

# Blended Education at Large Technical University Located in Highly Urbanized Metropolitan Region

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## ABSTRACT

Present state and near future perspective of e-learning development in Poland, in the Silesian University of Technology will be presented. Redesign of a course from traditional to blended model will be discussed, in general and in details for basic engineering course, namely Circuit Theory course. Both, the learning context and assessment program are considered. The AFT (American Federation of Teachers) guidelines for good practice were used as a criterion reference for assessment and analysis of the e-learning development program.

**Keywords:** Advanced technology in education, web-based education, faculty development, e-learning.

## 1. INTRODUCTION TO E-LEARNING: TENSION AMONG OBJECTIVES

Learning (education, training) has become an important part of economic activity, from 25% in 2000 to a predicted 60% in 2020 [1]! In recent years a rapid progress in Information and Communication Technology (ICT) development can be observed. Then, ICT-based learning, the so-called e-learning or e-education, seems to be the most promising form of knowledge acquisition and delivery - practically, there is no alternative to this form. World wide e-learning market forecast accounts 17 billion dollars in 2005 and 24 in 2006 [1]! However, faculty members must understand that providing access to information is only a vehicle to learning, technology should enhance the process of education not hinder it. When implementing ICT to education, three main objectives have to be taken into account:

1. quality,
2. access,
3. costs.

and there is a strong tension among them [2]. From academic teachers' good practice point of view enhancement of quality is the key objective.

Redevelopment of any course from traditional, face-to-face (f2f) model to e-learning model is absolutely

2. Private Universities: around 250 Universities, 50 offering also postgraduate courses; mostly single-faculty small Universities founded after 1990.

At present, few of them, mostly State Universities, are offering purely online courses. Polish Virtual University

inevitable. In Section 2, general approaches to e-learning and the present state of e-learning in Poland will be presented. In Section 3, strategy of course redevelopment from a traditional to blended model will be discussed, in general. In Sections 4, application of this strategy to Circuit Theory course, a basic engineering course, will be discussed in details.

## 2. FORMATS OF E-LEARNING, E-LEARNING IN POLISH UNIVERSITIES

Four possible formats of online course can be distinguished [3]:

- *Teacher-facilitated online*
- *Teacher-facilitated hybrid (teacher for both f2f and online portions)*
- *Teacher-facilitated f2f plus self-paced online*
- *Self-paced online only.*

When selecting the format, the following question has to be answered:

*Are there activities which cannot easily or satisfactorily be performed online?*

If yes, and this is the case for any engineering course, then only hybrid, the so-called blended structure may be applied.

Blended model of knowledge delivery has been portrayed as a good solution to constraints and disadvantages of traditional and online model [3], [4]. This model is extensively developed in the US Universities. Also, Universities in the EU States are developing blended learning, however stage of development is not the same in all 27 States. In Poland, the largest from the 12 members that accessed the EU in this century, dynamic development of e-learning can be observed.

Polish Universities can be divided into two groups:

1. State Universities: around 125 Universities, 70 offering both 3-year undergraduate and 2-year postgraduate courses; multi-faculty large Universities with many years' tradition (1.5 million students = 75% of all students),

(consortium of two State Universities) offers 3 year online studies (management and marketing, computer science). Warsaw University of Technology offers engineering online studies (electronics, computer science, automatic control), labs and some projects are in a traditional form,

course content is distributed in multimedia form. These two online projects have definitely given optimization of access criterion, however, optimization of other two criteria, quality and cost, is questionable, as no official reports are available [5]. Many other Universities have launched units responsible for e-learning development and already some courses are delivered there in an online format. Practically all Universities are introducing elements of e-learning to their education programs, however, these attempts are rather an effect of enthusiasts' activities than an integrated activity, supervised by the Ministry of Science and Higher Education (MoS&HE). Lack of legal regulations for e-learning development is the main hindrance. Just recently (25.09.2007) the Ministry have issued a document regulating conditions for e-learning development at Polish Universities [6]. Every teaching unit (faculty) may introduce elements of e-learning, for both stationary (daily) and non-stationary (correspondence and evening) courses, however total hours of online portion can not be greater than k%, of all teaching hours, set by the teaching standards (established by the Ministry), excluding laboratories and practical activities, where

k=80 for units that have a right for granting the D.Sc. degree,  
k=60 for units that have a right for granting the Ph.D. degree,  
k=40 for all other units.

