Proceedings of the 1st International Workshop on Cloud Education Environments (WCLOUD 2012)

Antigua, Guatemala, November 15-16, 2012

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PREFACE

Cloud Learning Environments (CLEs) or *Cloud Education Environments (CEE)* consider the cloud as a large ecosystem, which is not owned by any educational organization. Within this ecosystem, learners and educators act as the users and producers of cloud-based learning services. They have complete control over the choice, use and sharing of the learning tools and content provided by these services.

This approach has the potential to enable and facilitate both formal and informal learning. It allows learners to learn anywhere and at anytime. It also facilitates collaboration among learners and educators. Additionally, the openness, sharing and reusability of learning tools and content on the web are technically enabled and promoted.

This workshop has been focused on the exchange of relevant trends and research results, as well as the presentation of practical experiences gained while developing and testing cloud education environments, both from a teaching and a learning perspective.

All papers submitted to this workshop were peer-reviewed and 13 papers were selected for publication in the proceedings. We would like to thank all the authors for their contributions. We also thank the local organization committee from Galileo University in Guatemala led by Byron Linares.

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The importance of " Cloud Education " at Development Organizations

Proposed concepts, purposes, strategies and tools for the Education Network of AECID

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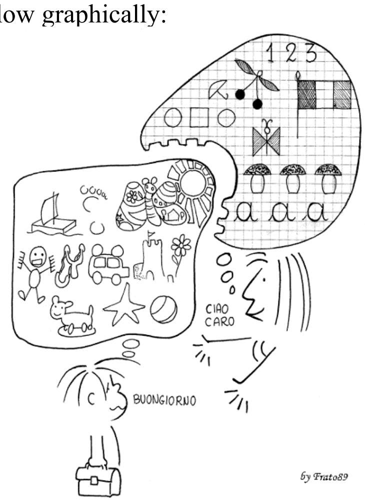
***Abstract*- This document is the summary of the proposals generated in the latter year of work for the consolidation of several tools to support the managers network of AECID's education programs in which, by the use of the TICs, we trie to create a collaborative environment of learning based on strategies of " Cloud Education " that help us to improve our daily work in the interventions that we are developing on cooperation in the educational area.**

Key words; Cloud Education, Development Organizations, Cooperation to development at the educational area, in service training, Tics.

I. INTRODUCTION

The first time I read about the concept of " in the cloud education " without depth knowing of it, This two words reminded me an anecdote of my childhood: When I went to collect my certificate of primary education at the school where I studied, There was a teacher who said that she could also give me a pilot certificate. When I Asked why, she told me smiling that it was because of the number of “flight hours” that I had, by the time I had spent “in the clouds” ... With this situation I try to show how is the common feeling of many of the students, after going through the traditional education system. Other examples of that situation are presented below graphically:



This image belongs to the Italian educator and illustrator Francesco Tonucci (Frato) [1].

Throughout his career he has made a lot of vignettes with which has captured this feeling of infant pupils

The following is taken from a presentation of the great communicator and expert in developing creativity Ken Robinson [2] which has helped with a significant contribution to changing educational paradigms through its work of spreading.

Summarizing Ariel Rodríguez [3] main constraints of this model of traditional education are supported by the following statements:

- Assume that teaching and learning are inseparable activities
- The unidirectional transmission from a recognized expert an isolated individual
- The proof of the acquisition of knowledge resides in the own knowledge (not the ability to use it)
- Learn only what other wants to teach
- Limited knowledge sources
- The environments are predictable and static (in other words, terribly boring)

This conception the educational environment has also been deeply rooted in the in-service training of staff within organizations..

II. SCENARIO DESCRIPTION

At the present time, the expansion and incorporation of ICT into our everyday reality have created a new scenario reeling the foundations upon which was the seat previous model and now are the basis for consolidate a new paradigm in training staff in service of development organizations.

The enumeration of the special characteristics of our work in education could be listed as follows:

- Coexistence of multiple actors and instruments.
- Care for geographical priorities, sectorial and transversal axes
- Need for coordination between peers and between different hierarchical levels.
- Scenarios changing and unstable frameworks.
- Loss of multicultural environments and references.

