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Improving quality of engineering education by utilization of Moodle courses

Peter Benko, Arpád Kósa, Lubica Stuchlíková

Slovak University of Technology in Bratislava
peter_benko@stuba.sk

Abstrakt: *Moderné informačné technológie otvárajú mnoho nových možností v oblasti vzdelávania. Vzdelanie je výmena informácií, ktorá sa radikálne mení: Digitalizuje sa všetko! E-learningové materiály sa stali bežnou súčasťou štandardného vzdelávacieho procesu. Tento článok uvádza skúsenosti autorov získané pri čelení výzvam v oblasti technického školstva rozvíjaním kvalitných e-learningových materiálov a ich využitím vo vzdelávacom procese. Pozornosť je zameraná na vplyv implementácie e-learningového kurzu Elektronické prvky a obvody v Moodli na vedomosti a výsledky študentov. Vyhodnotenie vychádza z desaťročných skúseností s výučbou predmetu a spätnej väzby študentov.*

Klíčová slova: *e-learning kurzy, kvalita vzdelávania inžinierov, MOODLE*

Abstract: *Modern Information Technology has opened up many new possibilities in learning. Education is an information transfer, which is radically changing: Digitize everything! E-learning materials have became common parts of the standard education process. This paper presents how authors face the challenges in engineering education by developing quality e-learning materials and its implementation in the face to face study process. Attention is focused on the impact of the Moodle e-learning course "Electronic devices and circuits" implementation on students knowledge and results. Evaluation was made based on authors ten years of teaching experiences and students feedback.*

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Keywords: *e-learning courses, quality of engineering education, MOODLE*

1 Introduction

One of the most important challenges in today's engineering education is to ensure a high quality and update educational process [1]. Naturally this challenge is connected to key problems and factors in terms of students knowledge and attitude, which has to be examined. Solving these questions has the potential to improve the education quality addressing key problems:

- knowledge and motivation: Secondary school graduates attending our university have very different levels of knowledge. These differences are mostly evident in technical subjects, which include practical measurements. Students with zero

practical experiences are often embarrassed and live through these subjects in fear without motivation.

- technology based knowledge: Incessantly growing gap between the knowledge delivery and technology. The fast progress in all fields of science and technology that creates the necessity of constant subject content update and adjustment.
- skilled Key Enabling Technologies (KETs) professionals: Demands on high quality preparation and training of great number of graduates as KET professionals in order to support the economy. It is essential for the future economic growth, competitiveness and innovation of Europe, because key Enabling Technologies represent the background of a greener economy and Europe's industrial modernization [2].

One of the possible ways to face and solve these challenges in engineering education is to develop quality e-learning materials and to implement these in the face to face study process. We have started to create the first e-learning materials for students in 2000. We have used our own interactive web pages for their publication and utilization [3]. But this solution did not match the continually growing demands of interactivity and effectiveness such as: educational texts, interactive animations, tests, dictionaries, friendly services for teachers and also for students. We have decided to create more comprehensive e-learning educational materials using the open-source e-learning platform LMS Moodle (Learning Management System Modular Object-Oriented Dynamic Learning Environment) in 2004, based on which we have created our own educational portal called "eLearn central". This chosen solution enabled us to focus on important tools for teachers like the learning content and context, explanatory animations and eye-opening tests, rather than the development of the course management system and programming. Today Moodle is one of the most widely used open-source platforms and we are very satisfied with our choice since 2004. The milestones of our using Moodle are shown on Fig. 1.

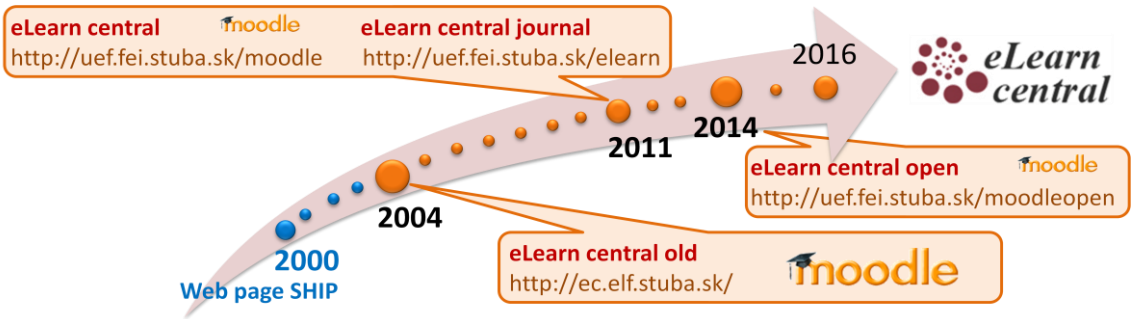

Fig. 1 Our journey of e-learning. Portals labelled as eLearn central using platform MOODLE.

