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Advanced Learning Tools for (non)Formal Education

Sanda Porumb, Cosmin Porumb, Aurel Vlaicu and Bogdan Orza

Centre for Multimedia Technologies and Telecommunications,15 Daicoviciu, 400020 Cluj-Napoca, Romania

{sanda.porumb, cosmin.porumb, aurel.vlaicu, bogdan.orza}@com.utcluj.ro

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Abstract. An important part of the articles published in the last years highlight teaching and learning approaches and technologies integrated in complex applications and present the concepts used for creating and presenting the educational content. They refer to the methodologies used in self and collaborative learning, including problem- and project-based learning. The assessment process is also illustrated in several articles but there is no a generic framework that complies with the rules of both formal and non-formal education acts. Our proposal is focused on advanced concepts for improving the educational services and the manner a generic framework for blended learning can be customized for higher education and lifelong learning. In addition, the paper proposes a virtual collaboration prototype that supports interpersonal and inter-process collaborative learning services that can be used as core of any rapidly growing educational community..

Introduction

A lot of research has been done in learning area, most of them regard the educational processes and activities. This fact has resulted in various theories such as cognitive learning theories, constructivist theories, and social-historic theories. Each of these theories is associated with a number of specific design principles and prescriptions. In parallel to the development of theories there was also an explosion of network-based technologies, mainly Internet and Web-based, enabling traditional and non-traditional distance learning approaches. Most of the developments have been learner and teacher centred while group centred designs sustain the learning process as being achieved through constructivism and collaboration. [1]

The special forms of education such as lifelong learning, especially training and career development, consist of complex activities that promote in a crossed way the knowledge retention in the cognitive domain, as well as skills in the psychomotor domain. Nevertheless, when it involves groups or learners, the scope of knowledge building expands to the relational/social domain. Consequently, the instructional design theories and models involved in the training process represent the fundamental factor for the development of shared cognitive schemes that can improve the team work. [2]

The changing nature of work and study under knowledge-based economy of this century constrains the teachers/instructors and students to adopt new methods of dealing with complex issues that require new kind of knowledge. They need to work, collaborate and learn new things from a variety of resources and people, to investigate questions and bring their learning back to their dynamic learning communities. Often the virtual collaboration tools focus on a specific solution or collaboration task only, without considering the integration of this process into a large environment composed by easy to use and very suggestive components. In addition, the virtual collaboration technologies require a change in human interaction. Thus the uptake is mainly driven by the benefit. If users do not experience an immediate personal benefit new applications are not applied even if the new tools are properly introduced.

Leaded by social and technological problems in the modern stage of e-learning systems the authors propose a low cost prototype based on an advanced collaboration architecture that provides the lecturers and learners with educational services in different domains such as engineering, or sciences. The authors review common groupware problems and reflect the changes in both higher education and life-long learning. The article highlights the Web 2.0 approach in the e-service environments, especially e-learning area, it describes the open architecture adapted to the requirements of a generic collaborative learning framework that works properly in different domains. It also illustrates how Computer-Supported Collaborative Learning (CSCL) tools improve the knowledge building process and what kind of solutions should be adopted in order to avoid the CSCL weaknesses.

This paper is organized as follows: the related works and proposals are presented in Section II. Section III is dedicated to the advanced approaches to be implemented for special forms of education. Several important aspects are taken into consideration: how to improve the retention factor during the individual study and group based learning sessions. Section IV consists of technological aspects related to the development of a virtual educational organization adapted to formal, informal and non-formal education requirements. Section V illustrates the experimental results and highlights the customization of such environment for creating and sustaining a virtual educational organization that provides an interdisciplinary MSc programme in eService area. In conclusion, the authors underline the importance of cloud computing paradigms in creating and sustaining the virtual educational organizations that include different educational/training institutions in Romania and abroad.