Then, it is clear that purely online format is not allowed by the Polish regulations. Blended format is acceptable only for lectures, however percentage of online portion is strictly limited. This document does not regulate a method for calculation of teaching hours in case of asynchronous knowledge delivery, what practically limits online format to synchronous elements.

Incorporation of e-learning elements into the traditional course is very time consuming but no general (Ministry, University) program for financial compensation can be expected. Funds necessary to compensate teachers' effort should be sought by teams in National and European grants, e.g. within the 7<sup>th</sup> EU framework programme – support of R&D projects in ICT is among main objectives of this programme.

Recent developments within e-learning, carried out by the Faculty of Automatic Control, Electronics and Computer Science (ACE&CS), of the Silesian University of Technology (SUT), will be described in Sections 4 .

### 3. COURSE REDEVELOPMENT FROM A TRADITIONAL TO BLENDED MODEL: GENERAL STRATEGY

A blended learning framework has been discussed in [4]. Redevelopment of a course is a complex process of determining priorities in relation to teaching and learning goals, the organizational context and disciplinary factors. and are the main problems. The change from traditional to blended model involves a change of routine and expectations of both, academic teachers and students. Fig.

1 presents a blended learning framework, as originally depicted in [4].

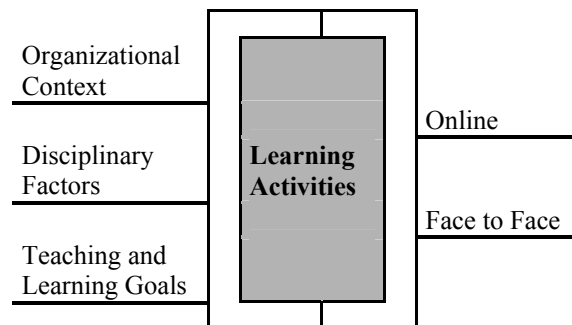


Figure 1. Blended learning framework

Some general points of consensus about what is important in a blended course can be enlisted and the following are the major ones [3]:

- *selection of an appropriate Course Management System (CMS),*
- *thoughtful integration of the f2f and online elements,*
- *assurance of interaction and interactivity.*

Interaction is the main factor determining the quality of learning. The following observations have been confirmed by many authors [3]:

- *high association between interaction and retention,*
- *high association between interaction and passing,*
- *high association between interaction and student satisfaction.*

Then, the following forms of interaction can be distinguished:

- *interaction with teacher:*  
teacher announcements; commentary/lectures; feedback in discussion; feedback on assignments,
  - *interaction with peers:*  
discussion; projects; peer review; presentations,
  - *interaction with content:*  
library and Web; textbooks; multimedia; teacher presentation and guest speakers; self-assessment,
- and all these forms have to be taken into account when redesigning a course.

The blended model should definitely enhance quality of education but also it should bring improvement to organizational context. The following basic questions have to be answered:

*What is the best mix of synchronous and asynchronous elements in a course?*

*What is the best mix of f2f and online elements?*

In general, a course content may be divided into two parts:

- *learning context (knowledge delivery),*
- *assessment program (knowledge assessment).*

Synchronous elements seem to be more suitable for knowledge delivery while asynchronous elements seem to be more suitable for knowledge assessment.

Face to face knowledge delivery, followed by online discussion (knowledge assessment) seems to be the better

mix of these two elements, rather than online knowledge delivery followed by f2f discussion.

Moreover, a course restructuring is a perfect opportunity to make changes and updates to the traditional content, not only introduction of online elements.

Course redevelopment strategy will be discussed for large and basic engineering course of Circuit Theory, and taking into account operating conditions of Polish Universities. In Poland, no distance education guidelines for good practice have been issued so far. Therefore, American Federation of Teachers (AFT) guidelines [7] have been utilized as a criterion-reference for the Faculty initiative, as they seem to be universal and can be accepted by any country. The details of these guidelines and their fulfillment by the Faculty are as follows.