The aim of this paper is to describe our experiences with the improvement of engineering education at our university by developing quality e-learning materials and their implementation in the face to face study process. These are discussed by one of our main practical subjects Electronic devices and circuits, and analysed for the academic year 2015/2016.

2 Subject "Electronic devices and circuits" in the academic year 2015/2016

The academic year 2015/2016 was the first year realized according to a new Complex accreditation of the Slovak University of Technology in Bratislava. The subject Electronic devices and circuits (EDC) has been designated for students who are at their second year of bachelor study programs at the Faculty of Electrical Engineering and Information Technology, namely: Electronics (ELN), Telecommunications (TLK), Electrical Engineering (ET), Electrical Power Engineering (ENE) and Nuclear and Physical Engineering (JFI). This subject deals essential practical and theoretical basics explained by elements of electronic circuits such as: resistors, capacitors, diodes, transistors, digital logic circuits, operational amplifiers and selected electronic circuits. The attention is focussed on basics of physical principles, electrical properties, technology and constructional principles of passive and active electronic devices, the basic knowledge about electronic systems, circuit properties electronic devices in different applications. EDC is a typical practical subject, mainly oriented on experiments. Practical laboratory exercises of this subject are enabling the verification of the student's knowledge, received by measuring physical dependences and properties of individual semiconductor devices and systems. This subject was proposed, prepared and adjusted according to ten years of experiences gained by the previously taught subject Electronic Devices for students held in the second year of the bachelor study program Automobile Electronics. Electronic Devices was introduced at our faculty in summer term of 2006/07 and finished in the summer term 2014/2015 [4].

EDC was presented as face-to-face lectures (2 hours weekly) with traditional practical laboratory exercises (2 hours weekly) with a complex e-learning support (nonstop online). In addition printed support materials were also available in textbook forms such as Electronics devices and circuits and Electronics devices – instructions for exercises and measurement protocol writing.

2.1 Complex e-learning support in Moodle

Complex e-learning support of the subject EDC consists of a standard interactive www course Electronic Devices and Circuits, the library of interactive animations Interactive flash animations (http://uef.fei.stuba.sk/moodleopen/course/view.php?id=104) and a key part: an interactive www course Electronic Devices and Circuits - interactive www guide for laboratory practice and exercises of the subject Electronic devices and circuits. All three introduced e-learning projects are developed for the portals eLearn central and are utilizing basic attributes of the Moodle platform. The first two projects were designed as freely accessible study materials, however the third one is protected by password and registration based access, because it is oriented on the actual study term of the laboratory and the current list of students attending the subject.

The library of interactive animations Interactive flash animations includes more than 30 interactive animations [5] created by the effective graphics creation strategy [6]. These animations present the inner processes in semiconductors and electronic circuits: passive devices, diodes and transistors and their usage in electronic circuits,

examples of planar technology produced diodes, bipolar junction transistor and CMOS gate, storage media, digital circuits and gates.

The most frequently used course by students and lecturers is Electronic Devices and Circuits - interactive www guide for laboratory practice and exercises. This e-learning course starts with basic information about the course content, followed by form of teaching, mode of completion, credits, regular and final assessment, course objectives, concise outline and course completion and two forums - Forum of news and the forum News in Electric Devices and Circuits in Electronics. The News forum is usually used as a teacher information and communication tool for students. The forum “News in Electric Devices and Circuits in Electronics” is mainly used as a motivation tool for the creation of new educational materials. Each part of this course includes presentations of lectures in pdf format, supposed to be free uploaded for students, information about the practical laboratory, exercises and course events, including illustration and motivation pictures. Ten parts of this course include: pdf formatted, educational texts as guides for individual practical laboratory exercises with practical notes for measurements and equipment settings, link on animations, self - tests assigned for students for home study and preparation for initial and final tests.

2.2 Results and Feedback

Students can successfully complete the subject Electronics devices and circuits if the following conditions are met. Accomplishment of two tests – first for 10 points in the 3rd-4th week of the semester and the second for 20 points in the 7th-8th week of the semester, with additional 10 points for active participation in the laboratory instructions and seminars. Students have to attend all instructions and complete all particular laboratory projects. Finishing the final examination test, where students can achieve maximum of 60 points. Final grade and credits shall not be granted to a student who at the final examination test earns less than 25 points and in summary less than 56 points. The final examination includes also an oral verification and personal test review. It is important to mention valuable possibilities prepared during the semester flow, besides the two usual lecturers representatives from practical companies are also invited, 80% percent of seminars are prepared as practical and others as theoretical, students are provided with the possibility of personal consultations and pre term examination according to agreements.