Related Works

Several approaches have been identified as solutions to e-learning issues and the special forms of education. They implement advanced educational methods and involve powerful technologies such as virtual reality (VR), serious games, augmented reality (AR) or collaborative tools. The virtual reality elements help the learner to easily transpose in the virtual environment for tele-presence, simulation work and interaction. Usually, VR implements the e-bridge concept and has the role of extending the real world where the teachers do their job with a virtual environment that properly fits the educational needs. AR helps the tutors involved in content creation and delivery to bring value-added to their educational materials or live demonstrations by adding new elements or hide existing ones with the main goal to make the educational process more effective.

Chandral's research has been focused on actual e-learning architecture model and issues in current e-learning applications by presenting the Hybrid Instructional Model as the blend of the traditional classroom and online education and its customization for e-learning applications running on the cloud computing infrastructure. Chandral's work highlights the e-learning (non)functional requirements such as openness, scalability, and development/customization costs, while it identified the limitations of existing e-learning systems hard to dynamically scale and extend with new features. In addition, the integration with existing e-learning systems or modules should be expensive [3].

Aguilar 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 [2]. It consists of the Collaborative Virtual Environment (CVE), which allows the human tutor to coordinate the virtual meetings of the group, and the Intelligent Virtual Environment for Training (IVET) that assists the group during the execution stage. TTS includes four interrelated stages: *integration* of human team by using the CVE components, *execution* of planned task based on IVET components and assisted by PVA, *evaluation* process of team members where CVE will be used by the human tutor in order to identify both individual an group errors, then by the team members for iteratively reproducing and analysing the previous plan execution, and the *improvement* stage when the team will gave the possibility to re-plan the assigned activities. [2]

Manseur [3] presented the synchronous distance learning concept (SDL) and its application 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 lecturer teaching in one location is videotaped and can be seen live on a TV screen in the other classroom. The hands-on experimentation is difficult to conduct without access to often expensive equipment and components and without competent on-site laboratory tutors. In order to complete the lab, the SDL environment consists of two sets of fully equipped and staffed laboratories, one on each end of the SDL-connected campuses. [4]

This paper highlights the importance of the advanced technologies for service improvements in the special forms of education. As illustrated by Mitchell, the collaborative learning concept and interactive tools have a major role in formal education, while the implementation of problem- and project- based learning (PBL) concepts in higher education have a great impact regarding the knowledge building and assessment [5]. In addition, Aguilar proposes the use of an Intelligent Collaborative Virtual Environment (ICVE) that assists the small groups during the training process [2].

Advanced Approaches in Different Forms of Education

After a laborious research in educational area, some important issues have been identified, especially regarding the responsibility of learning act, content creation and delivery, interaction between learners or lecturers and learners, even end-users and educational resources, students' satisfaction and retention factor. It is obvious that training sessions, usually considered as a part of the job, are conducted by qualified personnel and scheduled by team leads or heads of departments, with the scope to allow trainees to achieve knowledge and skills related to the activities and tasks they need to accomplish during their further work activities. On the other hand, the knowledge building in higher education has two main components, the first one deals with presentation of theory and assessment test when completing a learning object, during the study process, and the second enables the students to actively participate to problem solving, simulation work, applications or other practice activities. The presentation of theory is usually done based on a set of e-learning tools able to deliver the content as rich text or HTML format. The student surveys the content organized as a well-structured book and gathers each aspect non-clear he/she met during the study in the own vocabulary in order to discuss about it with the teachers and colleagues. Several practice activities request the student attention while they totally involved him/her in actions such as individual problem solving and simulation tasks or complex group-based applications, team projects or hands-on laboratory.

The traditional education process encourages competition and individual responsibility between students but discourages any interaction, even if most of the novel methodologies aim to redefine the relationship between students and lecturers. In addition, during the traditional teaching act the lecturer exposes the educational materials to the class, maybe answers few questions and individually talks to some students. It is obvious a part of students should assimilate the presented information in classroom [12]. Thus, most of the students need home preparation, starting with surveying the notes gathered at school and repeating the theory then gradually accomplishing the homework. For this reason, active and interactive learning play a significant role in assimilating the information and transform it in knowledge. In conclusion, both content creation and delivery are very important in the economy of formal education, especially, how the lecturer expose the educational materials, what students can survey, even review, at home and if there are some hints when accomplishing the homework.

