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INTERACTIVE LEARNING CONCEPTS IN HIGHER EDUCATION

BY

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Abstract. Most of the teachers in higher education consider the act of teaching/learning engineering as more than individual study and online assessment. The education process in engineering means theory and practice, individual study or experimental work that involves equipments, simulation/emulation software packages and laboratory applications. The traditional *e*-learning platforms consist of the learning management system, learning content management system, assessment and communication modules (especially forum and messaging). The third generation of *e*-learning platforms provides with advanced services such as online courses, tutorials and webinars. In order to develop *e*-learning platforms for higher education, especially engineering, new methodologies should be taken into consideration: project- and problem based learning, virtual laboratory (remote access to laboratory equipments and applications and task evaluation) or remote assistance for diploma projects and mobility grants.

Key words: higher education; blended learning; cloud learning; virtualization.

1. Introduction

According to Chandran (2010), *e*-learning applications can be based on commercial products or open source frameworks. Commercial products, like

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Blackboard, are widely used in universities, even if the initial cost of procuring the software is very high. Due to technical support from the vendor, the implementation time is quick, but we need to take into consideration an ongoing maintenance cost. Moreover, once an educational institution is locked with the vendor, it is difficult to move to a different vendor. Open source *e*-learning applications, like Moodle, are widely adopted by educational institutions. The initial cost of software is very low, but still there will be the cost of infrastructure and high learning curve to implement the solution. As this is open source based, 99.9% uptime/SLA (Service Level Agreement) will be hard to guarantee and the implementation process will take longer than using the commercial products (Chandran & Kempegowda, 2010).

Ouf (2011) referred to Web 2.0 as changing the World Wide Web from the original traditional publishing model of information into a collaborative information creation model. The great diffusion of Web 2.0 as new instrument has a strong effect and change on the way people search, find, collaboratively develop and consume information and knowledge. People are extensively using some of the Web 2.0 applications such as Wikipedia, YouTube and Twitter to create and share information. Cloud Computing presents a new way of deploying applications based on Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS) (Ouf *et al*., 2010).

In traditional web-based learning mode, system construction and maintenance are located in interior of educational institutions or enterprises, there left a lot of problems such as significant investment needed but without capital gains for them, which leads lack of development potential. In contrast, cloud-based *e*-learning model introduces scale efficiency mechanism, *i.e*. construction of *e*-learning system is entrusted to cloud computing suppliers, which can make providers and users to achieve a win-win situation (Xiao & Wang, 2011). There is no doubt that the future belongs to the cloud computing. This new environment supports the creation of new generation of *e*-learning systems that is able to run on a wide range of hardware devices, while storing data inside the cloud.

This work is organized in the following manner: the first part is a short functional analysis between traditional *e*-learning platforms and advanced virtual environments dedicated to technical higher education. The second part starts with the technological aspects and continues with the deployment diagram of the blended learning platform for technical education. The elastic cloud environment is presented in the third section of the paper. The experimental results, such as deploying the platform for "Applied Electronics, Telecommunications and Information Technology" and providing blended learning support for teaching/learning, practice and assessment processes, are highlighted in the fourth part. In conclusion, the authors underline the importance of software as a service, infrastructure as a service and platform as a service concepts in higher education by presenting a complex scenario for extending legacy *e*-learning systems in order to support blended learning capabilities.

2. Blended Learning and Cloud Computing in Engineering

Reichlmayr (2005) presented the blended learning pilot program applied in engineering and identified its great potential for improving the teaching/learning acts. In the list of benefits we can find: the increased access to a range of appropriate, individualized learning and teaching resources; the accommodation for learners and teachers of diverse ages, styles and cultures, which remotely access the educational services; the flexibility and cost effectiveness in terms of scalability, breadth, time, value and infrastructure; greater student and faculty satisfaction. In the pilot program, 25% to 50% of classroom lectures and other seat time are replaced by instructor-guided online activities, such as online quizzes, virtual team projects, synchronous chat sessions, and asynchronous discussions (Thomas, 2005).