Statistics of gained grades according to the number of students in 2015/2016 are summarized in Fig. 2. Results observed by the analysis of EDC's 2015/2016 academic year correspond with our ten years of experience gained by the predecessor subject Electronics devices [4]. These outputs indicate that there is a considerable impact on the grades of students in accordance with their previous educations. Graduates of secondary grammar schools usually have no practical experiences therefore for them this subject can be source of frustration with reflect on final grades, although they are excellent in theoretical calculations and report writing. Despite this consideration the overall results showed above average grades mainly in case of the Electronics study programme. The influence of students inner motivation was also visible, since the "Electronics" students were the best, while the "Telecommunications" students the

worst. This could be explained by the fact, that telecommunications study field is more software oriented as electronics where EDC is an essential hardware base.

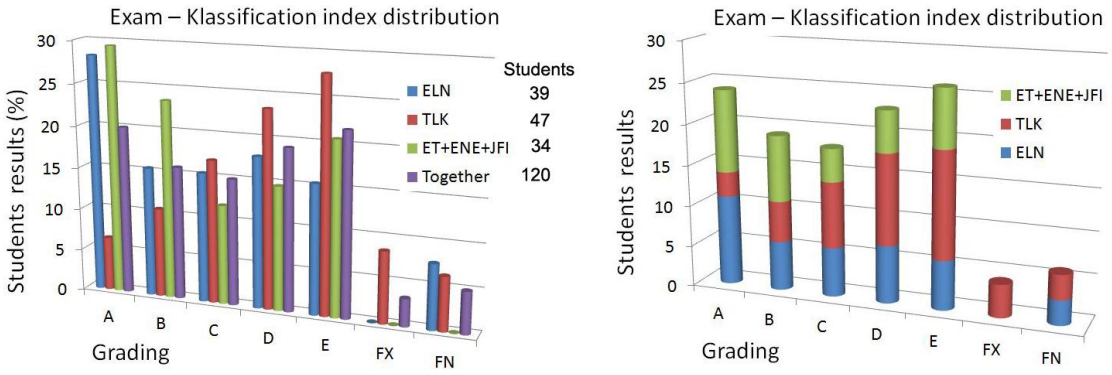

Fig. 2 Distribution of student results (gained grades) according to the number of students in 2015/2016. Grading: A-min. 92 points, B-min.83 points, C-min. 74 points, D-min. 65 points, E-min. 56 points, FX-less than 56 points. 100% Attending = 120 students

After course completion we regularly do research in the form of discussions, about the student's opinion on this subject and how the manner of education process (face-to-face and e-learning), amount and form of study materials affected their study. At the same time the students were able to evaluate the subject in the academic information system. Course finishers (subject graduates) gave us positive feedback related to this comprehensive education solution: presentations, practical seminars, available educational materials and related explanatory animations, possibility of a continuous communication with lecturers and a systematical management, which contributed to a successful final grade. They appreciated all the freely available on-line materials and "on hand" information on actual subject events, and concluded a creative and interesting educational process. Furthermore a higher number of practical seminars and praxis related presentations would be welcomed with a better clarified course navigation in Moodle.

3 Conclusion

In this paper we have reported an example, how to improve the quality of engineering education by utilization of Moodle courses in a currently studied subject Electronic devices and circuits. Developing and implementation of courses in Moodle with high quality to education enable us to realize a very effective way of education. Combination of face-to-face lectures, experimental laboratory tasks and complex e-learning support were tested on 120 students of the subject Electronic devices and circuits during the academic year 2015/2016.

Students have always reported, that they enjoyed and found really effective this way of education and will prefer this learning format in the future. As main factors affecting the effectiveness of learning education students listed several benefits. Most of them addressed a continuous and unlimited access to educational materials via the Web,

giving them flexibility, freedom, and convenience when working part time online from home. By this solution they have the opportunity to comprehensively prepare for lessons, seminars, exams or tests. Students observed an increased success as compared with other subjects without e-learning support. In this solution our students can participate more in various class discussions since they can choose the environment - online or face-to-face - in which they feel more comfortable.

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Informace o autorech

Peter Benko, Arpád Kósa, Lubica Stuchlíková

Telefon: +421 602 91 872
Email: peter_benko@stuba.sk, arpad.kosa@stuba.sk, lubica.stuchlikova@stuba.sk
Zastávaná funkce: researcher, PhD. student and teacher
Název instituce: Slovak University of Technology in Bratislava, Faculty of Electrical Engineering and Information Technology, Institute of Electronics and Photonics, Ilkovicova 3, 812 19 Bratislava, Slovak Republic