The retention factor achieved during online tuition, e-training, career development and certification sessions mainly depends on the learner's degree of involvement, quality of provided educational content and manner the information is presented to students. Nevertheless, the individual study act is most predominant in such non- and in-formal education processes, so that, the content creation and delivery in conjunction with the student's possibility to annotate each educational material then review it, at will, have a major impact in knowledge building.

Content creation and delivery in interactive learning sessions. The instructional design methods are based on sequential and logical structure of educational content, the manner it is created and delivered, as well as the degree of interaction between the actors that actively participate to the educational act. The logical structure of the educational content is usually implemented in individual study, interactive tutorial, simulation work processes and virtual laboratory during (non)formal education. It enables the students/trainees to survey the sequence of educational materials in a specific order. Its main advantages are the flexible study schedule and the gradual study progress, usually achieved according to the assimilated knowledge. The logical structure of the educational content is adopted by the special forms of education, while it guarantees the advanced user-educational resource interaction and a high retention factor. As mentioned, the student/trainee should opt for the own order the educational materials are explored. In addition, the student/trainee can annotate each resource and save the annotated material to be revised, at will, or even shared with the colleagues during ad-hoc meeting and scheduled collaborative learning sessions.

The modern educational/training act is student-/trainee-centred, so, the instructor, even if he/she does a laborious job, still plays a secondary role by assisting the students/trainees and interactively providing the requested information. In addition, the educational resources should be concise and well-explained, the information easy to assimilate and the problems or projects to highlight exactly the student'/trainee's tasks and contribution according to the knowledge evolved. In conclusion, the learning/training act should be considered as a collaborative process where students/trainees and teachers/tutors/trainers work together in a (a)synchronous manner for achieving the common goals. For this reason, the individual study can be also promoted as a part of an asynchronous process. Figure 2 illustrates the asynchronous collaboration process that involves the teachers/tutors/trainers, which create the interactive educational content and store it into the virtual library in order to be delivered to learners at will, and students/trainees that survey the content, modify it at will and create the own augmented resources.