III. Justification

The above bases the need for updated information, communication channels agile and efficient, and above all, with a great adaptability that can be trained and reinforced with models based on the theory of " Cloud Education" which they are based the proposals I want to present

.

The first meetings of the Network of Education responsibles took place in late 2011 in Montevideo, Uruguay for Latin America and the area in Madrid for the rest of the countries where the AECID works.

As part of these meetings was presented our PAS Sector Action Plan [4], which, in its Strategic Line 4 on the institutional strengthening established four lines of action:

- 4.1 Planning, Diffusion and Advocacy
- 4.2 Capacity Building
- 4.3 Knowledge Management
- 4.2 Coordination of stakeholders.

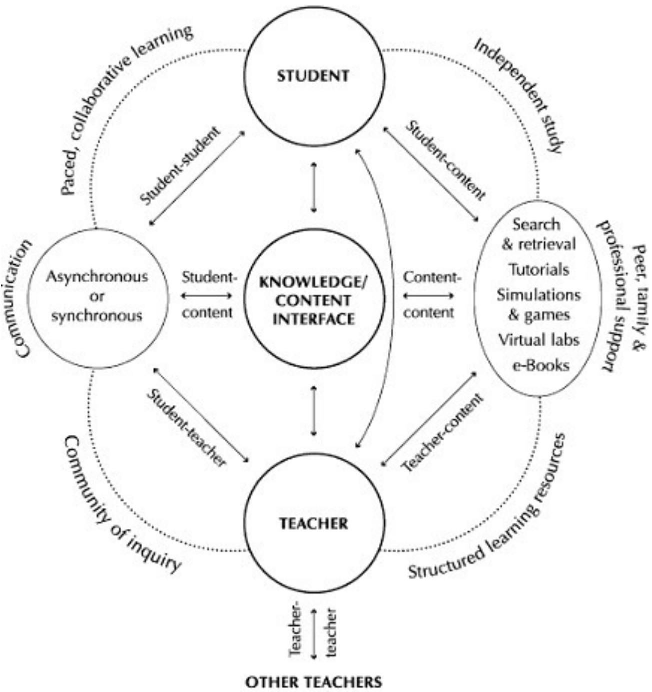
The response to this line of action in relation to training component was completed in the course of Expert Development Cooperation in for Education that now reaches its final stage and whose methodology of e-learning consider wise. It would be a pity that the training process had begun to stop with the end of it. In this respect it is necessary a response from the education network to supplement, update and especially sustaining through time the path initiated.

IV. OBJETIVOS

The aim of this paper is to present the concept of cloud education and the tools it uses. Submit in an orderly manner the proposals that have been made in the framework of the education network, towards their dissemination, implementation and improvement as well as raise two specific contributions: The document manager and the network stakeholders catalog by country using two specific ICT tools: *Biblio* and *Symbaloo*

V. Concepts

This diagram of T. Anderson and F. Elloumi [5] illustrates the new modes of interaction between the teacher, the student and the knowledge or content:



Starting from the different itineraries in sight that range of modalities and different paths you can take away from the traditional pattern with the teacher as a unique intermediary between the content and student.

Comes into play combined modalities between the passing of e-learning (learning through the web) and the p-learning (personalized learning) [6] and also collaborative learning or learning by personal inquiry. From this diagram emerge education approaches at the education network in the cloud learning environment.

The concept of Cloud Education, began to be used by its relation to the concept of cloud computing, term that describes today most Internet services supported on:

"…Web 2.0 and its evolution toward cloud computing, the emerging phenomenon with social software, makes the man of today is active participant in their training on a network read and write. This evolution of Internet-based communities of users and a wide range of communication services, information processing, knowledge socialization, information exchange, social networking, blogs, video and audio streaming, podcasts, wikis, among others. Make distance learning education evolves into a cloud that promotes collaboration and rapid exchange of information between users…" C. Castaño [7]

In implementation of the model three variables come into play with great relevance in the scenario described:

- **Cost:** The proposed tools are free for use by a registry, others offer the opportunity to acquire an extended version, and others finally are open source.
- **Flexibility**: They are scaleable, can be extended or compressed, abandoned or transfer content from one to another.
- **Accessibility**: You can access them at any time and under multiple platforms.

