Advanced Engineering Methods in Design and Education

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Abstract. The paper presented deals with the challenges occurring during the education of the new digital generation of students in the area of engineering subjects. This new situation in teaching technologies imposes the obtaining of appropriate feedback from the students during the lectures and tutorials. The objective of the research is to investigate the impact of the application of video games, graphical presentations, animations, etc. The feedback received in such interactive way gives the opportunity to improve the teaching models and to increase the active participation of the students during the lectures and tutorials.

1. Introduction
The classic teaching methods of lecturing scientific study material consisting of theoretical knowledge, empirical relationships and formulas often turn to be a challenge for the mentality and perception potential of the university students. These factors usually lead to difficulties in assimilation of specific knowledge, which is based upon previous theoretical subjects. Besides, negative emotions to certain topics from the study syllabi occur.

Finding solutions for such complicated problems both from pedagogical and from methodological points of view is a real challenge for the academic staff responsible for the study process. This dynamic situation imposes changes in the teaching and lecturing methods applying new and modern technological solutions stimulated by the development of computer and information technologies.

The authors’ team has experience in presenting and explaining academic study material, for example – application of multimedia educational systems, electronic laboratories and software products, [1]. The efforts indicated lead to significant results. Nevertheless, the process of improving the teaching methods is dynamic and it requires continuous changes and innovations.

2. Investigating options for using mobile applications in study process
Mobile applications have increasing influence upon the academic study process for students from different degree courses regardless for what kind of devices they are designed: iPhone, Windows or Android, [2, 4]. The university study process involving mobile devices includes three different aspects: focusing on the mobile device; focusing on the learning outside the lecture hall and focusing on the mobility of every educated and trained student.

The research presented treats another additional aspect: the usage of mobile applications in the process of lecturing and acquiring new study material. This option give the possibility to engage the attention of the students to a greater extend and to encourage their active involvement in the assimilation of the material delivered. The theoretical survey made by the authors’ team established that mobile applications could be especially appropriate for achieving feedback from the students concerning the level of the study material acquired, [3, 5].
All students possess mobile devices and some of them – several such devices. The students follow with enormous interest the new information in their mobile devices. This circumstance creates preconditions for improving the level of their attention concentration applying mobile devices for test control.

3. Specific features of the test structure for mobile applications

Creating question for students educated is carried out with the help of logic, taking into consideration several factors. These factors influence the level of complexity of the test control. The most important factor is the specifics of the education in the academic degree program. Students from different degree programs within the Higher education system learn study material different in scope and in degree of difficulty. The aim is to select questions in such a way that the level of the study material acquired by the students is to be controlled definitely.

The number of the questions is different for each control test depending on the topic taught. Within a topic, the selection of the questions is random. The selection of questions is to be done through algorithm ensuring different combinations of possible questions and corresponding answers. This procedure avoids the frequent repetition of the same questions and prevents memorizing the correct answers by heart. It is preferable to project each question through multimedia tools for a strictly defined time period. After the time interval is over, the next question is to be presented. In order to ensure independence and equality of all students evaluated, the system does not give options for making corrections or answering the questions after the time is over.

Control tests in different subjects are elaborated: machine science, machine elements, engineering graphics, internal combustion engines, intermodal transportation operations, etc. The subjects from the area of engineering design and engineering graphics are fundamental. They are especially important because they are the first technical subjects for future engineer professionals. These subjects form the necessary base within the education and training of these students. For the first time the students face different issues of technical nature during acquiring knowledge and skills within these subjects. They learn to apply the accumulated theoretical knowledge by solving problems from the design engineering subjects. Besides, the students acquire experience and routine necessary for their future engineering practice. These fundamental subjects introduce a great part of the technical terminology and systematize the applied terms and notions of mechanical components.

Therefore, it is very important to evaluate whether the students comprehend, understand fully and remember these terms and notions. Besides, the lecturers are delivering and presenting relative complicated 3D models and 2D drawings, especially in accordance with students' level of training. A great number of difficulties occur when the students have to figure out the information on drawings and to understand its meaning. It is envisaged that the control tests for mobile applications will include two difficulty levels. The first level should involve relatively easy questions which should be visualized in the form of video games. This degree of difficulty is intended mainly for students with a low level of attention concentration. The second level of difficulty contains more complicated control questions. Their number is significantly smaller than the quantity of control questions from the first level. This level is intended for students who demonstrate interest not only in the study activities but also in scientific and research problems. It is foreseen that the test control for mobile applications is to be implemented at the end of the relevant tutorial. At the beginning of the test session several questions from the first level of difficulty are to be given to the students. After these questions are over, one or two questions of the second difficulty level are to be presented.

