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## **Blended Learning Approach Applied to Electrical Engineering Courses**

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### **Abstract**

*The review paper is about how to Using Blended Learning Resources in Electrical and Computer Engineering Programs on the Moodle Platform of "Gheorghe Asachi" Technical University of Iași. Virtual environments for training and learning process based on Blended Learning methodology are highlighted. This paper presents elearning instruction materials for electrical engineering undergraduates developed on the Virtual Learning Environment <http://moodle.ee.tuiasi.ro>.*

**Keywords:** Blended Learning, Engineering Education, e-Pedagogy, Moodle

### **1 Introduction**

Traditional models of teaching (one-to-many communication supported with one-to-few encounters) do not sustain the quality of learning and teaching. e-Learning used creatively and effectively can offer support, maintain and enhance learning process. For training and learning process improvement dedicated to engineering students as one of the components in the foundation technological program has been a challenging task to engineering lecturers.

The article presents the concept of using current pedagogical methods based on the analysis of the advantages of teaching model in the network environment (Christiansen and Weber, 2017). The instructor's role in a networked learning environment changes: From lecturer to consultant, guide, and resource provider; Teachers become expert questioners, rather than providers of answers; Instructors become designers of student learning experiences rather than just providers of content; Instructors provide only the initial structure to student work, encouraging increasing self-direction; Instructors present multiple perspectives on topics, emphasizing the salient points; From a solitary instructor to a member of a learning team(reduces isolation sometimes experienced by instructors); From instructors having total autonomy to activities that can be broadly assessed; From total control of the teaching environment to sharing with the student as fellow learner; More emphasis on sensitivity to student learning styles. Also, the student's role in a networked learning environment changes: From passive receptacles for hand-me-down knowledge to constructors of their own knowledge; Students become complex problem-solvers rather than just memorizing of facts; Students see topics from multiple perspectives; Students refine their own questions and search for their own answers; Students work as group members on more collaborative/cooperative assignments; group interaction significantly increased; Increased multi-cultural awareness; Students work toward fluency with the same tools as professionals in their field; More emphasis on students as autonomous, independent, self-motivated managers of their own time and learning process; Discussion of students' own work in the classroom; Emphasis on knowledge use rather than only observation of the instructor's expert performance or just learning to "pass the test";

Emphasis on acquiring learning strategies (both individually and collaboratively); Access to resources is significantly expanded

As in all courses, the quality of the instructional planning maximizes the learning for all students. In the Web environment, the components of a course website, which enhance teaching and learning and save time by being posted for students to access online, are especially valuable. At the most basic level, instructors can post content and announcements at a course website. However, course planning usually begins with a course map – an outline of topics, weeks, objectives, activities, assignments, and assessments to show alignment of course components with each other in a weekly calendar format. Planning also includes the purposeful design of activities to create a student learning community – supportive student groups in a course that develop with the students' active access, pursuit, generation, and evaluation of information and learning in their discussion, chats, and e-mail communications.

### **2 Blended-Learning Concept for Basic Lectures in Electrical Engineering**

From a didactical perspective lectures with such large number of participants have particular shortcomings: differences in prior knowledge, in types of learning or in speeds of comprehension cannot be accounted for. Only minimal or at least no interaction related to the subject matter is taking place during each session in the lecture hall and students are driven into a consuming attitude. Usually no timely feedback to individual problems in comprehension or learning performance is available to the students. (Winterstein, T., et. al. , 2012). So, to achieve a good learning performance and learning outcomes, students had to be highly intrinsically motivated. Yet, in this case, the contrary is the truth for the majority of lecture attendees, since students are coming from other disciplines than electrical engineering and attending the lecture mostly for the single reason that it is prescribed by their study plans.

These problems were addressed by four main aspects for the new concept.

- 1) All-time accessible material that follows the curriculum and can be autonomously as well as repeatedly used allows self-study according to the individual skills and background knowledge
- 2) Elements with direct feedback shall allow control of the personal learning progress on a regular basis.
- 3) New and different learning elements shall create an incentive to continuously stick to the lecture and lower the inhibition threshold to electrical engineering.
- 4) The material has to be transparently organized, but administration effort needs to be kept low enough for one person to manage the lecture.