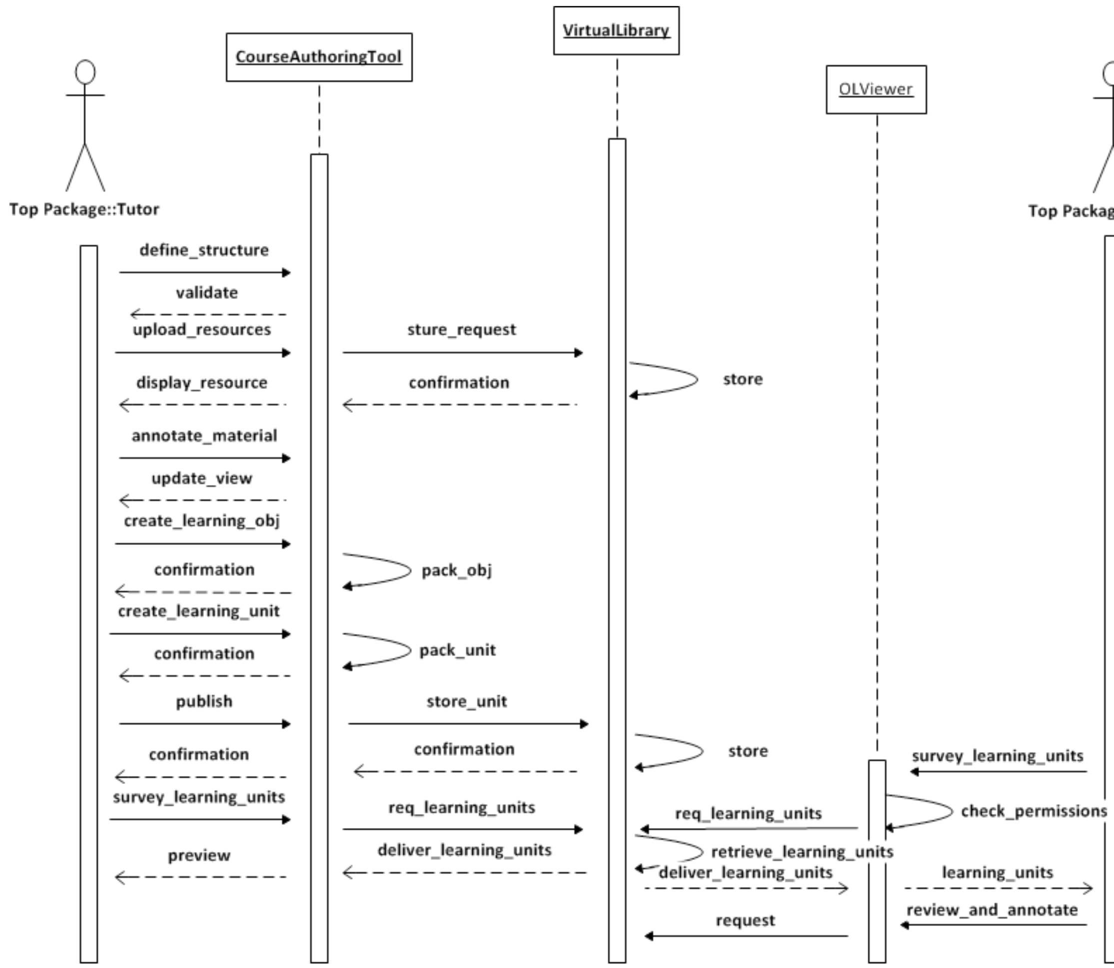

Fig. 1 – Interactive content creation and delivery

The content creation contains the following steps: elaboration of basic resource structure; upload of basic resources in the virtual library; creation of learning objects by enhancing the basic materials with multimedia and augmented reality elements; packing of learning objects in learning units; storage of learning units into the virtual library. Figure 1 also highlights the content delivery

procedure and the steps that compose it: validation of user's access to the interactive resources; allocation of privileges for each type of user: read, modify, recovery; survey of educational/training resources; human-educational resource interaction according to the allowed privileges; knowledge assessment at the end of learning unit survey; study progress review, at will.
Nevertheless, the tools dedicated to the individual study enables the instructors and learners/trainees to review the recorded webinar sessions and annotate them with important details then the recorded video sequences are stored into the virtual library as interactive resources (learning objects).
Content preparation and delivery in collaborative learning sessions. The sequential structure of educational content is usually used in the real classroom and collaborative e-learning act such as online tuition and webinar sessions where the teacher/tutor/trainer defines the presentation order and controls the sequence of materials shared among the real/virtual classroom. The content management approach implemented in online tuition and webinar tools consists of the procedures illustrated in Figure 2. Content preparation, as the basic procedure, usually occurs before starting the webinar session and contains three steps: preparation of educational/training materials for the webinar sessions; upload of prepared resources and storage into the tutor's section within virtual library; dissemination of educational/training materials to students/trainees before the virtual session.

