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CLOUD COMPUTING AND ITS APPLICATION TO BLENDED LEARNING IN ENGINEERING

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***Abstract**: The education process in engineering means theory and practice, complex self-study, team projects or experimental work that involves equipment, simulation/emulation software packages and laboratory applications. In order to develop e-learning platforms for higher and postgraduate education in engineering, new methodologies should be taken into consideration: project- and problem based learning, remote laboratory, which requires remote access to laboratory infrastructure, or virtual laboratory that means simulation of existing laboratory and virtual environment implementation to be as close as possible to the real world. The remote assistance for diploma projects and mobility grants is another important aspect, as well as the student's progress and coordinator's evaluation. This paper presents advanced blended assessment methodologies and the manner they can be customized for higher and postgraduate education in engineering, including the teacher's contribution in collaborative evaluation of project and laboratory activities.*

***Keywords:** learning cloud, blended assessment, project evaluation, remote laboratory*

I. INTRODUCTION

Engineering consists of lecture attendance, live demonstration, development of team projects, hands-on laboratory, computer simulation work, or complex knowledge and skills assessment. In this way, the contribution of teaching staff is significant in each type of activities, even if the educational act is a learner-centered one. The self-study component within the technical educational act enables students to access highly interactive educational materials, at any time in their original form. They can be initially created as recorded lectures and live demonstrations, or explanations during project meetings, then reviewed by teachers and annotated with audio, video, animations and text. For sure, lecturing seems to remain dominant form of teaching. It can be transposed in the virtual environment thanks to a hybrid classware component that allows the teaching staff to simultaneously conduct face to face and virtual classroom sessions. Due to the advanced blended learning components, live demonstrations, project meetings, or laboratory activities can be accomplished, as well. [11]

The use of assessment modules within course and learning management systems is quite widespread. In a typical web-based environment the assessment process includes three phases: 1 – authoring or preparation of the questionnaire, 2 – test delivery, 3 – evaluation and feedback. There are several e-learning approaches that extended the classic evaluation functionality. *E-studium* platform [2], for instance, added interactive features that enable students to express their intention of taking the exam and an intelligent component able to collect and process the data driven from evaluation act. The blended learning environment (BLE) Leone [1] proposes included students' feedback collection

related to assigned tasks during face to face and online tutoring sessions, as well as verification of learning outcomes and emotional learners' support during face to face classes. The *intelligent collaborative virtual environment* (ICVE) A [3] provides with virtual collaboration, adaptive user interface and multimodal interaction, capabilities that enhance the assessment act and make the knowledge building process more effective.

The paper relates several solutions for the problems faced during the implementation of a complex evaluation framework, which complies with enhanced blended learning methodologies and advanced assessment methods, being deployed on a cloud computing infrastructure. It is organized as follows: the related works and proposals are presented in SECTION II. Section III is dedicated to the assessment models for higher and postgraduate education in engineering, interactive evaluation of knowledge assimilated during the self-study process and project/laboratory documentation, as well as the collaborative assessment during the hybrid classes, remote laboratory and group project activities. Section IV presents the development of the assessment framework for blended learning and its integration within a generic framework for blended learning. The framework is deployed on a cloud computing infrastructure and implemented in electrical engineering and software development. In conclusion, the authors illustrate the most important advantages such a framework provides with, as well as further developments that include the customization for other domains.

II. RELATED WORKS

The knowledge assessment is an important aspect in higher education. Researchers in human sciences and ITC worked together for enhancing the assessment methods and implementing advanced evaluation tools for different domains. Several approaches have been identified as blended assessment solutions. *Leone* [1] proposed a blended learning environment that contains a 3C-based (*Collaborative Cyber Community*) integrated evaluation model targeted for foreign language learners. The model is built on the outcomes of a language blended learning environment (LBLE) that was adopted at the *University of Wollongong*, Australia, and an online course for PhD students at the *Università Politecnica delle Marche*, Italy. 3C platform provides a distributed learning environment that enables students to follow face to face classes. The sessions were hands-on; learning-by-doing was facilitated by individual or/and group tasks that students carried out with the different tools available in the platform: chat, joint web browsing, desktop sharing and sub-cyber classrooms, enriched with various markup tools. *Synchronous cyber assessment* (SCA) tools were set through open questions to be answered in text chat, considerations in a document to be uploaded in the discussion forum, or team solving-problem in small group meetings. Peer- and self-assessment were crucial for learners' practice in a *synchronous cyber classroom* (SCC).