To increase the flexibility of learning time and place, provide individual learning opportunities and thus support more self regulated learning on the one hand, and to address typical difficulties in comprehension, raise motivation and improve the learning experience on the other hand, e-Learning elements were chosen to complement the traditional lecture.

Amendatory material was added to give background knowledge and motivation, addressing incentive aspects as well as direct feedback. The educational material as well as organizational aspects of the lecture is administrated in on central online platform.

### **3 Planning the Components of a Website**

As in all courses, the quality of the instructional planning maximizes the learning for all students. In the Web environment, the components of a course website, which enhance teaching and learning and save time by being posted for students to access online, are especially valuable (Jiménez-Castañeda et al., 2018).

Course planning usually begins with a course map – an outline of topics, weeks, objectives, activities, assignments, and assessments to show alignment of course components with each other in a weekly calendar format, Figure 1.

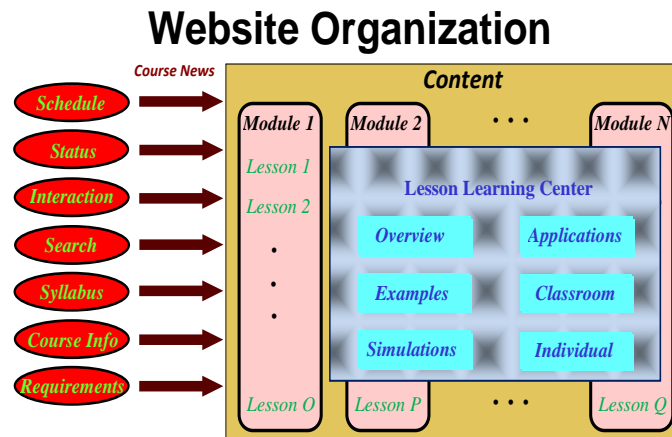


Fig. 1. Web site organization diagram

Planning also includes the purposeful design of activities to create a student learning community – supportive student groups in a course that develop with the students' active access, pursuit, generation, and evaluation of information and learning in their discussion, chats, and e-mail communications.

Course content is aligned with curriculum standards, objectives, assignments, assessments (Adascalitei, A. A., 2006).

- **Course Syllabus.** The course contains a syllabus and supporting documents. The course includes items such as: course title; correct course semester; course description; course contact and credit hours; course prerequisites; course objectives; course assignment; course test schedule; required course materials; grading criteria; testing information; library resources; any on-campus requirements; work ethics information.

- **Staff Information.** The course contains staff information: instructor name; appropriate picture (optional); e-mail address; telephone and fax numbers; office hours

- **Student Information.** The course contains a student orientation and explains: how to get started; technical equipment requirements; technology competency requirements; browser recommendations; drop deadlines; format for assignments; requirements for chat room and/or e-mail; instructor response time; troubleshooting advice.

- **Course Calendar –** Due dates for readings, activities, assignments, quizzes, and exams

- **Assignments and Activities,** including directions and due dates. Course assignments are designed: to be interactive and requires students to interact with: each other and their instructor via e-mail, chat room, and/or discussion board; and to address a variety of learning styles through: written assignments; reading activities; discussions; simulations; case studies; and give students the opportunity to engage in critical and abstract thinking.

- **Course Documents –** Additional documents for reference or study or answers to frequently asked questions. Course document section includes a variety of learning media. Includes course content delivered through media such as: PowerPoint presentations; Short lectures in audio or video format; links to resources on websites; CD-ROM materials.

- Lectures – Notes and audio to highlight key concepts of course content Caution: For face-to-face classes with web-enhancement, faculty may wish to include required assignments, even if minor, for extra points to be turned in at the scheduled class times or other incentives to maintain class attendance.

- Communication Tools – Areas for sending and receiving e-mail, participating in group or class discussions about particular issues, keeping electronic journals, completing “dry or simulated lab” exercises to prepare for “wet or real lab” experiences, or engaging in chat sessions.