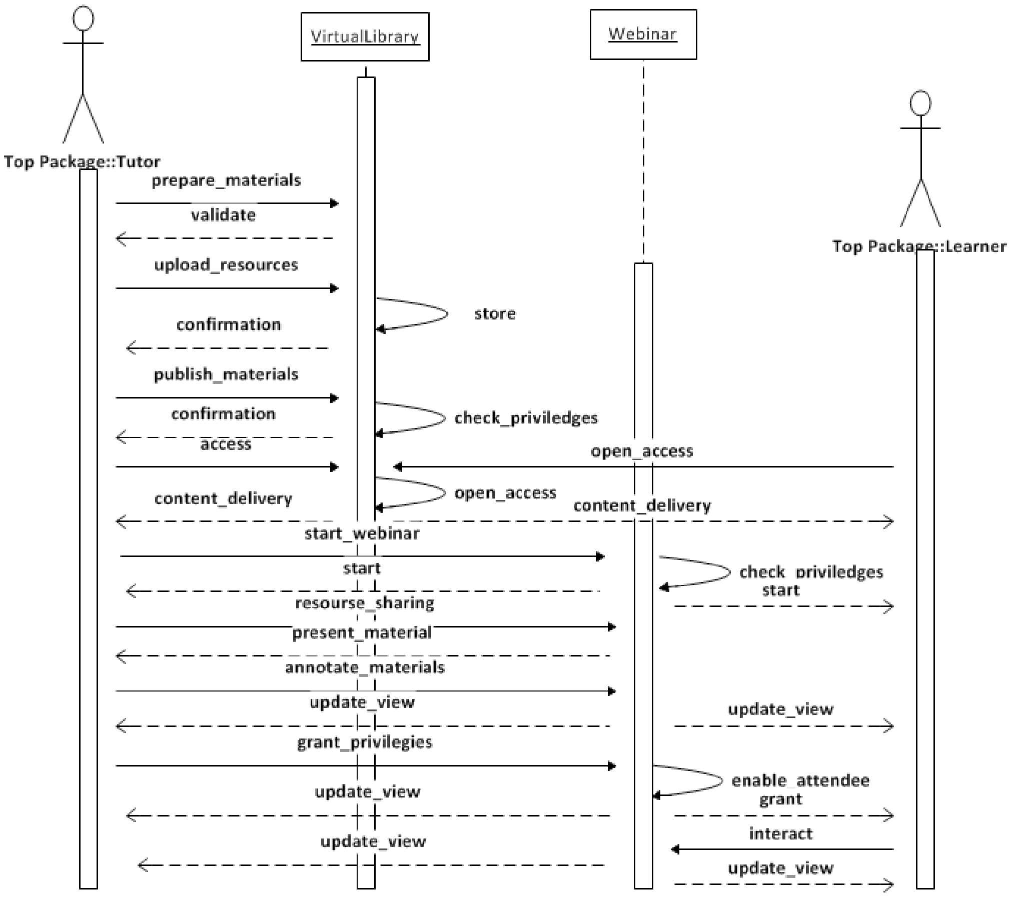

Fig. 2 – Content management approach in synchronous collaborative sessions

The educational/training content has multiple forms: original materials in HTML, MS Office, PDF, audio/video formats, or interactive resources created as a combination of original materials and augmented reality. In most cases, the students/trainees survey the educational/training before the live session (webinar) by using dedicated plugin components. It always happens with the laborious students/trainees but it can be also caused by explicit teachers'/tutors'/trainers' requests.
During the live sessions (webinar and online tuition) the content delivery consists of five steps: resource sharing – the educational/training resources are loaded in the virtual shared space and visible for all the attendees; presentation of materials – the tutor/trainer surveys the materials and presents the general subjects then takes them one by one and evolves an open discussion around each subject with the students/trainees; annotation – the collaborative tools allow the teachers/trainers to

annotate the materials with augmented reality scenes and multimedia elements; application and desktop sharing – the tutors/trainers are able share their desktop and applications with the class; session recording – the webinar and online tuition tools enable the tutors/trainers to record the video communication and events that occur within the virtual shared space, application and desktop included.

Interactive Learning Prototype for Special Forms of Education

We propose a complex prototype that implements advanced virtual collaboration capabilities: virtual assistance, human-computer interaction, video conferencing, online focus group, virtual shared space, media streaming, video capture and recording, virtual and remote laboratory, or project management. Its development is based on a hybrid architecture, illustrated in Figure 3, that extends the LAMP stack (Linux, Apache, MySQL, PHP) and complies with the advantages of SOA (Service Oriented Architecture).
The prototype architecture consists of the following blocks: Apache web server, MySQL database server, Flash Media Interactive Server, LibreOffice, GostScript, FFmpeg and MEncoder libraries. It provides integration functionalities and allows the developers to externalize the media services (Influxis or Amazon EC2) or storage capabilities (virtual library). Apache web server hosts the web components that implement the generic educational functionalities such as authentication, or web access to advanced service; MySQL database server stores the information regarding the lecturers, student and trainees, courses, interactive resources, skills or competences to be achieved, assessment sessions and certifications [11].