Laisheng (2010) proposed a generic *e*-learning cloud and identified several challenges such as: charge, bandwidth, security, user's awareness and acceptance, educational forms and methods and resource development, and proposed solutions for each challenge (Xiao & Wang, 2011). By setting up a market-oriented charging mechanism, and combining two types of fees: school fees and individual fees, with school charging for general resources and individual charging for special resources can be considered a solution. The bandwidth problem is almost fixed in Romania because RoEduNet and most of the Internet service providers developed peering networks. In order to keep the integrity and confidentiality of data an encryption mechanism should be implemented for both storage and transmission. The *e*-learning cannot completely replace teachers; it is only an updating for technology, concepts and tools, giving new content, concepts and methods for education, so the roles of teachers cannot be replaced. The teachers will still play leading roles and participate in developing and making use of *e*-learning cloud.

From the beginning, the role of blended learning was to improve the educational process by increasing the degree of students' satisfaction, retention factor and students' enrollment and developing students' skills. In higher education, especially engineering, the blended learning is a need because of the diversity of teaching/learning activities. The quality of learning can be considered another important aspect, so increasing number of students enrolled should not affect the educational process. The learning cloud means reliability and scalability, as well as cost effectiveness.

The proposed learning cloud architecture, illustrated in Fig. 1, 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, platform as a service and infrastructure, each one as a service), *application layer* that provides with content production, content delivery, virtual laboratory, collaborative learning, assessment and management features.

Blended learning approach in engineering will based on the *e*-learning cloud paradigms: Infrastructure, Platform and Software, each one as a service. Software as a Service is used to deliver applications to the browser of user or customer from the learning cloud. It helps the faculties and departments with limited IT resources to deploy and maintain needed software in a timely manner while, at the same time, reducing energy consumption and expenses. Platform as a Service facilitates development and deployment of applications such as laboratory simulation software packages without the cost and complexity of buying and managing the underlying infrastructure (hardware and associated software). Infrastructure as a Service get on-demand computer infrastructure (virtual desktop or data center, *e.g*.).

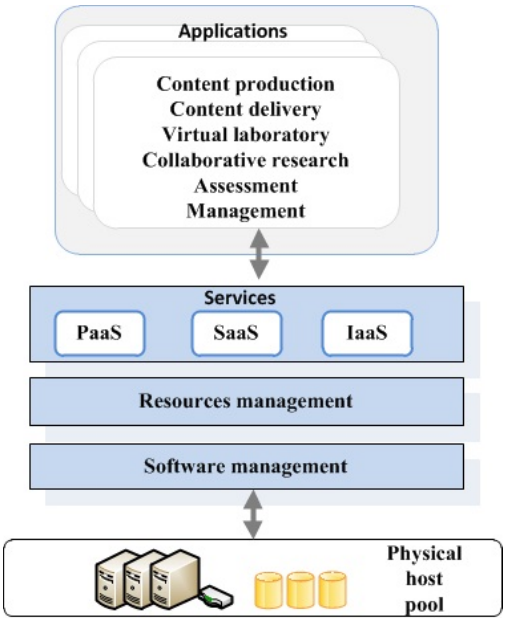

Fig. 1 – Learning cloud architecture

The real testing of learning cloud includes the students enrolled in applied electronics and telecommunications, Faculty of Electronics, Telecommunications and Information Technology, at the Technical University of Cluj-Napoca. We considered the students in third and fourth years of studies and proposed a learning cloud environment built around Citrix XenServer. XenServer is an enterprise-ready, cloud-proven virtualization platform that contains all the capabilities required to create and manage a virtual infrastructure and provides an efficient management of Windows and Linux virtual servers and delivers cost-effective server consolidation. The initial setup, illustrated in Fig. 2, must support the teaching/learning activities and practice.