Jasso [2] implemented the *e-studium* platform and customized its advanced tools for assessment and self-assessment to enable the students and academic institutions to get a thorough insight about students' readiness for undertaking demanding programs of scientific degree courses. After designing the architecture of an assessment module within e-studium platform, the authors analyzed the data regarding students' performance and their behavior in on-line examinations. The blended learning platform has been extended with a dedicated module that handles the students' enrollment to exams and collects data from the e-learning platform embracing students' intention to undertake the exam and their assessment over the efforts they make. In conclusion, the authors showed how information about students' achievement in on-line assessment can be exploited for evaluating a blended learning project in an academic environment where there is a great importance of making sense of data for decision making in teaching and administration activities.

Aguilar [3] proposes a *team training strategy* (TTS), which involves the use of an *intelligent collaborative virtual environment* (ICVE) that assists the small groups during the training process. The TTS includes four interrelated stages: *integration* of human team by using the virtual collaboration tools, *execution* of planned tasks assisted by intelligent components, interactive and collaborative *evaluation* of assimilated knowledge and the *improvement* of skills and competences by re-planning the assigned activities. The *evaluation stage* involves the virtual collaboration tools used by the human

tutors for identifying both individual an group errors, and the interactive components the team members handle for reproducing and analyzing the previous plan execution.

III. ASSESSMENT MODELS FOR BLENDED LEARNING IN ENGINEERING

The solution proposed in this paper is built according to a set of constrains. Most of them aim at the assessment of knowledge assimilated in the self-study activities, face to face lectures, or project documentation, as well as the evaluation of skills and competences during the team projects, hands-on laboratory, or simulation work. We take into consideration the typical web-based knowledge assessment process with its phases, authoring, test delivery, evaluation and feedback, then add interactive features for each one and integrate the evaluation components within an evaluation framework for blended learning. The evaluation components will be synchronized with a set of tools that create and update the learner's profile, as well as monitor the student's progress during the educational process, self-study and collaborative learning included. The student's profile consists of a set of parameters that define the interests, learning objectives and study progress, soft skills and technical competences achieved during the educational process. It is visible for both student and teacher: while the student is able to analyze the own profile regarding whole educational act, the teacher/tutor reviews the learner's profile related to the own courses, or laboratory/project, and an overall profile regarding the class.

3.1. Interactive evaluation model

The framework enables the teaching staff to create interactive evaluation content and impose the fulfilling criteria, define the assessment schedule and re-plan such activities, if necessary. Evaluation content management is an important aspect in assessment, it complies with the aimed educational activity.

In order to make the self-study sessions more effective, the teaching staff typically propose the quiz containing a set of multiple choice and true/false questions (Figure 1). The teaching staff build up a database of questions, divide them into categories, and enclose the set of possible answers. The interactive elements have their contribution to the assessment effectiveness, so, each question can contain interactive elements, according to its category and overall class profile. The interactive multimedia brings value for question and answers, while the virtual assistance provides the teaching staff with information regarding the learners' profiles, general interests or study progress, when creating the assessment content.