Looking for its utility for our case and applying the theory of George Siemens [8] on the seven roles of teacher learning about networking I have compiled a reference table to identify what would be the potential role that can play in our Education Network

Role of the education network in the educational environment in the cloud		
Role	***Activity***	***Eestrategies and Tolls***
Amplifiy	Draw attention to relevant ideas	Twitter, blogs
Intermediate	Facilitate access to readings and resources	Design tutorials
Signpost	Create a social sense of the activities	Comments on blog posts,
Aggregate	Reveal patterns	Google alerts, RSS
Filter	Helping to think critically	RSS, discussions about the reliability of information
Model	Highlight relevant information and interaction patterns	Collecting and disseminating good practices
Continous presence	Maintaining the continuous presence	Newsletters, Foros, posts, podcast

VI. Tools Catalogue Classified According Purpose and Strategy..

In this section I propose a classification of tools to be used according to their purpose and strategy for implementation, to the many possibilities offered by the net I have selected five tools for each of the identified purposes. The common characteristics of these 20 applications are its gratuity, its relative ease of use and its good design in order to comply with its function

A. Colaboration tools

Tools and resources for cloud education	
Purpose	***Estrategy***
Colaboration	Its utility is the ability to work and interact with others on projects of common interest in a shared and collaborative way

Tools and resources for cloud education	
Google Drive https://drive.google.com/#my-drive	Allows working with text or spreadsheets collaboratively (evolution of Google Docs)
wikispaces wikis for everyone http://www.wikispaces.com/	Creating and Managing Wikis
spaaze http://www.spaaze.com/home	Pinboard or virtual "cork"
slideshare http://www.slideshare.net	Tool for sharing presentations
Dropbox https://www.dropbox.com/	File sharing tool

B. Comunication Tools

Tools and resources for cloud education	
Purpose	***Estrategy***
Comunication	Useful for sharing ideas and information in text, audio or video. synchronously or asynchronously.
skype http://www.skype.com/intl/en/home	Audio / Video Conferencing and Instant Messaging
ooVoo http://www.oovoo.com/home.aspx	Audio / Video conferencing: allows multiple simultaneous users for free

Tools and resources for cloud education	
http://www.blogger.com/	Management Tool for Blogs
http://www.scoop.it	Curate content tool
http://vocaroo.com/	Recording and storage audio online

C. *Documentation Tools*

Tools and resources for cloud education	
Purpose	***Estrategy***
Documentation	Useful to collect or presenting evidence of experiences, productions.
http://www.symbaloo.com/	Creating "Webmix" (virtual desktops)
http://dotepub.com/	Creating eBooks from a web
http://calibre-ebook.com/	Management eBook collections
http://evernote.com/intl/es/	Tool to create notes
http://www.livebinders.com/	Create digital portfolios

D. *Creation Tools*

Tools and resources for cloud education	
Purpose	***Estrategy***
Creation	Útiles para la creación y representación de las ideas o los conceptos
http://cmap.ihmc.us/	Useful for the creation and representation of ideas or concepts
http://prezi.com/	Presentation of ideas with zoom.
http://audacity.sourceforge.net/?lang=en	Recording and editing podcasts
http://www.gimp.org/	Image Editing
http://camstudio.org/	Videotaped desktop activity. Very useful for create tutorials.

E. *Interaction tools*

Tools and resources for cloud education	
Purpose	***Estrategy***
Interaction	Allow the exchange of information, ideas, resources, or materials in multiformat
http://www.facecoop.org/	Spanisih social network on cooperation

Tools and resources for cloud education	
twitter https://twitter.com/	Social network
moodle http://moodle.org/?lang=en	Tool for creating online courses.
Google Groups https://groups.google.com/	Virtual communities
InfuseLearning http://www.infuselearning.com/	Tool for creating learning spaces for students and teachers

VII. EXAMPLES OF THE TOOLS USED

A. *Our blog with Blogger*

This was the first tool that came into use on the network is the main function of communication but also serves as documentation of the process and even the expression of ideas as a comment to the posts.