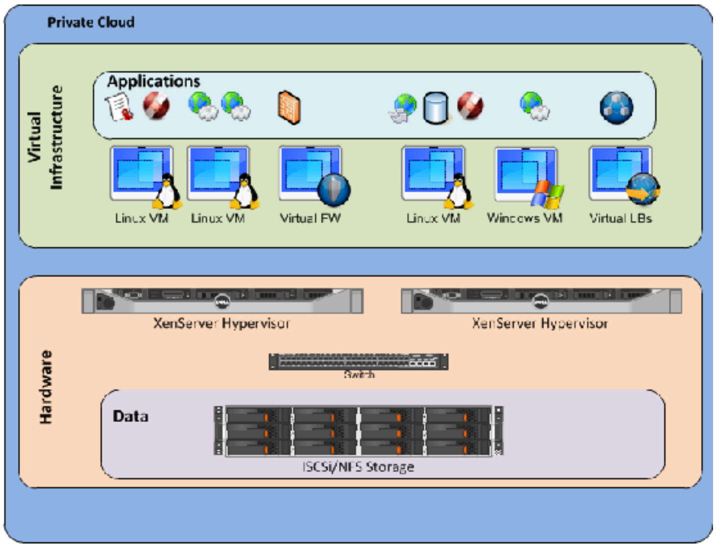

Fig. 2 – Deployment diagram.

3. *e*-Learning Cloud Setup

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, they create flexible and diversified theoretical and practical scenarios and teaching contents, using authentic materials to let students to 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 cannot 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. In applied electronics, telecommunications and information technology, the learning environment also provides with hands-on experimentation work, simulation software packages and semester/diploma projects.

The setup is built as an elastic environment that starts with eight virtual machines at the initial point: two allocated for web hosting, two for the data warehouse, two for media hosting and two for the virtual library. The learning management system allows the students to schedule online laboratory activities. The resource pooling mechanism dynamically allocates twenty virtual machines when the first student scheduled a virtual laboratory session. When fifteen of these virtual machines are allocated, the resource pooling mechanism allocates other twenty. Just the simulation software package needed for completing the tasks will be loaded in the virtual machine. The activity starts with an interactive tutorial when the tutor describes the tasks and gives some suggestive examples related to the practice. At the end of the practice, the student saves the own work then the tutor can verify it. If the tasks are not properly done, the tutor notifies the student to repeat the work or attend a collaborative session in order to fix the problems together. Fig. 3 illustrates the educational flow supported by learning cloud environment.

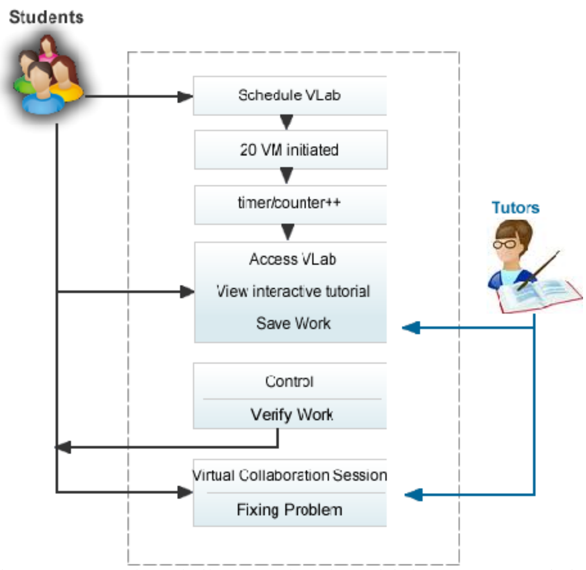

Fig. 3 – Functional diagram in virtual laboratory module.

The online access to virtual laboratory infrastructure is realized according to a well-defined schedule. It is almost impossible to be able to allocate one virtual machine for each student enrolled in the program. So, the students will access the virtual laboratory in groups of ten students. At the same time we can have ten virtual machines to be allocated for each field/line of study.

4. Experimental Results

The prototype will be implemented in the Technical University of Cluj-Napoca, Faculty of Electronics and Telecommunications, for third and fourth years of study, where 510 students are enrolled. One of the pilot courses, “Multimedia Technology”, involves 50 students in the fourth year of study, Romanian and English lines of study. The virtual educational environment will provide with classroom-based lectures, online course, interactive tutorials, virtual laboratories (especially access to simulation software packages), problem- and project-based learning, and remote assistance for semester and diploma projects.

