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BLENDED LEARNING AND ITS APPLICATION TO POSTGRADUATE EDUCATION

BY

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Abstract. In recent years, with the advances of the Internet and *e*-learning technologies, a blended mode of learning, which effectively combines the traditional face-to-face learning and *e*-learning, has evolved. Yet, this blended learning mode is not widely adopted in higher and postgraduate education in engineering. One major reason is that teachers are not familiar with the practices of designing courses under the blended learning environment. Another important reason is that a big number of teachers do not consider the *e*-leaning methodologies as stable and functional enough for engineering, especially for laboratory and project task completion. This paper presents the blended learning methodologies and the manner they can be customized for both MSc and PhD programmes in engineering.

Key words: postgraduate education; blended learning; engineering education.

1. Introduction

Huixin (2010) presents both conventional classroom teacher-centered teaching and the *e*-learning mode with their advances and deficiencies and suggested a new teaching mode by integrating advantages of the two together. The basic model of traditional English classroom teaching (“PPP” model –

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presentation, *practice* and *production*), where the teachers have the control of the educational act and identified some learning issues is also described. The most important issues regard the student's learning autonomy as well as the students' participation in learning process. Network teaching system offers wider space for teaching, creating colourful and vivid multimedia application learning environment, which is of great help to the establishing of student-centered, autonomous, creative learning model (Huixin, 2010). Even if using classroom-based and computer-based learning concepts as separated educational directions the results in the human sciences are visible.

Engineering consists of lecture attendance, project development, hands-on laboratory-based activities and computer simulation work. That way the educational act can be considered as learner-centered. (Manseur, 2010) presented the synchronous distance learning concept (SDL) and its applications to Electric and Computer Engineering and Mathematics. Students follow lectures live *via* videoconferencing but they attend laboratory sessions taught by on-site faculty. The advanced technology has been used for linking the local and the remote classrooms: the tutor teaching in one location is videotaped and can be seen on a TV screen in the other classroom live. The hands-on experimentation is difficult to conduct without access to often expensive equipment and components and competent on-site laboratory tutors. In order to complete the lab SDL environment consists of two sets of fully equipped and staffed laboratories, one on each end of the SDL-connected campuses (Manseur & Manseur, 2009).

Qui (2010) presented a blended learning environment that implements the face-to-face teaching and *e*-learning capabilities in Advanced Software Engineering. A set of integrated projects was selected as stimulus to learning. Both inter- and intra-group collaborative learning are encouraged. A survey conducted at the end of the course showed that students accept the problem-based learning quiet well, and their academic achievements were also better than expected. The methodology consists of grouping student in teams, dividing the semester in project phases and developing the project using iterations (Qui & Chen, 2010).

In that paper, the authors underline the blended learning methodologies and the manner they can be customized for both MSc and PhD programmes in engineering. After a suggestive introduction in blended learning, its models to be applied in postgraduate education will be presented. Two important aspects are taken into consideration: how to improve the retention factor in the individual study and how to support fundamental and applied research activities within individual, group-based projects or international partnerships. They are illustrated in the second and third sections of the cited paper. The task management features and remote access to laboratory equipments and applications are very important in postgraduate and training processes. The fourth part of the work presents the concepts and details the manner to remotely control and assist the students in different locations or mobility grants. In

conclusion, a technological analysis between the traditional *e*-learning platforms and advanced blended learning environments will be presented.

2. Blended Learning Models

From the teaching point of view six essentials can be identified: teaching subjects, teaching content, teaching environment, teaching models, teaching organizers and teaching administration. In order to improve their knowledge and skills the students (subjects) actively participate to both real and virtual educational acts. So, the learning service providers should pay attention to both teaching modes: face-to-face and Internet-based modes. The advances point out the manner of getting them together in order to expand the real educational environment and make the virtual platforms as an important part of the education system.