- Student Tools – Areas for using a digital drop box to send and receive completed papers, homepages, or personal profiles of students, and access to grades.

- Assessment Tools – Areas for quizzes, exams, and surveys; online grade books; and assessment statistics. Course assignments are designed to be interactive and require students to interact with: each other and their instructor via e-mail, chat room, and/or discussion board.

#### **4 Using the Moodle Platform in Class**

Moodle is a tool which enables instructors to create a website environment for your class with online activities such as forums and quizzes. “Moodle is a Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It is a free web application that educators can use to create effective online learning sites.” (<http://moodle.org/>)

The web application was designed for a course entitled “Fundamental of electrical circuits (FEC)” which was a core module offered to engineering students. The front webpage provides the overall course content of the FEC module with the names of the chapters, followed by the activities in a drop-down list for each chapter. The activities involved in each chapter include: course materials, additional materials, quizzes, open forum/chat and latest news message/calendar (Zhang and Sun, 2017).

Teaching electrical engineering laboratory procedures by means of a virtual laboratory on a personal computer will be much welcome by educational institutions for whom maintaining a hands-on electric engineering lab is not viable due to various reasons. Instructional laboratory simulations can be incorporated in the virtual laboratory resources where students are free to make the decisions they would confront in an actual laboratory setting (Aradoaei et al., 2005; Beetham and Sharpe, 2013).

There are a total of four chapters in FET with different topics. Each of these chapters has plenty of information and activities related to the topic. This includes the course materials in the form of PowerPoint slides and Acrobat PDF documents, which are the duplicates of hand-outs that the students received in class. It is important to provide a softcopy to the students, as it is coloured compared to their hardcopy and helps better in comprehending complex figures or diagrams.

Nowadays students are very much visual learners (Ng et al., 2017). The majority of the students expressed the strongest preference to visual learning style compared to other learning style dimensions. This implies that engineering students are strongly depending on visual learning environment. Video is clearly a valuable additional learning activity that provides a sensory experience that allows concepts and ideas to actually become alive and connected. It has the option to rewind and review a particular section of the video to ensure students understand the key concept. Thus, free educational video sharing websites that explained the FET theories were uploaded in the webpage. In addition to this were video links from YouTube.

Apart from this, problems and solutions as well as simplified diagrams explaining complex concepts, taken from textbooks or take-home questions which were not discussed in class, were made available online for students. In each of these adapted materials, references were stated clearly in order to allow students to seek the original sources if the need arises, apart from avoiding copyright infringement (Svoboda, Špaldonová, and Guzan, 2006).

#### 4.1 Learning Process

##### *Before Attending Class:*

- Explore the Overviews & Theory, Examples, Applications, and Simulations sections for the Lessons to be covered in the Classroom Activities, Figure 1. (See Schedule).
- Complete Language Quizzes for Lessons to be discussed in class.

##### *Classroom Activities:*

- Attend class!
- Be prepared to contribute!
- Active learning environment with team-based problems solving.
- Web ready solutions from each team are due by the end of the week (Friday at 5 pm.)

##### *After Attending Class:*

- Complete team-based analysis and design problems assigned in the classroom activities.
- Optional analysis and design problems are available on the website.
- Complete the Integration Quizzes for Lessons covered in class.

Quizzes were incorporated in each chapter for students who were keen to self-test their knowledge and learning after the revision of a chapter. Short quizzes in the form of true/false, multiple choice, short answers or numerical questions were assigned, depending on the chapter content. The majority of the questions were of problem solving type that involved calculation with pre-determined specific units and significant figures of the numerical answers. Positive responses were provided if the students were successful in answering the questions. However, there was no time limit to answer each question as the students were given sufficient time to read and understand the questions, and to answer calmly at their own pace.