A complementary tool that allows the lecturer to dynamically handle the educational content is integrated into the learning cloud. Two types of educational content are stored into *virtual library*: public and private content. If the lecturer considers one of his/her materials as really important for the public interest, that material will be uploaded on the server, convert to an internal format (SCORM compliant) and stored into the virtual library as a public material. If the material is private or the lecturer has no rights to make it public, it will be converted to the slideshow format and then stored into the library as private. The tutor is able to browse the media library, load it within the *shared space* and share it among the *virtual classroom* session. Asynchronous collaborative learning is also allowed. The lecturer is able to create interactive learning content and store into the virtual library by using *Course authoring tool*. The student accesses the virtual library, browses the content and manages the own schedule.

Most of the IT projects comply with Agile methodologies, so, the authors propose the blended learning approach and Agile methodologies to be implemented in the project-based learning module. Both semester and diploma projects are developed according to Agile methodology. It allows iterative development and full control of the project phases. The students are grouped in virtual teams (2…3 members). Forum, messaging and online focus group, document management and sharing capabilities are added to the project module in order to allow team members to collaborate during the project.

The learning environment can be extended by setting up entire platforms or educational tools for other 9 faculties and 36 departments in the Technical University of Cluj-Napoca. The cloud computing paradigms (SaaS, PaaS and IaaS) enable transparent access to services, software packages or hardware infrastructure.

5. Conclusions

The paper presents the blended learning concept based on cloud computing and the manner it can be customized for higher education in engineering. It starts from a functional analysis between traditional *e*-learning platforms and blended learning environment dedicated to technical higher education, then continues with the technological aspects and the deployment diagram of a blended learning environment that supports technical education. The advantages of elastic cloud environment are illustrated in the experimental results. An educational infrastructure has been setup in order to provide with individual study and collaborative learning support, access to virtual laboratory, especially simulation software packages, project- and problem-based learning features. The implementation of cloud computing approach (SaaS, IaaS and PaaS concepts) allows the *e*-learning service providers to extend their legacy *e*-learning systems in order to support blended learning capabilities in higher and postgraduate education.

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CONCEPTUL „INTERACTIVE LEARNING” ÎN ÎNVĂŢĂMÂNTUL SUPERIOR

(Rezumat)

Majoritatea cadrelor didactice din învăţământul ingineresc consideră actul de predare-învăţare ca fiind mai mult decât simple activităţi de studiu individual şi evaluarea online a cunoştinţelor. Procesul educaţional din domeniul ingineresc înseamna, pe lângă teorie şi practică, mult studiu individual şi experimental, care implică utilizarea echipamentelor şi aplicaţiilor de laborator, inclusiv a pachetelor software de tip emulator/simulator. Platformele *e*-learning tradiţionale sunt compuse din modulele de management al actului de predare-învăţare, a conţinutului educaţional, instrumentele de evaluare a cunoştinţelor şi cele de comunicare, de obicei, forum şi mesagerie electronica. Generaţia a treia de sisteme *e*-learning oferă o serie de funcţionalităţi educaţionale avansate, precum curs online, tutoriale interactive sau webinar-ii. Pentru a dezvolta o platformă *e*-learning dedicată actului de predare-învăţare din domeniul ingineresc, se au în vedere o serie de noi metodologii: învăţământ colaborativ având la bază lucrul în echipă pentru finalizarea cu succes a problemelor şi proiectelor de grup, laborator virtual, prevedere a accesului la distanţă la echipamente şi aplicaţii de laborator, inclusiv evaluarea activităţilor practice, sau asistare la distanţă a studenţilor pentru finalizarea cu succes a proiectelor de licenţă sau a mobilităţilor în străinătate.

Prima parte a lucrării reprezintă o analiză tehnologică pornind de la platformele *e*-learning clasice şi terminând cu cele dedicate învăţământului ingineresc, la nivel de ciclu de licenţă. Partea a doua vizează trecerea în revistă a principalelor aspecte tehnologice pentru furnizarea caracteristicilor de tip blended learning în inginerie şi se încheie cu diagrama de deployment a prototipului propus. Fiecare bloc din cadrul arhitecturii este prezentat în partea a treia a articolului. Partea a patra cuprinde rezultatele experimentale elaborate prin derularea unor cursuri specifice învăţământului tehnic precum Tehnologii Multimedia. În concluzii autorii subliniază importanţa implementării conceptelor Cloud Computing pentru îmbunătăţirea serviciilor din educaţia formală (ciclu de licenţă) din domeniul tehnic.