2.1. The Blended Learning Model for MSc Programmes

In MSc programmes the students are focused on research and career development activities. The educational schema consists of theory, hands-on experimentation, individual- and group-based projects, virtual team cooperation or mobility grants and it is defined around the following skills: information synthesis in theory and hands-on experimentation or online simulation, requirement analysis, project design, implementation, or result presentation. The blended learning model illustrated in Fig. 1 proposes the following needs in the

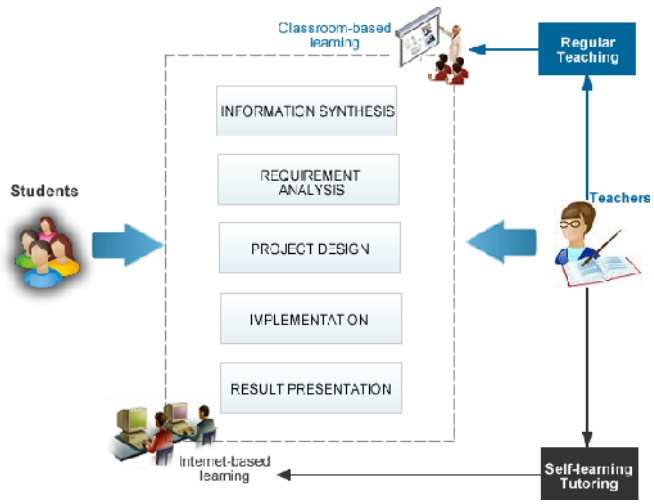

Fig. 1 – Teaching model in MSc programmes.

educational act: regular teaching, self-learning and tutoring and Internet-based learning. IT&C is important in education: even regular teaching involves the advanced technology (presentations, video projectors, etc.) and self-learning

means individual study starting with educational materials teachers created and posted onto the *e*-learning platform then browsing the Internet to find and select correct information about the interesting subjects.

Online tutoring approach consists of interactive tutorials and face-to-face Internet-based learning. Interactive tutorials can be used as introduction in hands-on experimentation activities and face-to-face Internet-based learning can be used for online classrooms/webinars and remote assistance during the projects or mobility grants.

2.2. The Blended Learning Model for PhD Programmes

Blended learning is not new. What is new is the recognition of its potential to help fundamentally redesign the learning experience in ways that can enhance the traditional values of higher education and postgraduate scholarship (MSc and PhD programmes). Preparing PhD students using a blended strategy can be challenging, since it requires acquiring different teaching skills and technologies. Redesigning the educational process takes new teaching and learning opportunities, managing the educational content both online and in-class, and preparing PhD students to work in a hybrid format into account.

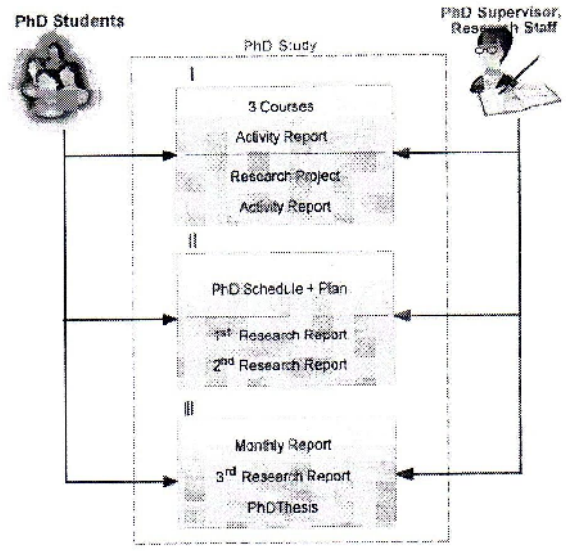

Fig. 2 – ESF-based PhD schedule.

In Romania the PhD scholarship based on European Social Funds (ESF) constrains the students to complete their PhD in three years, so, the activities should be well-defined and supported by clear results. This aspect completely changed the PhD methodology (illustrated in Fig. 2) and for the moment the PhD students must be integrated within research projects and work close to real

and efficient research teams. Most of the research projects comply with Agile methodologies, so, the authors propose the blended learning approach and Agile methodologies to be implemented in the PhD scholarship based on ESF Funds.

The PhD programme means theory and practice and research activities with their results to be published in scientific journals and conference proceedings. That way, the problem- and project-based learning should be considered as necessary. The Technical University of Cluj-Napoca provides with PhD programmes in the following domains of interests: Automation, Computer Science, Electric Engineering, Applied Electronics and Telecommunications, Civil Engineering, Mechanics, etc. With the big number of domains and the increasing number of MSc and PhD students, the blended learning environment that supports MSc and PhD activities should be both horizontally and vertically scalable. So, an elastic learning cloud infrastructure should be implemented.