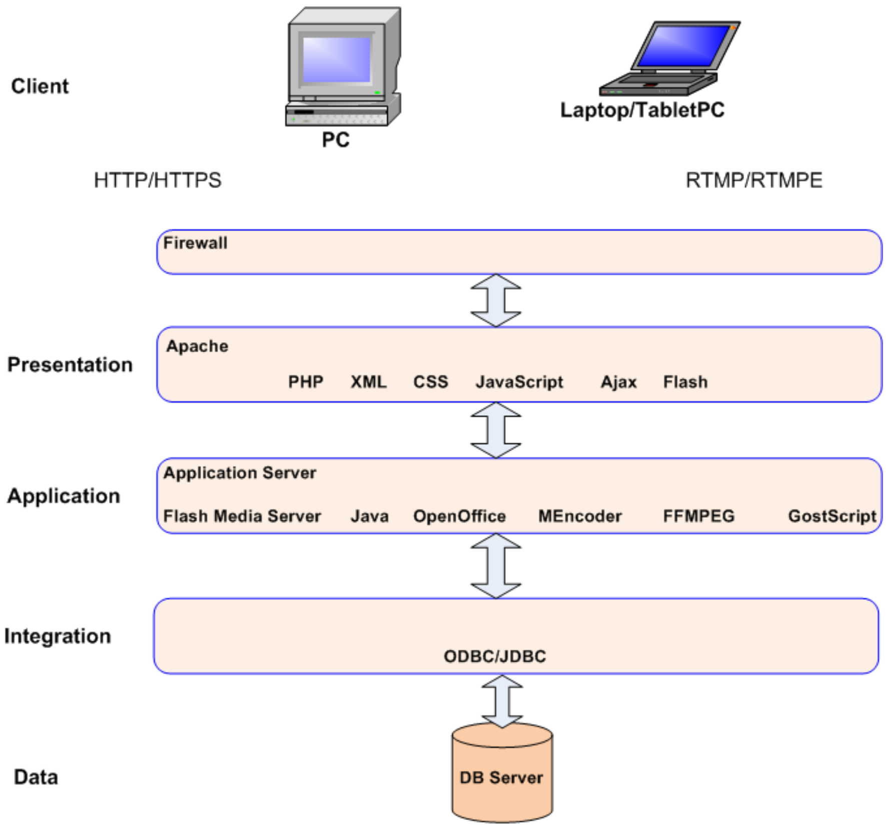

Fig. 3 – Architecture of the interactive learning prototype

Flash media interactive server provides with video communication and virtual collaboration capabilities such as video conferencing, media streaming and video capture/recording, as well as remote shared objects support. The educational/training resources are converted from original formats to internal symbols and integrated as slideshow then stored into the virtual library. The conversion block is composed by two different components: the document convertor and the media convertor. While the document convertor is a Java-based component that uses LibreOffice and

GostScript libraries for converting MS formats or PDF files to slideshow, the media convertor uses MEncoder and FFmpeg capabilities for converting the multimedia elements to .flv, mp3, or mp4 formats. This way, the virtual library supports most of the file formats and the *internal service handler* component can manage the digital content in an unified manner.

Content preparation and delivery in collaborative learning sessions. The interactive learning prototype aims to provide with (a)synchronous virtual collaboration capabilities and contains a set of components dedicated to the online educational and training activities: user management block, course authoring tool, virtual library, search engine, statistics module, electronic agenda, project management module, virtual shared space, multimedia messaging, forum, virtual assistance, videoconferencing tool, online focus group, and blended assessment component.

In order to simplify the development process, the framework components will be divided in four main categories: *generic components*, *interpersonal collaboration components*, *interactive components*, and *inter-process collaborative components*. The generic components implement the main functionalities such as database management, user management, statistics and electronic schedule. Interpersonal collaborative components enable teachers/trainers and students/trainees to actively participate to online training sessions using advanced instruments such as multimedia messaging, forum, interactive content creation tool, virtual shared space, videoconference, online focus group, video/screen recorder or webcasting. The interactive components, such as search engine, virtual library or project management tools, allow the end-users to control and interact with the system by using the natural language. Inter-process collaborative components are intelligent components such as business intelligence and virtual assistant that permit the instructors, trainers or teachers, to supervise the trainees'/ students' progress and improve the educational process.