- G1.** Faculty must retain academic control.
- G2.** Faculty must be prepared to meet the special requirements of teaching at a distance.
- G3.** Course design should be shaped to the potentials of the medium.  
The Faculty of ACE&CS has access to wide range of delivery media. Delivery formats include two-way interactive video, streaming video, audio conferencing and web-based documents. In 2004, the Faculty e-learning unit has been established and Open Source – Moodle LMS (Learning Management System) has been installed. Today, this platform is used by all 12 Faculties of the University, with 16000 users and more than 600 courses registered. Practically all courses should be redeveloped into the blended model, however it is teachers' initiative rather than coordinated action. As mentioned before, such action is impossible due to the lack of funds - no extra funds for e-learning promotion can be expected.
- G4.** Students must fully understand course requirements and be prepared to succeed.  
No extra requirements are imposed by online knowledge delivery, as this knowledge can be acquired in the traditional way as well. Practically, all students have access to the Internet at dormitories or their homes, and they possess necessary distance learning skills.
- G5.** Close personal interaction must be maintained.  
For all Faculty courses, both real-time interchange and asynchronous communication is maintained. The course include traditional and e-platform based discussion groups and consultations.
- G6.** Class size should be set through normal channels.
- G7.** Courses should cover all material.
- G8.** Experimentation with a broad variety of subjects should be encouraged.
- G9.** Equivalent research opportunity must be provided.  
These last four guidelines are clearly fulfilled in the proposed blended model. Cohort size limits are set at 30 students for classroom lessons and 12 students for labs.
- G10.** Student assessment should be comparable.  
This guideline is also evidently fulfilled. All the pre-exam tests and the final examination have been

performed in a traditional manner so far. However, online communication enables introduction of new assessment schemes, quizzes and variety of electronically submitted assignments. The last, especially regards pre-lab assessments and post-lab reporting.

- G11.** Equivalent advisement opportunities must be offered.  
Same-time same-place advising is available to all students.
- G12.** Faculty should retain creative control over use and re-use of materials.  
Polish Universities do not yet have specific guidelines in place governing ownership of intellectual property in online courses or their elements. Formal and official policy, guiding the development of online material, should be sought
- G13.** Full programs should include same-time same-place coursework.  
For a stationary course, this guideline is fulfilled in an apparent way. Any non-stationary (correspondence) online course includes a significant face-to-face component in an extended weekend format.
- G14.** Evaluation of distance coursework should be undertaken at all levels.  
As it has been mentioned before, no governmental program for evaluation of distance education has been launched. Therefore, standard course evaluation has to be applied in its distance format.

Concluding, most of the guidelines are already fulfilled in a self evident way, others will be fulfilled when redeveloping a course.

#### **4. REDEVELOPMENT OF CIRCUIT THEORY COURSE**

Circuit Theory (CT) course is a basic engineering course, delivered practically to students of all engineering branches and therefore it seems to be a perfect example for engineering course redevelopment. The Silesian University of Technology (SUT) is one of the largest Polish Universities (35000 students), the Faculty of ACE&CS is the largest one (4500 students). The CT course is delivered to students of four teaching branches that are run by the Faculty: Electronics and Telecommunication, Automatic Control and Robotics, Computer Science and Biomedical Engineering. This gives enormously large number of around 500 students that have to be taught and examined each year by the CT team of only 10 teachers! To maintain high quality of education, both incorporation of ICT into the learning context and development of Computer Assisted Assessment (CAA) program is absolutely inevitable. The SUT is located in highly urbanized and industrialized metropolitan region of around 30x30 km<sup>2</sup> area and 4 million inhabitants. All students of the Faculty are accommodated within 30 km distance from Gliwice, and then there is no need for synchronous distance learning - a

synchronous learning is limited to at-classroom f2f format. Then, inclusion of asynchronous e-learning is the target. Before starting the course redevelopment, the following should be assessed:

1. expected effect
2. present situation and possible measures,
3. limitations.

### **Expected effect**

Enhancement of education quality is the major expected effect. This effect should be achieved by using the e-platform for the following:

- lecture updated program and conspectus,
- drill problems database,
- simulation and animation interactive programs helping better understanding of the content,
- brief quizzes over the topics just taught,
- lab instructions,
- pre-exam and pre-lab assessments (formative tests),
- post-lab reports,
- summative assessment (final examination),
- student e-portfolios, quiz/examination results,
- discussion forum and online consultations, interaction between fellow students (p2p) and between students and a teacher.