3. Effectiveness of Blended Learning

In the classic blended learning model, teachers assign teaching tasks, conduct regular lectures, or train students' skills. The students attend the online autonomous learning act and cooperative learning sessions, or accomplish teachers' assignments. The teachers make assessments over students' learning effect and solve their problems. So, teachers set objectives and tasks of different levels, they put forward requirements and suggestions according to the teaching contents and make assessment to students' learning effects through task-based activities. Teachers also answer students' questions and offer essential teaching to major and difficult points. In addition, teachers can also use multimedia to supplement teaching contents. Of course teachers create flexible and diversified theoretical and practical scenarios and teaching contents, using authentic materials to let students come upon more technical information related to real problems/projects. Students work out their own learning plans, determining learning methods autonomously. They conduct on-line autonomous learning when they study each unit, finish its test *via* Internet and do some statistics to the test results. Teachers also encourage students to cooperate with each other to finish simple learning tasks or complex group-based projects. Through cooperative learning, students can not only acquire knowledge, their team spirit and coordination will also be fostered, skills in dealing with people will be improved and abilities to express themselves will be enhanced.

The effectiveness of the educational process consists of the following factors: the degree of students' satisfaction, retention factor, developed skills and students' enrollment. In the MSc and PhD programmes the technical and soft skills are considered as a priority and they are linked to the students' satisfaction and student enrollment. MSc and PhD studies in engineering are complex educational acts that need a high degree of interaction between students, students and teachers, students/teacher and educational resources/ research equipment. The motivation is high, students enroll in such programmes

with big interest, but even in that case, the activity management should be optimized because of the short period of time allocated for both study and research.

The PhD supervisors and teaching staff have an important role and their effort will be focused not just on providing educational content but also to assist the students in the research and development activities. When creating the educational content teachers should synthesize the information and package it in a compact format. The content of lectures and research approaches can be organized in modules, each one consisting in the theory (synthesized information) and the flashcard (auto-assessment). The theory can contain complex multimedia content improved by annotations and metadata. That way the individual study will be more effective and the results are immediately. The results of the individual tasks will be collected into activity reports assessed by teaching/research staff.

The big number of students registered in the postgraduate scholarship imposes the elastic learning cloud infrastructure. In order to attend the tutorial sessions and the simulation software packages the learning environment will be allocating parallel interactive sessions that support synchronous and asynchronous collaborative research and development. Agile methodology supported virtual teams, as well as virtual collaboration, that involve teachers and researchers, PhD and MSc students working on (inter)national co-operations, scheduling and conducting collaborative sessions, elaborating research reports, and publishing the results in scientific journals and conference proceedings.

4. Learning Cloud Environment

Laisheng (2011) presented the cloud learning approach as the migration of cloud computing technology in the field of *e*-learning in order to easily expose the educational resources. After these computing resources are virtualized, they can be afforded in the form of services for faculties, departments, students, even other universities or businesses to rent educational resources.

In the Technical University of Cluj-Napoca there are 3,019 MSc students and 1,432 PhD students registeded in 9 faculties and following different educational programmes. Not just the diversity of themes and interdisciplinary character of MSc and PhD recommend the implementation of a learning cloud environment. Another important aspect refers to research management during the PhD mobility grants where the knowledge transfer and approaching new technology represent priorities. The proposed learning cloud architecture (Fig. 3) can be divided into the following layers: *hardware resource layer* as a dynamic and scalable physical host pool, *software resource layer* that offers a unified interface for *e*-learning developers, *resource management layer* that achieves loose coupling of software and hardware

resources, *service layer* containing three levels of services (software as a service, platform as a service and infrastructure as a service), *application layer* that provides with content production, content delivery, virtual laboratory, collaborative research, assessment and management features.

