

## TECHNOLOGY ENHANCED BLENDED LEARNING IN TEACHING ENGINEERING

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**Abstract:** *Blended learning is an intentional integration of traditional and e-learning in order to provide educational opportunities that maximize the benefits of each mode of delivery and thus effectively facilitate student learning. This paper shows blended learning model implemented at College of Computer Science and Business Communications eMPIRICA for distance-learning students at study programme Engineering Informatics. First, the blended learning structure is presented; then technologies used for development of interactive multimedia e-content and technologies used for conducting of e-learning are presented. E-learning does not involve only the development and delivery of e-content, but also the continuous teaching, learning, assignment, assessment and communication activities of all participants in the educational process (students, teachers, tutors, administrators and others). Finally, an evaluation is presented, which has been carried out by use of an anonymous survey, aiming to ascertain student satisfaction.*

**Keywords:** *Blended learning, e-content, e-learning, engineering, ICT*

### 1. INTRODUCTION

Technology is ubiquitous, touching almost every part of our lives, our communities, our homes. Teachers are weaving technology into their lesson plans and classrooms, even if they are not teaching intro to typing or programming. The introduction of technologies for the preparation and implementation of e-learning in traditional learning environments usually result in more efficient education process, teaching is individualized and the participants of the educational process have more frequent electronic communication. Blended learning represents a combination of traditional forms of learning and e-learning. Blended learning students have continuous access to e-materials, as well as other contents and activities in e-learning environment, and also the ability to individually determine place and pace of learning.

Many higher education institutions have started to adopt and implement information and communication technology (ICT) for example e-learning as a source for flexible teaching and learning process either in the classroom or outside the classroom. The integration of ICT in teaching and learning has changed the way curriculum is designed, the way we learn, and changing the way we communicate [1]. Further development of new forms of learning and the use of ICTs for their presentation has led to teachers losing the role of direct transmitter of knowledge and that the educational and

digital competence of teachers become more appreciated. In e-learning environment, teachers are expected to devote more attention to the preparation of e-materials, preferably multimedia and interactive, as well as to plan and implement of e-learning process in detail. In recent models of learning, such as blended learning, focus is on learner and on learning process. It is important to know the learner's previous knowledge and experiences as well as his/her needs, motivations and characteristics, such as personal abilities, learning strategies and learning style [2]. The steps of planning e-learning are described in [3] and include definition of educational design, design of e-learning activities and type of interaction, used at e-learning and supporting activities. Also there is a need to consider the pedagogical principles and select appropriate technology, in order to create media-rich and high quality educational content. In this process, institutional centers for distance education give a significant support to teachers and students, since teachers do not always have the necessary digital competences for the development and implementation of e-learning.

Blended learning breaks through the barriers of the use of time, place, path to understanding, and pace to allow each student to work according to his or her particular needs - whether that be in a group or alone, on practice problems or projects, online or offline. It preserves the benefits of the old and provides new benefits - personalization, access and equity, and cost control [4].

Schools that make the most effective use of new technology will adopt a model of blended learning – “a formal education program in which a student learns at least in part through the online delivery of content and instruction, with some element of student control over time, place, path and/or pace” and “at least in part at a supervised brick-and-mortar location away from home” [5].

This paper presents the experience gained by applying blended learning in teaching students of Engineering Informatics at College of Computer Science and Business Communications eMPIRICA. Our motivation was to create such learning environment which are going to use the benefits of traditional F2F (Face-to-Face) and e-learning, in a ratio that is adjusted to engineering studies. Distance-learning students were provided with interactive multimedia e-materials, online activities and electronic communication, in addition to traditional teaching and learning. Positive feedback from students has been received for ICT-supported teaching and learning, in class and online.

The following section discusses characteristics of blended learning, while third presents blended learning model implemented at College of Computer Science and Business Communications eMPIRICA. The use of ICT for development of e-content and conducting blended learning is shown in fourth section. The fifth section presents the evaluation of technologies used for development and delivering of e-learning. Finally, there is a conclusion drawn on the basis of evaluation, institutional experience in blended learning and practices of other educational institutions that implement blended learning and use ICT in their educational process.

