves, following the lectures, magazines, seminars and

conferences in the particular field of professional interest, both domestic and international.

Bearing all this in mind, respecting the curriculum, teachers of technical education and computer science, being aware of the fact that this course provides an opportunity for every student to progress and develop their potential within the field of interest, attend seminars and training depending on the area of interest.

II. TERM :ADVANCED TRAINING OF TEACHERS

Advanced training of teachers of technical education and computer science takes place over the three basic forms of learning:

1. Formal education (pre-school, primary, secondary and college / university education),
2. non-formal education (training programs, seminars, courses) and
3. informal education (communication with other people, reading vocational journals, etc..).

The welfare of each advanced training and professional development of teachers is reflected in the action of applying theory into practice, which is particularly important when the subject of technical education and computer science is in question due to its practical and theoretical character, and being such, it provides the ability to connect theoretical learning with practical model implementation. The fact that the training gives the possibility of qualifying the employees for various professional tasks, more active participation in the improvement of educational work and the development of a more open approach to the process of lifelong learning, is definitely of particular importance. The role of career advancement through the acquisition of titles can contribute to the strengthening of motivation, the increase in the quality, and the development of a system of evaluation and self-evaluation of both teachers and schools.

Professional development of teachers is particularly important in the preparatory period and making the first steps into the work in the field when the exchange of experience and knowledge combined with the knowledge acquired in school are of special importance.

The areas in which the teacher can professionally develop are pedagogically - psychological and methodological, as well as specialized expert skills and knowledge relevant to the subject of technical education and computer science.

The roles that a teacher can have in their advanced training and professional development are:

1. Presenter / lecturer / conductor,
2. second participant and
3. organizer.

Advancement in career through the acquisition of titles may contribute to the strengthening of motivation, rising in the quality and development of the system of evaluation and self-assessment of the teachers, as well as the schools in general.

III. FORMS OF ADVANCED TRAINING OF TEACHERS

Teachers of technical education and computer science have the option of external and internal advanced training. External professional training include participation in seminars, conferences, meetings of professional sections/councils and societies of teachers of technical education and computer science at different levels - school, municipal, district and national, as well as taking part in the summer and winter schools and professional conferences and forums which can be of both domestic and international character.

One of the forms of the advanced training can be following of the different types of videos and tutorials on the Internet, a resource that can be used as an important educational tool as well, especially if the lectures of recognized experts from various fields of teacher competences are followed. The Internet gives the opportunity to follow electronic journals and educational portals where professional works from various scientific fields can be found , as well as blogs and webinars of the teachers of the same or similar subjects.

Using the platform of e-learning, teachers have the option of online advanced training that is increasingly being used due to the conveniences of financial nature, as well as for the comfort of attending courses in time and space that is suitable both to the teacher and the seminar participants .

The school subject: technical education and computer science is of theoretical and practical nature with a number of practical exercises that are demonstrated through both constructor modeling, and using the computer, as well.

Teaching technical education and computer science is realized through the workshops with tools, as well as in the classrooms equipped with computers, projectors and electronic boards. Teachers, using video clips and simulations, can clearly explain their students the numerous technological methods of processing materials in industrial plants from their own working

environment. This is especially important if we take into account the fact that, due to the students' and teachers' safety, for each visit to an institution as well as for taking students out of the school environment, written parental and school principle consent is needed.

Information and communication technology (ICT) leads to an increase in the efficiency of learning, depending on the content and amount of the knowledge and ability of its users. Educational computer programs are increasingly being used in the classroom, particularly in the modernization of schools, but also in the training of the teachers how to apply it in the work with their students, which leads to the need for educating not only the students but the teachers also. In addition to the necessary computer technology, it is necessary to have an appropriate level of knowledge in order to know how to and for what purpose to use it, so it is necessary to train the teachers in order to modernize and enrich the classes. In respect to this, there is not only a fair number of seminars which are carried out in the classrooms of the schools and faculties equipped with computers and information and communication technology (ICT), but there is also online education by which through the system of distance learning teachers are taught from their own homes at a time that suits them in relation to the work and life commitments that school employees have. It is particularly important to emphasize the fact that in recent years an increasing number of teachers, not only of technical education and computer science, chooses exactly electronic seminars with the aim of saving time, space and, broadly speaking, financial means. Skeptics in terms of this kind of professional development still exist, but the time shows that this view changes in teachers and that they realize that this way of learning is far more comfortable, and that they learn and master more through the individual work with the mentorship of the lecturers than through conventional frontal lectures.