The aim of all test control questions is to receive feedback from the students and to examine the opportunities of mobile applications for accomplishing better communication between lecturers and students. Creating such options, the academic staff will be able to evaluate in details the degree assimilation of the study material and to increase the activity and the attention of the students to the training process. The final goal of the usage of mobile application for test control will be to help the students to understand and learn the greater and the more important part of the study material during the lecture or tutorial.
4. System for cross-platform mobile applications MATE

Based upon the theoretical research on the possibilities for using mobile applications in the academic study process and the analysis concerning the specific methodological requirements to the structure of the control tests for these applications, the authors' team created a system for test control MATE: Mobile Application Test Evaluation.

The system for control and assessment of the knowledge acquired by students during lectures and tutorials consists of the following components: a desktop or a laptop computer; a multimedia projector or a LCD television set; a server and a mobile device (a smart phone or a tablet). An application is to be installed on the lecturer's computer. The function of this application is to generate test questions on each topic or section of the study material delivered, included in the test system MATE, see Fig. 1.

The diversity of mobile devices with various displays leads to a number of difficulties in visualizing the specific test questions and the possible answers. For example, graphical information cannot be represented well enough in a great number of mobile phone models. This graphical information is especially important because the students need to reflect on its meaning.

Therefore, the system MATE solves this problem by visualization tools which are equal for all students attending the tutorials. Most often, these tools are multimedia projector, interactive whiteboard or LCD television sets. The selection of these multimedia and visualization tools of the test questions is driven by the fact that the greatest part of the study material within general engineering and engineering design subjects is related to equations, diagrams, schemes, drawings, three dimensional models and pictures of real objects and to significantly less amount of text explanations. Consequently, the authors' team made the decisions that the small mobile phone displays are not suitable for visualizing the information and knowledge necessary for the aims of the study process and the research.

Fig. 2 shows one of the questions which is used during the education and training in the subject Engineering graphics. A plane is defined through two intersecting lines. Three points are designated on the drawing. The students have to decide for a certain period of time which point (among the 3 points) belongs to the preliminary given plane. The same graphical presentation can be used for a variety of questions about the appurtenance of a point to a line and a plane. Each question related to this drawing can be chosen on a random basis and in random order.
The system MATE consists of two separate software products. The first one is installed on the lecturer’s PC or laptop. The second component is installed on the mobile device. The computer application is developed on the language C# in two compiled versions. The first version is designed for Windows. The second one is intended for Linux. Due to this option, a great number of available computers and operating systems are covered. The application is also developed in portable version. Thus its usage on computers with administrator restrictions is possible. The application for the mobile device with operating system Android is designed on Java. The downloading and installation can be done in two possible ways: from FTP (File Transfer Protocol) server or with the help of Bluetooth.

The algorithm of the computer application consists of the following units: unit for the selection of a topic, unit for the selection of a question, unit for generating the possible answers. After executing the whole algorithm, a timer is activated. It defines the time for answering. After this time is over, it is impossible for the students to answer the corresponding question. The time for answering a test question is the same for all students participating in the test session. However, time periods can be different for different question. The algorithm of the application for the Android device includes communication with the SQL (Structured Query Language) server. Thereby, it reads the number of the possible answers and the maximum time necessary for the relevant response. After starting the process of answering the questions, the students are given the option to choose and confirm the correct answers. When the time for answering is over, the corrections become impossible.

The appearance for a mobile device showing the buttons for the selection of the true answer by the student is to be seen on Fig. 3. The database containing the subject topics, the possible questions and answers and the necessary time for each question is located on the SQL server. The server exchanges information with the lecturer’s PC and also with the mobile devices of the students participating in the test control session.

The system MATE introduces a new center of attention – a focus on feedback from the students aiming to make some correction in implementing the lecture or the tutorial in order to increase the quality of the study process through better comprehensibility of the teaching material. In order to make this option possible several control tests during the lecture or tutorial are made.
They do not take long time from the study process and at the same time the tests give valuable information to the lecturer. Another important advantage of application of the elaborated test control system MATE in real time is the optimal time use during the study process. The volume of study material delivered in not diminished and the quality of the study process ca be increased. This advantage of MATE complies with the circumstance that all students possess one or several mobile devices – smart phones, tablets and laptops. The application of MATE leads to another positive effect. The students show increased attention to the study material delivered because the answering of the questions imposes certain minimum of knowledge acquired during the relevant lecture or tutorial.

5. Conclusions and future work
The elaboration and usage of the system MATE has contributed to the investigation of the opportunities of the mobile applications for performing better communication between lecturers and students. MATE facilitates the lecturer’s evaluation of the level of the acquired material by the students and contributes to increasing the activity and the attention of the students during the study process. Due to this option the greater and the more essential part of the material delivered is to be understood during the lecture or the tutorial. Therefore, the quality of the study process is increased significantly. Applying MATE new academic teaching models for students from the engineering bachelor programs are created and tested. MATE has fulfilled the aims set: the attention concentration of the students has been increased during the study process and the motivation of students with significant interests in study and scientific activities has been improved.

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