## 2. CHARACTERISTICS OF BLENDED LEARNING

Blended learning is the most logical and natural evolution of our learning agenda. It suggests an elegant solution to the challenges of tailoring learning and development to the needs of individuals. It represents an opportunity to integrate the innovative and technological advances offered by online learning with the interaction and participation offered in the best of traditional learning [6].

Blended learning is not just another district initiative. It is a fundamental redesign of instructional models with the goal of accelerating learning toward college and career readiness. It is a large-scale opportunity to develop schools that are productive for students and teachers by personalizing education to ensure that the right resources and interventions reach the right students at the right time.

This model uses the benefits of e-learning and traditional learning, combining them in a ratio which, if well adjusted to the nature and content of individual study courses, and to the students characteristics, should result in more efficient educational process. To effectively blended learning, there is a need to exploit an appropriate technology, teachers with developed digital competences and support of specialized e-learning teams that are usually organized within distance learning centers. Strict ratio between F2F and online components is not

determined in advance, but they are combined in such a way to ensure effective educational process, which is adjusted to individual needs and learning styles of students, and learning outcomes. In order to design blended learning that will use the benefits of these two components to achieve learning goals, , it is important to be familiar with strengths, weaknesses and challenges of traditional learning and e-learning, which are summarized in Table 1..

**Table 1.** *Advantages and disadvantages of traditional and e-learning*

	<b>Traditional learning</b>	<b>e- learning</b>
Advantages	Social interaction Fast and intensive communication Intensive feedback Students practical work Classroom environment has fewer technology requirements Instruction clarity	More effective use of time Easier differentiation More active students More creativity Less paperwork All your teaching resources in one place Lower costs Extending the reach Optimizing development cost and time Helps students to develop valuable and necessary twenty-first century learning skills Development of student activities and critical thinking, as well as the ability to analyze and concluding. Lifelong learning and professional training
Disadvantages	Places students in a passive rather than an active role Unconformity to student needs Too much focus on presentation, little time left for practice Timeout There is almost no group or individual study Spatial limit Encourages one-way communication	Learners must have basic technology knowledge or a willingness to learn Learners must devote a significant amount of time Lack of eye contact among participants Unreliability or unavailability of technology Require significant self-discipline and motivation of participants

Development of blended learning requires a detailed analysis of many factors of which the most important are: pedagogical, technological, institutional, management and support in terms of available resources. Neither learning model should not result in learning that will be just a one-time event as it is often with traditional or e-learning, but it must represent a continuous process in which knowledge becomes usable and applicable. According to the basic classification, there are 6 models of blended learning [7]:

- Face-to-Face Driver – In this model, teacher presents the entire teaching material face-to-face, in standard classrooms and online learning applies only in special intended laboratories
- Rotation - Blended learning model in which the "blend" is achieved by rotating learning stations, both in and outside the classroom or between learning in the classroom and online learning. Rotation is done after a pre-arranged time or after the initiative of teachers that can be done in many different ways.
- Flex - Teaching materials and tasks are primarily delivered online to students, through an appropriate e-learning system, during which their teachers are available for various forms of assistance. Face-to-face component is implemented flexibly and according to the needs of students and courses, and can be performed through various forms.
- On-line Lab - In this model the entire material is delivered through the appropriate online platforms and student work and learning are supervised by staff who are specially trained and in charge for this task. In this model, students still have traditional courses.
- Self Blend - Blended learning model that simply uses an online learning as a complement to traditional learning. In this model, students can use developed online courses for learning that can be followed from home or from school premises. In this model, students can also learn an entire course using online material, while other courses learn by a combination of face-to-face and online components.
- Enriched-Virtual model – Students independently distribute their time for learning in the classroom and at home with the help of the delivered materials and instructions. Classroom learning is done mostly on weekend.