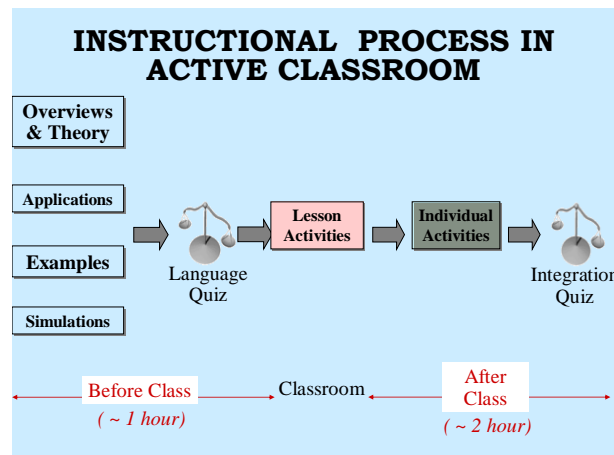


Fig. 2. Instructional process in Blended Learning Environment.

Since the quizzes were not part of the students' assessment, it was considered as an independent study at the students' own will. Hence, the quizzes were designed with a due date of two weeks, in order to encourage the students to have a constant revision and to avoid last-minute cramming before examination.

Open forum serves the purpose of allowing a student to post his/her questions or doubts and can be viewed by their fellow peers. This allows the lecturer to disseminate the answered questions to the whole class without repeating in the classroom. Hence, each of the chapters was constructed

with their very own Open Forum. Students were also encouraged to use the chat function that facilitated live discussion and interaction with their instructors and peers.

Another interesting feature of Moodle is the function on the right of the webpage which allows the lecturers to post any new messages. It also comes with the list of recent activities so that students can keep-track with any updates. General announcements such as due date of assignments, examination dates and venues, replacement classes etc. were posted at this section and these were linked to the students' email accounts, so that they were notified of every update studies.

#### 4.2 Learning scenario for Course “Fundamental of Electrical Circuits, FEC”

The course was organized in blended mode with support of e-learning environment Moodle. The scenario for course “FEC”, Table 1 are stressed on the use of SCORM compatible interactive and simulation learning objects combined with practical problem solving in “face to face” mode and development of assignments in online mode.

**Table 1.** Learning scenario schema of the course “E-Learning technologies”

<b>Face to face activities</b>	<b>Online activities and resources</b>
Workshop – Topic 1 (2 hours) <ul style="list-style-type: none"> <li>• Demonstrations by the tutor</li> <li>• Solving Tasks with resources prepared in advance and published in the online course (all task are implemented in the e-learning environment)</li> </ul>	Home work (1) <ul style="list-style-type: none"> <li>• Preparing home work – solving tasks in their own Learning Project</li> <li>• Using of SCORM compatible simulations.</li> <li>• Discussion</li> </ul>
Workshop – Topic 2 (2 hours) <ul style="list-style-type: none"> <li>• Discussions about home work from previous session</li> <li>• Demonstrations by the tutor</li> <li>• Solving Tasks with resources prepared in advance and published in the online course (all task are implemented in the e-learning environment)</li> </ul>	Home work (2) <ul style="list-style-type: none"> <li>• Preparing home work – solving tasks in their Learning</li> <li>• Using of SCORM compatible simulations.</li> <li>• Discussion</li> </ul>
Workshop – Topic 7 (2 hours) <ul style="list-style-type: none"> <li>• Discussions about home work from previous session</li> <li>• Demonstrations by the tutor</li> <li>• Solving Tasks with resources prepared in advance and published in the online course (all task are implemented in the Moodle platform)</li> </ul>	Home work (7) <ul style="list-style-type: none"> <li>• Preparing home work – solving tasks in their own course</li> <li>• Using of SCORM compatible simulations.</li> <li>• Discussion</li> </ul>
Assessment: 1. Developed individual assignments; 2. Performance of the assignments in front of all students	

The course was organized in blended mode with support of e-learning environment Moodle.

The students had 14 hours lectures and 7 hours exercises in “face to face” mode and around 30 hours for development of own e-learning course in Moodle. During the lectures they learned mentioned above topics of the course. During the face to face exercises the students mastered basic techniques for solving problems and performing virtual experiments. They worked under supervising of the tutor with resource files, prepared in advance by lecturer and used on-line

simulations and demonstrations. To master basic skills for development of e-learning course all students followed common tasks.