In order to enable the partners to share their skills, competences and resource for creating and sustaining a virtual organization, the interactive learning prototype has been deployed on a cloud computing architecture, illustrated in Figure 4. The result is a hybrid collaborative cloud infrastructure consisting of 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 and online training developers, resource management layer that achieves loose coupling of software and hardware resources, service layer containing three levels of services: software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS), application layer that provides with content production and delivery, remote and virtual laboratory, virtual class, assessment and management features.

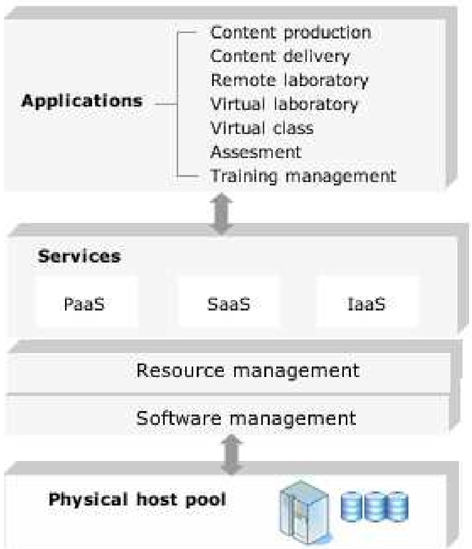

Fig. 4 – Hybrid collaborative cloud infrastructure

SaaS is the paradigm used for delivering applications to end-users' browsers according the policy and privileges of the own host institutions. It can help universities and training companies with limited IT resources to deploy and maintain needed software in a timely manner while, at the same time, reducing energy consumption and expenses. In the same manner, it sustains the institutions with limited human resources in different fields of expertise or new educational/training directions to benefit by the ones the other partners shared within the virtual organization, while the instructors can perform their activities from anywhere, anytime, in a real-time manner.

The biggest issue in any virtual educational organization is related to manner the partners can share complex educational platforms or infrastructures in order to reduce the costs. PaaS paradigm facilitates the development and deployment of lab applications and simulation packages (hardware and associated software) once for the entire partnership while IaaS gets on-demand computer infrastructure, from a simple virtual desktop to a rack or whole data centre.

Experimental Results

The interactive learning prototype aims to improve the educational process by increasing the degree of trainees'/students' satisfaction, retention factor and trainees'/students' enrollment. It gradually evolves trainees'/students' knowledge, skills and competences, as well. Such prototype that complies with the advanced approaches defined in Section III supports the diversity of learning/training activities. In addition, its deployment on a hybrid cloud infrastructure enables universities and companies to create and sustain the virtual organization in education domain. The cloud technology and its optimized resource management approach lead to a great quality of the education/training act considered a very important aspect. Even if increasing the number of partners, so, explicitly, teachers/trainers involved and students/trainees enrolled in the educational/training programmes, it should not affect the learning/training process. In fact, the quality of education/training should increase with the number of partners participating in the virtual organization, while improving the experience and increasing the number of shared resources.

The initial setup for each partner in the virtual educational organization, must support the learning/training activities such as individual study, collaborative learning, assessment and experimental work such as project- and problem-based learning, simulation work, interactive tutorial and virtual laboratory. The virtual organization setup should be a dynamic environment that creates educational/training programme instances. Each instance consists of several virtual machines allocated for hosting the interactive learning component and has the own storage space.

During the experimental process some weaknesses of the advanced learning methodologies and tools was taking into consideration, as well as their main effect on academic stuff, responsibility in the educational/training act, content creating and delivery, interaction time management, communication application of workplace skills, computer competency, or class geography and size [12]. The presented interactive learning prototype should enable the partners in the virtual educational organization to solve an important list of issues identified in the educational/training act. Moreover, its deployment on a hybrid cloud computing architecture guarantees the adoption in each special form of education.