### **3. BLENDED LEARNING MODEL AT eMPIRICA COLLEGE**

Blended learning model that was applied to the Engineering Informatics study program at the College of Computer Science and Business Communication eMPIRICA most closely matches to Flex model. Selection of appropriate ratio between e-learning and F2F component has a key role for the successful implementation of this teaching model. In applied blended learning approach e-learning is a dominant component with 80%, while F2F component makes up 20% of the classes. E-learning does not involve only the development and delivery of multimedia and interactive e-materials, but also the continuous participation of all participants in

the educational process (students, teachers, mentors, tutors, administrators and others) in asynchronous and synchronous activities. For the purposes of real-time web lectures Cisco WebEx Meeting web conference system has been used. Its main features include multipoint audio and video conference, data sharing and collaboration, chat and recording. All sessions were later uploaded to the dedicated YouTube channel and further embedded into the e-courses delivered via eCampus.

eCampus combines tool functionality with user data and course information to enable communication, content delivering, assessment, assignments, e-classroom analytics and e-Index, in a password-protected web environment. In addition to the feature of importing different formats (MS Word, SCORM, Flash, HTML5, MP3 audio, MP4 video etc.), this module provides an editor for the multimedia content authoring.

External educational resources were used, in addition to self-developed, in order to improve educational repository, such as e-books, animations and web-based applications. eCampus is a contemporarily designed system for e-learning, where learning environment tends to be organized in an intuitive and attractive way. The purpose of visualization of the key information (chart learning time, transparent allocation table of e-learning materials, simple index) is to make learning enjoyable and motivating [8]. Learning environment is personalized and in addition to these options provides a range of other useful services, such as online exam registration, submission of final paper topic and area of research, annual calendar, class schedule, as well as a variety of information.

In order to increase motivation and encourage continuous effort of distance learning students, diverse e-classroom activities were created, such as weekly-based assignment, essays, seminars, online assessments and self-assessments. E-materials referring the subjects that are processed with traditional students in the classroom, were published on a weekly base to distance learning students, in order to maintain the same course performance for traditional and distance learning students. eCampus provides statistics for the presence of each student on e-materials and overview of their activities in e-classroom. That feedback is very important for tutors that are dedicated to a specific group of distance learning students, and whose role is to continuously monitor and support their learning progress.

Since student-student and student-teacher electronic communication proved to be very important in blended learning, those activities were enabled in eCampus via forums, personal messages and chat rooms. Students usually communicate with other students, school administration and teachers in forums and via personal messages. eCampus communication module and web conference tool have the potential to bring distance students and teachers in common virtual space, build community and enable interactive and collaborative activities that facilitate the joint construction of knowledge.

Learning with the help of eCampus is an active process where the strategy of “learning by doing” leads the student to cognitively approach and work through the learning material and to create links between experiences, new and existing knowledge [9].

Final exams for distance learning students were carried out in the classroom, either as conventional tests, or in combination with practical tests on HW and SW, and/or project presentation.

#### 4. TECHNOLOGY FOR THE E-LEARNING

##### Development of e-content

For development and delivering of e-content, performing assignments, assessment, self-assessments and synchronous and asynchronous communication with distance learning students it is recommended to use an appropriate LMS/LCMS and additional authoring tools. eCampus LMS/LCMS enables development of e-materials through its own editor and import of SCORM-compatible content created in other authoring tools.

For the preparation of educational content at the College of Computer Science and Business Communication eMPIRICA are used: multimedia authoring tools, webcasting tools, animation tools, testing tools and PDF tools. Video-based educational resources are created using modern technologies, such as interactive smart board with audio recording feature, synchronized multimedia authoring tools and languages (SMIL), screen-casting tools and web-conference tools, as shown in the Figure 1..