Professor Mladen Vilotijević (2005.) says that the new role of the teacher demands the change and enrichment of the functions of the school of the future where there will be two groups of student (student-student and student- teacher), [2].

The teacher gets the role of the organizer, co-worker and the knowledge manager where they plan the change of the work organization and the existence of flexible models of teaching that will take different amounts of time and that will better meet the growing needs of the audience in relation to the education and age. To what extent is it expressed is clearly seen from the results of testing students not only through competitions and festivals but also through organization of the

classes, no matter they being model type or everyday work of the teachers of technical education and computer science. In fact, teaching this course requires constant engagement of the teachers of technical education and computer science as well as being up-to-date with the innovations. This is necessary because we are all witnesses of the fact that technology and IT disciplines are constantly developing and as such require continual observation and mastering so that students are always presented fresh and the latest information.

Of course, it should be stated that teachers are different in respect to their personality or level of ambition and commitment, so this also must be taken into account in order to carry out teaching in a modern and interesting way. Normally, schools are there for the student and not for the teachers, and if this is taken as essential, then this continual professional development and lifelong learning of teachers certainly will never occur as a problem. A large number of teachers of technical education and computer science emphasizes exactly this fact, as well as the lack of sufficient financial resources to support the story of professional development.

This could be another indicator of the need for advanced training of the teachers, especially when one takes into account the current concerns of a large number of countries in which there is a significant teacher abandonment of their profession, and thus the loss of teacher expertise necessary for the achievement of quality education for the next generation of students.

IV. FEATURES IMPLEMENTING ADVANCED TRAINING OF TEACHERS

Examples of the application of various forms of advanced training of the teachers of technical education and computer science in practice are really numerous, starting with the implemented classes to the participation in various competitions and projects within the educational system of the Republic of Serbia. Teachers usually display their newly acquired knowledge and information by organizing numerous forms of internal advanced training within the school as an institution in which they are employed.

Within the school in which they work, the teachers of technical education and computer science have the opportunity to exchange the ideas from the realised class preparations, to organize exhibitions of students' works, to demonstrate how the models, programmes etc. function and many other things. It often happens that teachers of technical education and computer science, by participating in competitions, festivals and exhibitions of both domestic and international

character, share their experience with other colleagues, thus exploring the optimal solutions not only for their students but also for the school and the community in which they live.

V. PROFESSIONAL DEVELOPMENT OF TEACHERS OF TECHNICAL EDUCATION AND COMPUTER SCIENCE

One of the reasons for the advanced training of the teachers of technical education and computer science could be their professional development and career advancement. In some countries, it is resolved through mentoring younger colleagues who have just started their career. In addition to this, another very important reason should be taken into account, that be the improvement in the terms of finances, which may be reflected in the wages of teachers, and in this way to regard and provide even greater motivation to ambitious teachers.

Professional development is a complex process that involves continuous development of teachers' competencies in order to better the performance as well as to improve the development of children and students, and their achievements, too. Personal plan for the professional development of teachers is also based on the self-assessment of the level of the competence development in the profession of each teacher individually .

Technical education and computer science teacher systematically monitors, analyzes and evaluates their educational work, competence development, their progression and professional development and keeps in a certain form the most important examples of their practice, advanced training and personal professional development plan called portfolio. This type of systematized documentation teacher shows on the request of the school principle, school pedagogist, educational counselor and counselor - external collaborator for review.

Bearing in mind that advanced training is very complex and that the issues of selecting high-quality forms designed for the teachers of technical education and computer science is very important, it follows that the existence of competent and expert committees, and their greater commitment not only on the level of the facility itself, but also on the larger grounds is of great importance .

VI. ADVANCED TRAINING OF THE TEACHERS IN THE NEIGHBOURING COUNTRIES

OECD is a unique forum in which governments of the thirty democratic states work together to cope with the economic, social and environmental

challenges of globalization. Most countries, in their concern for the efficiency of the work of the teachers, realise that the roles of the teachers are changing, and that they need new skills in order to meet the needs for the knowlegde of different groups of students, and to collaborate more efficiently with the new types of staff in schools and other organizations. Education ministers from OECD countries have set a goal in their countries, which is based on improving the quality of learning, which would be obtained only if high-quality teaching is provided.