The approach was implemented as a pilot project that includes the eService directions, run by teachers and students from the Technical University of Cluj-Napoca, the "Politehnica" University of Timisoara, the Babes-Bolyai University of Cluj-Napoca and "Transylvania" University of Brasov. Most of the teachers involved in the pilot project (75%) are experienced with the novel methodologies for creating and delivering the educational content in collaborative learning, as well as the use of such innovative teaching technologies as online tuition or webinar tools, course authoring, video and screen recording, annotation instruments. The other part, 25%, is not familiar or have no time to explore the interactive learning prototype to be used as main support for their teaching activities. In the same way, an important part of the students (70%), even if they already become to *Net Generation* and possess IT skills, consider the virtual infrastructure as a complex entertainment environment not a flexible learning platform. For these reasons, the user experience continuously plays the most significant role, while the teachers and students are not constrained to do more work with a non-friendly IT system for same results as in a real classroom.

The *first challenge* came from the teachers that desired to extend their face-to-face classes over the Internet while it can automatically increase the enrollment of students and make the educational act more effective. This fact promotes the collaborative learning perception as more complex than team

projects, video conferencing sessions and students/trainees connected with teachers/trainers from home or work place. So that, the proposed interactive learning prototype, beyond powerful server-side modules, also provides with an intuitive and well organized graphical user interface exposed by flexible and interactive client-side components that implement the procedures for content creation and delivery during the (a)synchronous collaborative sessions, team project management or blended assessment tools that enable both theory and practice evaluation.
At the end of the pilot project, 84% of the teachers and 93% of the students were pleased of the new methodologies and innovative technology provided by the collaborative learning cloud infrastructure.
The second challenge happened when an important part of the teachers involved in continuous education and training activities continue to use the system and run it external activities. A Romanian software company plans to implement a *multimedia hub* that provides with high definition (HD) capabilities. The company already developed several web conferencing tools that offer SD quality. High definition is a challenge and the implementation process is tight. This way the management board decides to opt for training services from a specialized department at *the Technical University of Cluj-Napoca* focused on data capture optimization, audio/video compression, transmission and rendering. The research department allocates a team of specialists with a strong background in multimedia technologies, which initially completed a survey in multimedia technologies. The teachers also conducted several online training sessions with the following topics: web conferencing tools, web TV and mobile multimedia. The main subjects were: audio/video data capture, implementation of advanced encoding standards and communication protocol, HD rendering, audio/video recording, multimedia storage or concurrent access to huge amount of data, and integration of television equipment. At the end of the training stage, the university specialists and software development team provided the management board with the implementation scenario and a state-of-the art report that included some of the most powerful technologies to be taken into consideration during the implementation process, as well as several optimization algorithms for data capture, audio/video encoding, multimedia transmissions, audio/video decoding, HD rendering.
The continuous work raised a *third challenge* when 70% of the teachers registered in the pilot project asked for recording the live sessions and deliver them as learning objects over the Internet. Its main reason was to increase the income, at least during the economic crisis, by creating and delivering learning units within valuable education and training programmes. For this reason, the research group suggested the use the course authoring tools for creating and delivery interactive educational/training materials. Nevertheless, the tools for interactive content creation and delivery transform the individual study process in a collaborative educational act, where the teachers elaborate the content and update it, then students explore the learning units, make annotations and extract the information. Of course, each annotation can be used for updating the learner's profile and advising the teacher about aspects related to the own resources.
The last challenge comes from the young teachers involved in hands-on laboratory activities and semester, diploma or dissertation projects, where the redundant tasks are not confortable. They started using the interactive educational tools for creating recorded or live tutorials and simulation processes or even remote / hands-on laboratory. The impact was appreciated while 75% of the teaching staff and 95% students preferred the innovative technology instead of the classic way.

Conclusions

The paper illustrates a collaborative learning prototype customized for special forms of education and its deployment on a cloud computing architecture. It also describes two main classes of methodologies, as well as their implementation in a set of collaborative learning modules. The collaborative learning cloud has been quickly adopted for *engineering*, especially *electrical engineering*, *applied electronics*, *telecommunications* and *computer science*. Nevertheless, the same methodologies can be also customized for other domains, for instance human science or telemedicine. Such an infrastructure enables universities, organizations and companies to focus on education and training process management, as well as content creation and delivery, then benefit by managed services while a specialized team takes care of IT system construction, maintenance, platform development and management.

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