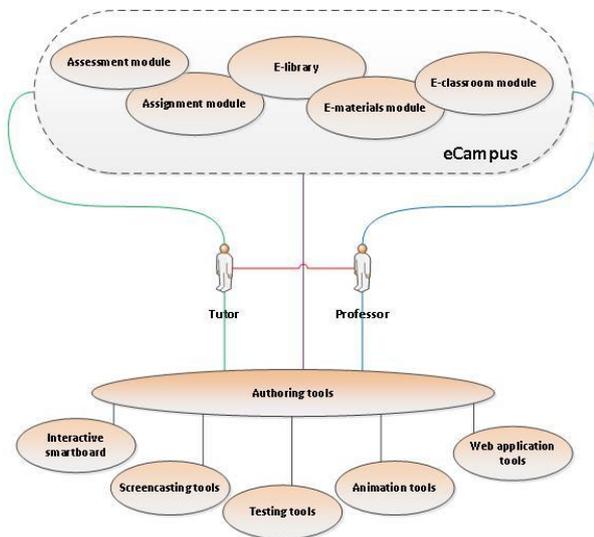


Figure 2. Technologies for educational resources developments

##### Conducting of e-learning

Web conference lectures were delivered using Cisco WebEx. Video-based educational resources that are developed using several authoring tools, as well as recorded WebEx sessions, were uploaded to the private YouTube channel and further embedded in e-materials, as shown in the Figure 2.

For conducting of e-learning classes the following eCampus modules were used: e-classroom module, module for synchronous and asynchronous communication and notice services, assessment module, assignment module and e-library, in addition with web-conference tool, Cisco WebEx.

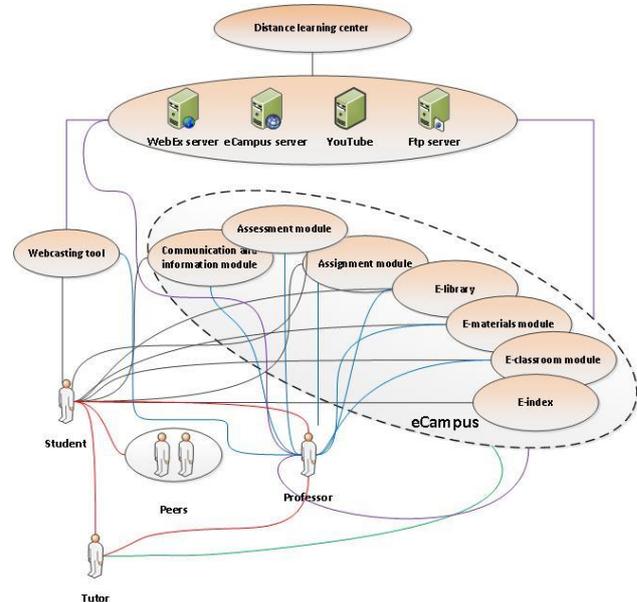


Figure 2. Technologies for conducting classes on distance

Some lectures were performed via web conference system, in order to achieve greater involvement of distance learning students in the educational process.

Web conference system enables the creation of the virtual classroom, through which students attend classes from their own locations. Both full-time and distance learning students are able to attend this virtual classroom from their homes or work. For distance learning students some lectures during the semester are organized in class, face to face, when implementing tutorials and mandatory lab exercises on the real equipment.

Integrating technology into classroom instruction means more than teaching basic computer skills and software programs in a separate computer class. Effective tech integration must happen across the curriculum in ways that research shows deepen and enhance the learning process. In particular, it must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts. Effective technology integration is achieved when the use of technology is routine and transparent and when technology supports curricular goals [10].

The goal of the modern technologies introduction in the teaching process is to improve digital competence and communicational skills of both, students and teachers.

The reason for creating different forms of educational content comes from the fact that students learn faster and achieve better results by using different types of educational content for different types of students

learning styles. In digital age students want to have access to content using technology that best suits. Limiting the student in terms of the technology used, can result in poorer outcomes and in a lower studying interest.

On the other hand, when students have the ability to use large a variety of different educational contents, resources and technology in the process of course material mastering, we can expect from them better results and greater motivation.

All these modern resources can't completely replace other teaching resources, such as textbooks, students' engagement, practical assignments and hands-on activities, but they are represented as support for achieving more efficient education and better student results.