Link: http://cooperacioneducativa2012.blogspot.com/

B. *Our Wiki with Wikispaces*

This Wiki was created with the idea of having quick access to all web links grouped by sorted according to the lines of action and the strategic lines established in our education Sector Action Plan.

Link:

http://cooperacioneducativa2012.wikispaces.com/

C. *Our Twitter*

Cuenta: @cooperacioneduc

D. *Our topics with Scoop. it*

With *scoop.it* we create a constantly updated newsletter.

Links:

http://www.scoop.it/t/noticias-sobre-educacion

http://www.scoop.it/t/cooperacionydesarrollo

http://www.scoop.it/t/noticias-sobre-guatemala

VIII. SOLUTIONS TO SPECIFIC PROPOSALS

A. Symbaloo Catalogs by country

At the network we feel the need for a directory of organizations, experts and national and international partners. After creating the database on the 23 priority countries we uploaded it to Symbaloo that lets us create and share these "webmix": virtual desktops with all links grouped by color:

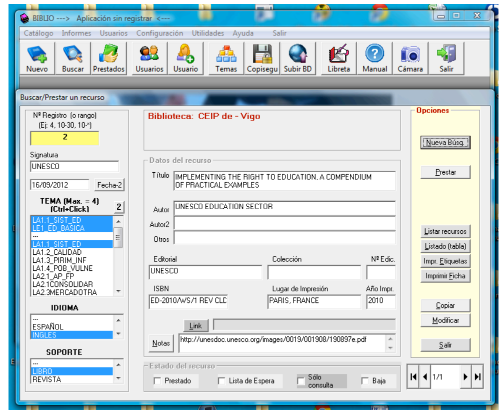
- **Orange:** AECID country office, Cultural Center, Embassy
- **Blue:** International organizations such as UNESCO, UNICEF, UNDP, OEI, SICA
- **Black:** Country Profiles: site profile at AECID webpage, HDI Human Development Index by UN, World Bank statistics, Wikipedia entry, Sheet country statistical office of UNESCO-UIS, entry on Relieweb on humanitarian action, and the refence of Human Rights Wacht for.human rights issues
- **Brown:** The main stays of government: The Ministry of Education, the educational portal, the web and general government body responsible for planning or related international cooperation
- **Green:** major NGDOs education sector with a presence in the country
- And last **blank,** national entities related educational

Links:

http://www.symbaloo.com/mix/educacioacute-nguatemala

B. Document Management System with Biblio

The volume of documentation generated in network was becoming bigger so that it required a management system such documentation for this and as in previous case import the database created in Excel software program created BIBLIO by the Department of Education of the Government of Galicia to manage school libraries who also asked for permission to use it. This program allows us to export the catalog that is stored in a file or on the web so that whoever installed the program to import the file and get the complete catalog.



Download link:

http://www.edu.xunta.es/centros/ceipdepetelos/?q=node/16

IX. CONCLUSIONS

En n this paper we have presented a wide range of options towards the implementation of a system of "learning cloud" on the net now the rest is kept in engagement with the end goal of all this is basically inform, educate ourselves, share information and work in a collaborative environment to improve our professional and personal performance. At the end of the material presented here are but mere tools that can help us for achieve these higher goals.

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weSPOT: A cloud-based approach for personal and social inquiry

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***Abstract*—Scientific inquiry is at the core of the curricula of schools and universities across Europe. weSPOT is a new European initiative proposing a cloud-based approach for personal and social inquiry. weSPOT aims at enabling students to create their mashups out of cloud-based tools in order to perform scientific investigations. Students will also be able to share their inquiry accomplishments in social networks and receive feedback from the learning environment and their peers.**

Keywords-social learning, scientific inquiry, personal learning environment, cloud learning environment

I. Introduction

Seely-Brown and Adler [1] describe learning as "based on the premise that our understanding of content is socially constructed through conversations about that content and through grounded interactions, especially with others, around problems or actions". In addition, learning is facilitated and triggered by one's individual interaction with objects in an (real) environment, constructing meaning and testing 'hypothesized' constructs while facing and (re)acting upon unexpected phenomena or problems [2].