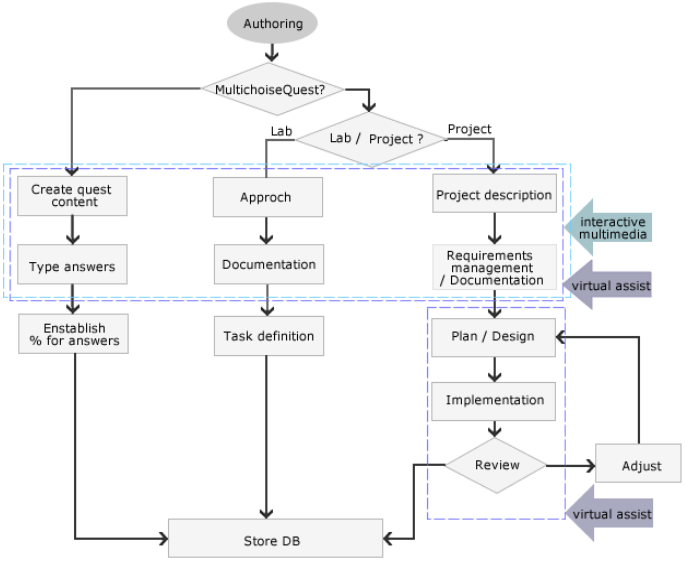

Figure 1. Advanced authoring methods

Individual projects (semester, diploma, dissertation) are developed using Scrum methodology (Figure 1) and consist of documentation phase, hands-on activities, simulation processes, applications, tuition, testing, review and adjustments. A part of project description can include interactive materials, other part contains a survey of project functionalities. The teacher types the project description then defines the manner the requirements have been managed and project documentation completed, by using the virtual assistance tools. The next point the teacher should pay attention is the development approach. It is important to divide the project in modules and components, define project versions (releases) according to the project requirements, then establish real periods for each release. The iterative development consists of four main phases: plan and design, implementation, review and adjust. Each phase can be virtually evaluated by an interactive component but the human factor is also necessary, at least for review and suggestions.

The hands-on laboratory and simulation work (Figure 1) include small projects to be accomplished in less than two hours, a suggestive documentation of what the student needs to do and the implementation process. The teacher must elaborate the laboratory description, add the documentation and other references, then define the tasks and their order. The interactive components will be used for counting how many times the student review the documentation, the order he/she approaches the tasks and how long the task completion took.

The system delivers a customized test version to each student according to the student's profile and criteria the teacher setup when elaborating the test. The criteria are also introduced by teaching staff, for example, wrong answers of basic questions can re-schedule the evaluation session because the student has no basic knowledge to take the exam. One correct answer and other one wrong regarding the basic questions generates a third basic question even if the teacher's settings include just two basic question. This flexibility is assured by the interactive components able to control the question delivery according to the category and the student's profile.

3.2. Collaborative assessment model

The framework allows the teachers to evaluate students in a face-to-face manner, during the online webinar or tuition sessions. The teachers can evaluate the students' skills and competences achieved during the team projects or laboratory activities. The quiz can be used during the face to face lectures, or online tuition and interactive tutorial acts; the same database of questions will be used for collaborative face to face assessment, as well as the interactive elements (Figure 1).

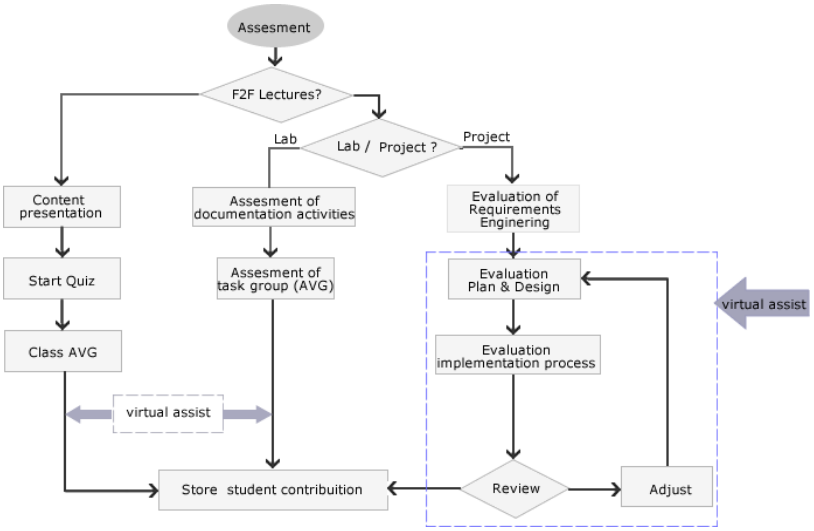

Figure 2. Collaborative assessment methodologies

The team projects comply with the Scrum methodology and include group documentation, hands-on activities, simulation processes, applications, team meetings, common tasks, testing, review of common versions and adjustments. The authoring tools used for evaluation of knowledge and skills achieved in group projects enable teachers to control each phase of the project, from requirements

engineering to iterative development, and measure the contribution of each student involved in the implementation team.