## 5. EVALUATION

Evaluation is an important element, that shows us the ways, how to improve the use and efficiency of ICT, for blended learning. In order to estimate the efficiency and usefulness of technologies used in development of learning resources and conducting classes, an anonymous survey, as part of Digital Systems course, was done with the first year of Engineering Informatics students at the College of Computer Science and Business Communication eMPIRICA. Their feedback has been used to acquire the following information: whether the developed e-content and modern technologies used in the course influenced studying motivation, helped in faster mastering of coursework, how it changed their approach to studying and also which e-content and software tools are the most suitable and useful for learning. The survey consisted of 11 questions and several types of these questions were made: single answer (Yes-No answer) questions, multiple-choice questions, ordinal 1-5 scale questions and textual questions. Three generations of students, that attended the Digital Systems course took a part in carrying out of this survey.

Taking into consideration the feedback from students it can be concluded:

- Regarding the questions about, whether the developed e-content and modern technologies used in the course changed students approach to studying, influenced studying motivation and helped in faster mastering of coursework, 76% of them considered that e-content and technologies have changed their studying approach, 83% of them confirmed that it helped them in faster mastering of coursework and the same percentage of students believe that by using the e-content and modern technologies they had higher motivation to learn better. Considering the results of the statements, as well as textual responses in which they have suggested advantages and disadvantages of e-content, we ascertained the great satisfaction of students with the developed e-content thanks to their accessibility, transparency and richness in various media kinds. As suggestions for further improvement of e-content, these students suggested the introduction of a higher degree interactivity.
- As the most useful e-material, according to the speed

of coursework mastering, the students pointed out e-books (overall grade 4.2) while the following e-materials were evaluated with the same overall (4.0) grade: ppt content, interactive smart board with audio recording feature and eCampus e-materials.

- The largest number of students found personal messages (overall grade 4.2), e-materials and interactive smartboard with audio recording feature as the best contents and activities on this course (score overall grade 4.1), Figure 3.

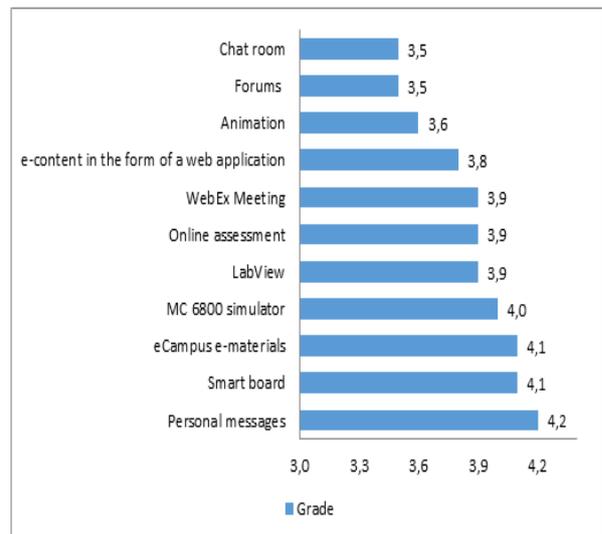


Figure 3. Overall grade for study resources and tools

## 6. CONCLUSION

Through detailed analysis of various blended learning models and their characteristics, and the way in which ICT can be applied to prepare the content for teaching and learning, we can conclude that blended learning includes not only the development and delivery of electronic content, but it allows you to create a new, modern learning environment for students and teachers, that can be realized in both, traditional and virtual classrooms. In both cases these environments are aided by the use of modern ICT.

Based on the analysis of theoretical basis, the advantages and disadvantages of traditional and e-, which are the components of blended learning, we developed blended learning model at the College of Computer Science and Business Communication eMPIRICA that is described in this study.

Due to the dominant role of e-learning in the developed blended learning model, this study describes how to use ICT for preparing of the educational resources and performing e-learning, as well as the methods that are used to motivate distance learning students for active and continuous participation in the educational process. The usage of technologies in education process has great importance, because of many reasons. Some of them are: development of technical competence, listening and presentation skills, and understanding of how the new media affects social and professional dialogue. In order to

improve the learning outcome, teachers should use their creativity, especially when using web conference technology, to save their valuable session time, and use it for more interactive discussions and activities.

Based on the positive feedback of students, regarding the e-materials and the use of technology for conducting of F2F and online activities, it can be concluded that it is necessary to continue with the ICT inclusion in the educational processes, especially when it comes to blended learning. It is also necessary to invest more funds into new technology and to raise the digital competence of teachers.

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