The tasks were related to: 1. Using learning resources - web page, link to file or external web resource, label; 2. Using and management of learning activities –assignment, lesson, test, forum, blog, wiki; 3. Questionnaire etc.; 4. Management of students – grouping, assigning students to activities and resources.

The students were grouped approximately 5 students per group. Each group was assigned to one common e-learning course activity. During the face to face exercises students used resource materials offered by the teacher to learn basic techniques and functionalities of the e-learning electrical engineering environment. Also they had a possibility to use SCORM based e learning demonstrations and simulations. Each student in role of “teacher” could assign another student in her/his course like “a student”. In this way another students have a possibility to be enrolled in the course with student rights and could observe work of their colleagues.

### **5 Effectiveness of e-learning within Universities**

This paper describes a methodological framework consisting of factors necessary for assessing the effectiveness of e-learning within Universities.

An e-learning framework comprises eight dimensions namely: pedagogical, technological, interface design, evaluation, management, institutional, resource support, and ethical.

Effectiveness of blended e-learning can be determined by evaluating four main dimensions, namely: E-learning Readiness, E-learning Course Delivery Strategies, Quality E-learning Systems and Effects of Blended E-learning.

E-learning Readiness (in terms of costing and budgeting, policies, support, cultural awareness, and infrastructure) have an influence on the quality of elearning systems and e-learning course delivery strategies, which in turn have an impact on the effectiveness of blended e-learning.

To ensure effective blended elearning, that review paper propose a framework that focuses on having a well balanced mix of effective pedagogy in elearning course design and delivery, relevant institutional readiness for e-learning and use of quality e-learning systems to meet institutional and student learning goals.

### **Conclusions**

This paper presents e-learning instruction materials to develop on the Virtual Learning Environment <http://moodle.ee.tuiasi.ro/>. Processes of: design, development and implementation of interactive educational modules are presented, for the topic of electrical engineering.

The modulus is divided into a number of teaching and learning units which can be studied autonomously (or independent). Fundamental of Electrical Circuits (FEC) discipline model is a new approach to learning electrical technology-one that presents concepts in the customary logically developed order but illustrates them with exemplars that reflect the applications students are interested in (<http://www.walter-fendt.de/ph14ro>, accessed 2018; <http://electronics.wisc-online.com/>, accessed 2018). eLearning modules are using visualization of electrical engineering concepts. These principles focus on a few specific pedagogical pointers: 1) providing multiple representations and descriptions; 2) making linked referential connections visible; 3) presenting the dynamic and interactive nature of electrical engineering; 4) promoting the transformation between 2D and 3D; and 5) reducing cognitive load by making information explicit and integrating information for students (<https://www.wisc-online.com/learn/technical>, accessed 2018).

This paper is a synthesis that presents how use Moodle Virtual Learning Environment for the development courses which mainly contains materials in order to educate the Engineering Students. There exists a greater acceptance of the online mode of instruction as an adjunct to learning. Their positive attitude was observed towards the model of blended learning approach,



and Moodle platform did create a positive impact on students' learning experiences in terms of the accessibility of learning materials and the support of online assessment activities.

Although the students agreed that the hybrid learning provided them with the needed assistance, one of the drawbacks observed was that this method of delivery was prone to become a one-way communication. Communication tools such as forum discussion and online chat room have the features that create interaction with instructors and among the peers. However, most students are likely to participate in the learning practices only if the activities are considered as part of the evaluation of their academic performance. It is therefore necessary to assign grading procedure in e-learning activities to increase students' participation. With the improvements at these loose ends, Moodle application in Electrical Engineering will be an invaluable and imperative tool for the instructors as well as for the students (<http://phet.colorado.edu/en/simulations/translated/en>, accessed 2018; <http://moodle.ee.tuiasi.ro>, accessed 2018).

The development of courseware materials for student engineers in Romania will have an increasing impact on the national scene of Engineering Education, and the development of online materials devoted to the development of human resources and human potential will accelerate the process of transfer of up-to-date technology.

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