Lecture is the course core, while classroom component helps understanding the lectured methods and algorithms by means of the so called “academic examples” as well as practical ones. The lab component is focused on practical knowledge and skills and allows practical observation of phenomena discussed during the lecture. All three components are strongly interrelated and have the same ordering of the content. Classroom and lab components are credited separately, based on assessments and pre-exam tests, and form a basis for a final credit. The final credit is granted based on the final examination, a multichoice test. Increase of the course effectiveness and student satisfaction are expected, as the result of quality enhancement. Inclusion of asynchronous e-learning should also bring an effect in savings in organizational context and consequently in teachers’ time effort. For example, pre-lab assessment and post-lab reporting is much more time consuming in a traditional form, than in an online form. Organization of formative assessments in a traditional manner is practically impossible for a class size larger than 100, and then, redevelopment of the assessment program from traditional to CAA program seems inevitable. Also, incorporation of active learning techniques, such as web-based discussion forum and consultations should save teachers’ time effort.

### **Present situation and possible measures**

Most of the course educational software is already available [9]. This software has to be thoroughly examined and eventually adapted, as the platform content. This may require creation of new own tools of the content development. These tools should enable unification of data format and form of the content presentation. Moreover, some new elements of the content have to be created - first of all, this relates to simulation and

animation programs. These programs are normally an effect of student projects. That way, library of specialized programs is continuously updated and supplemented. Library of interactive programs, illustrating all individual elements of the content, is the target. Drill problems database is present in a printed-text format and consists of more than 500 problems. This database has to be continuously updated and converted into a format required by the used LMS (Moodle).

### **Limitations**

There are two main factors hindering rapid development of course restructuring:

- Teachers can not expect gratification for their work, what never helps rapid action, regardless their strong emotional commitment.
- Teachers are heavily loaded by traditional learning and organizational duties, research activities, and therefore not much time is left for e-learning development..

### **Learning Context [8]**

The CT course is key-protected so the tutor retains full control on the course users. The students can be divided into groups of different profile, in order to impose various requirements, depending on the status of the student (graduate, postgraduate, correspondence etc.). All the registered students have access to all the student contents available on the platform. They are not allowed, however, to place their own material, except from comments published on the forum.

The main page of the CT course (key-protected) is user-friendly and can be easily navigated (see fig.2). Students can choose among the basic information, referring to the whole course, and the main units of the course: lecture, laboratory and the classroom tutorials. The lecture material consists of lecture updated program and conspectus, main definitions, terms and concepts, as well as drill problems.

The most frequently visited are the CT lab resources. Firstly, all the lab instructions are placed there as pdf – files. The instructions contain detailed information on all the tasks to be solved at the lab. It is assumed that a good-working student, who has studied the instruction carefully, is fully prepared to do the lab exercise without supervision. In practice, however, this refers to the minority of students, due to the lack of experience, problems with comprehension, equipment failures etc. Secondly, a number of obligatory problems to be solved before entering the lab can be found at this web site. The solution to the problems, however, is usually checked in the traditional manner in order to prevent students from cheating. Nevertheless, all the diligent students can practise a lot and develop their abilities while training.



Figure 2. Main page of the CT course

The most attractive CT resources are the interactive Java calculations and simulations of DC as well as AC circuits. Our main goal is to increase the number of simulations so as to cover all the fundamental ideas of the CT course.

One of the biggest advantages of using the platform is fast, interactive communication between students and tutors. Teachers' forum is used (as defined) by tutors, to exchange various ideas related to the course and chat is eagerly used by all users to comment on the problems, ask questions concerning tasks, assignments, dates, etc. Students can save a lot of time by this form of obtaining information and so can the teachers – for instance, by accepting the post-lab reports in electronic manner. Thus, undoubtedly, introduction of the CMS has substantially increased the quality of learning and the effectiveness of the course.

### Assessment Program [9], [10]

Redevelopment of the CT assessment program comprises both formative tests and summative test (final examination). The traditional, open-ended tests are replaced by the online close-ended multichoice tests. It practically requires creation of a new database of problems. Straightforward conversion of the old open-ended problems into the format required by Moodle and multichoice form of test is senseless. In 2006, an experimental CT examination had been carried on. A group of 100 volunteers had been tested twice, firstly by means of traditional examination, then by means of multichoice online test. In 2007, following the experiment findings, both formative and summative traditional tests have been fully replaced by the online ones. The final examination consisted of 20 multiple-choice questions. This number is the optimum for a single-session exam, as confirmed by many authors. The questions emphasize conceptual understanding over problem solving mechanics. If the students understand the concept, they are able to select the correct answer with little or no computation, within 3 to 5 minutes. After adding 20 minutes for answer revision, the total exam time is  $20 \times 5 + 20 = 120$  min. Single-concept questions are used, obviously some of them are linked, but they are evaluated