Common in all curricula of our neighboring countries and further, is the following [4]:

1. Technical education and computer science is considered an important means of education,
2. students are introduced into the world of work, technics and technology,
3. students develop skills and working habits,
4. are preparing for life, work, and the use of leisure time,
5. pre-professional briefing and guidance is performed and
6. technical thinking and creativity is developed.

One of the aims of technical education and computer science is the contribution to the technical and technological education and upbringing of the students, forming a creative personality, acquiring technological knowledge, skills and habits, and training for applying it all in the field of work, learning and everyday life.

Educator Development Program (EDP) as a regional program for training of educators sponsored by the International Development Agency of Canada (Canadian International Development Agency-CIDA) are implemented by Universalia Management Group and the University of Calgary and they have been providing the support to the educational reforms in the Balkans since 2001. The program includes the development of skills of teachers , strengthening the capacity of the planning, implementation and evaluation of continuous professional development, and strengthening of the institutions that manage educational reforms.[1]

The aim of all this is to encourage the lifelong learning, as well as the professionalization and modernization of the educational system. The process of advanced training affects the environment in which it develops, empowering teachers and schools as learning organizations in which both teachers and pupils acquire knowledge, and teachers, in addition to this, develop a professional culture. [1]

In Serbia, in particular, the three factors of cooperation are expressed, these be the state, the school and the teacher individually, which, when united, make an important contribution to the management of the process of professional development.

In 2001, the countries of European Union (EU) adopted strategic objectives of education and training in order to discuss concepts such as standards of the teaching profession, the education of future teachers, their induction and continual advanced training. The main objectives of the European Union are related to the improvement of the quality and efficiency of education and training systems in the EU, facilitated access to the education and training systems, as well as opening up education and training to the outside world. In this case, teachers become members of the team, work outside the classroom, collaborate with community members, parents and colleagues from home and abroad.

Obligatory advanced training, methods of regulating absence from work for training, implementers of the program and its contents, become the strategic objectives of the education and training of the members of the European Union. Most countries provide approximately 20 hours per year for advanced training and professional development, but there are examples such as Latvia, where it is 12 hours per year, and Liechtenstein, with 42 hours per year. In Slovenia, Spain, Portugal, Bulgaria and Poland, there is an opinion that the training is not obligatory, but is necessary to make progress in teacher's professional career. In the Netherlands, around 10% of annual working time of teachers is estimated for advanced training, which amounts 166 hours, whereas in Sweden it is 104 hours per year. [1]

In Finland, a country that is often mentioned for significant achievements in the fields of education, professional development programs depend on the Ministry and local employers. In Serbia, the Institute for the Advancement of Education is in charge of this, and it accredits programs and conducts monitoring and evaluation of progress made in implementing the programs in accordance with the standards. In Romania, universities, pedagogical colleges, vocational training centers, as well as NGOs are in charge of this, while in Lithuania and Slovenia there are school principals that are significantly responsible for the development of teacher competencies in accordance with the educational objectives.

The most common advanced trainings of teachers are related to the deepening of knowledge in information technology, teaching methodology,

management, school development, special needs, multicultural education and conflict resolution.

VII. RESEARCH METHODOLOGY

a. Scope of the research

The scope of the research is advanced training and professional development of teachers of technical education and computer science. As it is stated in the theoretical part of the paper, professional development is of particular importance for professional advancement and career development of teachers and the educational system of the state. Through numerous research papers and discussions with the colleagues in the same profession, it may be noted that teachers of technical education and computer science take part in a number of programs of advanced training so they meet the legally defined requests.

b. Problem of the research

This survey reveals what it is that motivates teachers in technical education and computer science for advanced training, as well as what it is that affects their professional development and career advancement in the best possible way.

c. Purpose and character of the research

The aim of this research is to determine if the teachers of technical education and computer science take part in the advanced training, as well as how this professional development is determined by the financial and personal factors. Due to the small number of survey respondents, this research belongs to a small, micro research which, since it studies teaching practice, is empirical.

d. Hypotheses

The main hypothesis is:

- The teachers of technical education and computer science are motivated in terms of advanced training and professional development.