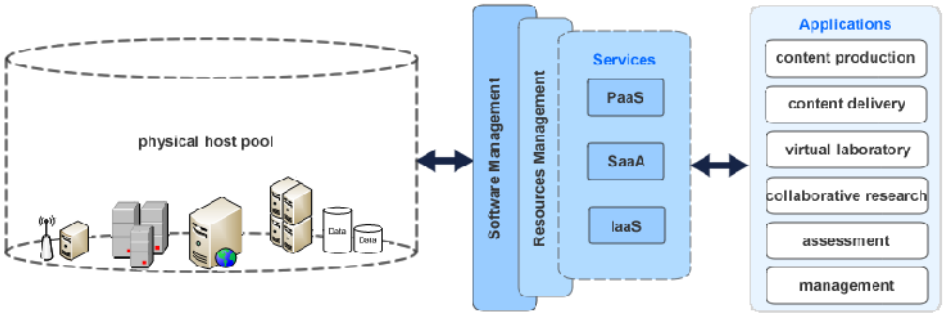

Fig. 3 – Learning cloud architecture.

Even for experienced PhD students is hard to be integrated in other research teams for 3…6 months, as well as continuing the collaboration with the PhD supervisors and the home teams. Learning cloud infrastructure allows the supervisors to control the research activities and assist the students during the stage abroad.

5. Conclusions

The paper surveys the blended learning methodologies and the manner they can be customized for both MSc and PhD programmes in engineering. After a suggestive introduction in theory, the blended learning models to be applied in postgraduate education will be presented. A demonstration of how effective is blended learning for postgraduate education is illustrated. The effectiveness of learning system is estimated based on retention factor in the individual study, fundamental and applied research support, task management features and remote access to laboratory equipments and applications.

The learning cloud architecture that supports blended learning for MSc and PhD programmes can be considered as the best solution for providing blended learning capabilities for faculties, departments, students, even other universities or businesses. If analysing the new learning cloud infrastructure with the related works presented in the paper, the advantages are really clear: individual study support, Internet-based collaborative learning features, online access to simulation software packages, collaborative research provided, project- and problem-based learning implemented.

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CONCEPTUL „BLENDED LEARNING" APLICAT PROGRAMELOR POSTUNIVERSITARE

(Rezumat)

În ultimii ani, odată cu îmbunătățirea continuă a serviciilor Internet şi apariția tehnologiilor *e*-learning moderne, s-a dezvoltat o nouă abordare privind actul de predare-învățare, prin combinarea educației tradiționale față-în-față cu cea online (blended learning). Pentru moment, această manieră de educație nu este pe deplin adoptată în învățământul superior, la nivel de ciclu de licență sau în programele post-universitare. Unul din motive porneşte de la premiza că un procent semnificativ de cadre didactice din învățământul universitar nu stăpânesc metodologiile de concepere, creare şi gestionare a suportului de curs pentru blended learning. La acesta se adaugă scepticismul cu care sunt privite metodele educaționale moderne, instrumentele *e*-learning fiind considerate încă instabile şi nefezabile pentru învățământul tehnic, în special pentru activitățile practice dsfăşurate ca proiecte de grup şi lucrări practice. Lucrarea de față prezintă metodologiile blended learning şi maniera în care acestea pot fi adaptate pentru programele masterale şi doctorale din domeniul ingineresc.

După o introducere sugestivă în blended learning, autorii definesc scenariile ce urmează a fi implementate de mediile educaționale virtuale dedicate programelor postuniversitare. Sunt vizate două aspecte fundamentale şi anume, îmbunătățirea factorului de asimilare a cunoştințelor pe parcursul studiului individual şi implementarea funcționalităților colaborative şi interactive pentru desfăşurarea activităților de cercetare în cadrul proiectelor individuale şi de grup, inclusiv parteneriate (inter)naționale. Gestionarea activităților practice, din care nu lipseşte accesul la distanță la infrastructura de laborator – echipamente, simulatoare şi aplicații, reprezintă o prioritate în învățământul postuniversitar tehnic. Aceasta este completată cu implementarea conceptelor de monitorizare a tinerilor ingineri în desfăşurarea activităților din cadrul programelor de mobilitate internațională. În partea de concluzii se urmăreşte elaborarea unei analize comparative a tehnologiilor *e*-learning existente momentan pe piață sau descrise în literature de specialitate şi prototipul propus în acest articol.