independently. Some questions test understanding of basic problems, some other test understanding of complex and more difficult to comprehend problems, however no weight is introduced. A question may require either “forward” or “reverse” reasoning skills. The latter ones require students to process the information in a different fashion than typically presented, e.g. given the output and system they must reason backward to find the input or given the input and outputs reason backward to find its parameter or structure. Classroom experience suggests that students who do not fully understand a concept may correctly answer a “forward”-reasoning question while they fail when answering a “reverse”-reasoning version of the same question. In the applied e-exam, “forward”-reasoning questions prevail, what seems to be reasonable. The e-exam had been carried out in computer rooms, integrated with the installed Moodle LMS in its standard version. All students have had the same set of questions, however presented in the randomized order with randomized order of answers to individual questions. Four choices per question have been proposed, one of them is “other answer” and this answer is the correct one for 4 questions, 25% of all questions.

After the e-exam, prior to marking, two parameters of the multiple-choice are set:

1. Pass/Fail threshold –  $Th$ ,
2. Penalty point weight –  $Pen$ .

The experiment findings have been confirmed and the following values of parameters have been designated and applied:  $Th=7.5$ ;  $Pen=0.25$ .

The automated form of examination allows its statistical analysis. For each question, its

1. “easiness”,
2. “discrimination”,
3. “percent choosing”

can be calculated [Ogi]. Then, all questions can be evaluated, classified into:

1. “good”,
2. “fairly good”,
3. “not too bad”,
4. “bad”.

A question is considered “good”, if it gives good “discrimination” - is answered well by top students, not well by bottom (below average score) ones, its “easiness” is close to 50% and has good “percent choosing” – distribution between five possible answers (three distractors+correct+no answer) is reasonably uniform. A question is considered “fairly good”, if its “easiness” is close to 50%, it gives good “discrimination” but its “percent choosing” not to diverse. A question is considered “not too good”, if it gives good level of “easiness (close to 50%) but non-uniform distribution of distractors and low “discrimination”. “Bad” question fails all three criteria.

Both the students and the staff have been questioned to express their opinion about the newly developed form of examination.

Generally, students praise the effectiveness of the online formative assessments and rate them highly as an efficient component of their learning. Majority of students have

found the e-exam objective, its problems similar to those of tutorials and formative tests, the duration-time sufficient. Percentage of wild-guessing has been declared low, however it has not been confirmed by the exam statistical analysis - for seven questions number of wrong answers is greater than number of correct answers! There was no distinction between two possible wild-guessing strategies: systematic and occasional. The 6% that have declared Yes, probably have applied the wild-guessing strategy to all questions, many others that decided to take a wild-guess occasionally have declared No.

For the staff, the open-ended form of questioning has been used, members of the CT team have been asked to outline positives and negatives of e-exam, as compared with the old traditional one. The consensus has been achieved when evaluating positives of e-exam:

- easy to check,
- more objective,
- cheating reduced practically to zero.

When outlining the negatives, the opinion was not so unanimous. Only 50% expressed absolutely positive attitude to the CA form of examination, other 25% expressed positive attitude however recommended some serious modifications. These recommendations are as follows:

- introduction of questions with only one numerical answer,
- increase of distractors from three to four (total of five choices),
- increase of the penalty point weight, from 0.25 to 0.5 or higher,
- providing questions with randomized parameters and/or structure of a circuit.

The first three recommendations will be taken into account with no delay. To randomize question parameters and/or structure of a circuit, a specialized software has to be elaborated and incorporated into an open-source CMS. The question randomization is the new field of research and the first results have been already reported [11], [12]. Both, learning context and assessment program redevelopment is a very time consuming task and can not be accomplished without a financial support. Nevertheless, it is our great belief that learning context and assessment program restructuring will proceed dynamically and within next year the CT course will be redeveloped into a blended model and CAA system will be fully operational and ready to use by other teams.

## 5. CONCLUSIONS

One of the main goals of today education is to increase the quality of learning by introducing the modern techniques like internet. The ICT based e-learning has already become the standard of modern education. Blended model of education seems to be the most suitable for an engineering course, such as the CT course.

Conversion of the major engineering course (Circuit Theory) from the classic to blended model has been presented. The redesign comprises both the learning context and assessment program. The first survey

definitely has proven that quality of education has been improved.

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