Auxiliary hypotheses are:

- Financial factors affect the professional development of teachers of technical education and computer science.
- Personal / subjective factors influence the professional development of teachers of technical education and computer science.

e. Tasks of the research

Research tasks are:

- To determine the attitudes of the teachers of technical education and computer science in terms of advanced training and professional development;
- To determine the attitudes of the teachers of technical education and computer science in terms of financial factors that support professional development;
- To determine the attitudes of the teachers of technical education and computer science in terms of the personal factors for professional development;
- To find out what factors motivate the teachers of technical education and computer science for advanced training and professional development.

f. Population and the research sample

This research is conducted on 30 teachers that are active and regular members of the Professional Section of the teachers of technical education and computer science in Zrenjanin. It is important to note that the teachers who took part in this research have different length of service, from beginners who have not taken the exam for teaching licenses yet to those who are facing retirement.

g. Methods and techniques

In conducting the research, the survey is used. „The survey (poll) is, in the educational research, the process in which the subjects are asked questions about the facts of scientific interest in pedagogy, and which are known to the subjects, or questions regarding the subjects' opinions. The subjects respond to them in writing“ (V. Mužić 1979, p.262.).

The survey consists of three parts: the questions, that are in the middle, the column named „Important“ which is on the left, and the column named „True“, which is on the right.

The column „Important“ consists of four levels:

- 1 not important,
- 2 of little importance,
- 3 important,
- 4 very important.

The column „True“ consists of four levels:

- 1 false / not present,
- 2 to a lesser extent true / present,
- 3 to a greater extent true / present,
- 4 true / present in full.

After an introduction to the survey and reading the questions, the teacher gives the answer, depending on their own views and experiences, by filling in the left (important) and right (true) column. The survey is conducted at the meeting of the Professional Section of the teachers of technical education and computer science in Zrenjanin, after introductory remarks about the goals and objectives of conducting the survey.

VIII. CONCLUSION

Every teacher of technical education and computer science, as a part of the educational system of the country, should have the opportunity to continue their education to the highest level of qualification in order to develop their competences and acquire professional development. The benefit of the advanced training of the teachers of technical education and computer science is reflected primarily in the results of the students, the quality of knowledge, presentation of the mastered curriculum and their engagement in regular classes, as well as in enrichment classes and extracurricular activities.

Being witnesses of the fact that even in the financially stable and rich societies certain period of time was needed to raise teachers' competence and to modernize the educational system, as well as taking into account our life circumstances, the process shouldn't be stopped but the new opportunities for avoiding the inconveniences should be looked for.

In most countries, teachers must financially contribute to the costs of transportation, registration fees or purchases of course materials for accredited professional development programs. The exceptions are Chile, Sweden and Scotland, where teachers bear no financial costs, and many countries provide the possibility of scholarships for research and further education [1].

New tendencies of creating teachers of modern times require greater involvement of an individual in terms of professional development, with particular highlights on the creativity and innovation in the teaching process in order to achieve a greater interest and a higher level of knowledge of the students. Professional development of teachers of technical and computer education is seen not only through the attendance and the implementation of a variety of trainings, seminars and courses, but also and primarily through their work, their teaching process, students' satisfaction after the implementation of the innovations into the system of teaching, as well as in the way of understanding and implementation of teaching material content. This increases the quality of the educational process and affects

students' qualitative and quantitative level of knowledge acquired on the regular classes at school, as well as on their extra classes by attending model, prototype, information technology and transportation clubs and sessions.

When analyzing the influence of personal / subjective factors on the professional development of the teachers of technical education and computer science, it should be borne in mind that there exists a group of teachers, of the so-called „put-to-sleep“ motivation, that are not inspired by the desire for the changes in the work, considering them hard and unnecessary.

Colleague support in the acquisition and implementation of the new knowledge into practice is a very important personal motivational factor, so, with the development of the professional culture of teachers and work subjects of the school, a lot could be achieved regarding strengthening the motivation for advanced training and professional development.

An important fact regarding the professional development of teachers is their recognition of the fact that changing yourself, which is not even a little painless, results into obtaining positive effects in the learning process of education. Because of all this, advanced training and professional development of the teachers of technical education and computer science should be seen as a long-term and continuous process, and the real needs of both the teachers and school as an important segment of the educational process, should be taken into account.

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