While each team member is involved in requirements engineering phase, the teacher should be able to verify the students' progress and conduct collaborative sessions with the scope to enable students to sustain their contributions, as well as define new directions in the current phase (Figure 2). Then the team members will be involved in design and planning processes where the teacher should closely work with the students, review their work and adjust if necessary. Design and plan is really important, so, the teacher cannot permit problems and misunderstands in such a phase.

The iterative development is accomplished on a common setup provided by the institution. This virtual environment provides each team member with remote access to the project infrastructure: the student uses the own credentials for accessing the project setup, completes the tasks and saves the work on the allocated storage space [14]. The system continuously notifies the teaching staff about learners' progress and allows the teacher to verify the performed tasks.

IV. IMPLEMENTATION OF ASSESSMENT MODELS

The assessment models will be implemented in the *assessment aramework* that consists of generic components, most important being *Authoring*, *Deliver* and *Evaluation*, and specialized packages such as *Interative_Evaluation* and *Collaborative_Assessment*. The *assessment framework* is deployed within the collaborative learning cloud presented in [11], which provides SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) capabilities. SaaS is used by faculties and departments with limited IT resources to deploy and maintain interactive and collaborative evaluation sessions in a timely manner while, at the same time, reducing energy consumption and expenses. PaaS facilitates the development and deployment of interactive assessment tools that involves laboratory simulation software packages, without the cost and complexity of buying and managing the underlying infrastructure. IaaS allows the faculties and departments to schedule complex eevaluation sessions that involves on-demand computer infrastructure (virtual desktop e.g.).

The approach has been implemented in *engineering*, especially *software development, electrical engineering, applied electronics, or telecommunications* but the same scenario should be customized for *e-health* or other domains. The intelligent components interpret the student's activities and tasks based on ontologies easy to modify according to the domain constrains

4.1. Interactive evaluation in engineering

Engineering means theory and practice, complex self-study, team projects or experimental work that involves equipment, simulation/emulation software packages and laboratory applications. The assessment process is a laborious one and involves interactive and collaborative components. The Assessment Framework enables teachers in Electrical Engineering Department to evaluate students' knowledge by using multiple choice questionnaires and their skills during laboratory and individual projects. The teaching staff use the authoring tools for assessment content management (creation and update and remove), as well as insertion of interactive multimedia sequences and virtual assistance points to be processed by intelligent components during the evaluation work. There are authoring tools used for creation of multiple choice questions, laboratory tasks and individual project proposals.

A set of intelligent components will deal with student's profile and update it according to the study progress. Same intelligent components will interpret the profile and study progress then deliver the questions during the quiz according to student's profile and previous questions already delivered. Other set of intelligent components will be responsible for interpretation of the manner each student accomplishes the lab tasks analysis, review of laboratory documentation and tasks completion. Another set of intelligent components will be dealing with interpretation of the mode each student manages the project requirements, planning/design and iterative development phases.

4.2. Collaborative assessment in engineering

The Assessment Framework allows the teachers to evaluate students in a face-to-face manner, during the online classes (webinars, tuition), as well as the skills and competences they achieved during the team projects or laboratory activities. The quiz can be used during the face to face lectures, or online tuition and interactive tutorial sessions, delivered by hybrid class component.

The teacher can conduct the collaboration assessment but the intelligent components will interpret the evaluation results and calculate the class/group average. There are intelligent components responsible for interpreting the manner each student accomplishes the laboratory and project tasks, estimating the student's contribution for each task and updating the student's profile, as well as the study progress.

V. CONCLUSIONS

The paper describes several solutions for the problems experienced during the implementation of a complex assessment framework that complies with enhanced blended learning methodologies and advanced assessment methods. After defining the methodologies for blended assessment, the authors illustrate the implementation of such models in the evaluation framework and its integration within the hybrid cloud for blended learning.

The assessment framework provides with several advantages that include the advanced knowledge evaluation during the self-study, assessment of laboratory tasks and activities, as well as evaluation of student's contribution during individual/group projects, and quick quiz during face to face lectures. The approach can be customized for other domains such as medicine or language learning. The intelligent components interpret the student's activities and tasks based on ontologies that can be modified according to the domain constrains.

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