Nonetheless, students in secondary schools and universities assume mostly a passive role within the classroom, whilst the mentoring role is often exclusively held by the teacher. Students are seldom motivated to take initiatives within their learning and extend it outside school settings, motivated by their curiosity. In an Inquiry-Based Learning (IBL) approach learners take the role of an explorer and scientist as they try to solve issues they came across and that made them wonder, thus tapping into their personal feelings of curiosity. It supports the meaningful contextualization of scientific concepts by relating them to personal experiences. It leads to structured knowledge about a domain and to more skills and competences about how to carry out efficient and communicable research. Thus, learners learn to investigate, collaborate, be creative, use their personal characteristics and identity to have influence in different environments and at different levels (e.g. me, neighbourhood, society, world).

Learners can go through IBL workflow processes at various levels of autonomy and complexity, consequently with various degrees of support [3]. At the highest level, called 'Open Inquiry' they are only guided by self-reflection, reason and they make sense of phenomena individually or collaboratively, organize and orchestrate their (shared) activities and construct and disseminate knowledge. At the lowest level, they are completely guided by the teacher when defining a problem, choosing a suitable procedure (method) and finding a solution.

In addition, students are not sufficiently supported by technology for conducting their inquiries and investigations in their everyday environment and in a social and collaborative way. weSPOT will employ a learner-centric approach in secondary and higher education that will enable students to:

1. Personalize their inquiry-based learning environment.
2. Build, share and enact inquiry workflows individually and/or collaboratively with their peers.

Thus, weSPOT aims to lower the threshold for linking everyday life with science teaching in schools by technology.

From the European teachers' perspective, the project will enable teachers as well as students to adopt methodologies for inquiry based science learning based on experiments conducted outside schools in a real environment. Such experiments could be backed-up with computer simulations and 3D images and video, which will enable students to go deep to the science subjects. This in turn will enable new models of learning and teaching to emerge, bringing students close to the research, and creating new bridges to business usage of science results.

The remainder of this paper is structured as follows. We will first explain how we plan to support personal and social inquiry based learning processes. Than we elaborate on the role of technology and its merit to support these processes. We conclude with future steps that need to be taken in order to support IBL.

II. Personal and Social Inquiry in weSPOT

weSPOT will develop a reference model for inquiry skills as well as a diagnostic instrument to measure the individual performance on inquiry skills. The reference model and diagnostic instrument are based on the five inquiry skills areas described by the US National Research Council [4]:

- engaging by scientifically oriented questions
- giving priority to evidence in responding to questions
- formulating explanations from evidence
- connecting explanations to scientific knowledge
- communicating and justifying scientific explanations to others

The reference model will define the skills and competence levels in inquiry and these are translated in observable indicators in the diagnostic instrument.

Based on the reference model, inquiry workflows will be defined, which can be build, shared and (en)acted individually or collaboratively. The role of the teacher as well as the peers can vary when a learner follow these workflows, based on the level of support needed by the learner(s), the need to reflect and/or to provide feedback and the need to collaborate to acquire an inquiry competence. So, the instructional strategy will vary, dependent on the learner, the context and the targeted inquiry competence level. However, learners are in most cases stimulated to go through the whole inquiry process, although the level of complexity of the inquiry tasks guiding their activities will vary [5].

Inquiry workflows can be described by graphical representations, whose aim is to help users visualize and orchestrate their inquiry projects. They are key to personal as well as social inquiry based learning. Learners can link diverse steps of their investigation as well as represent their scientific reasoning by integrating graphically their questions, hypothesis, concepts, arguments and data. Inquiry workflows play an important role as visual strategy and mediating tools in scientific reasoning. As knowledge mapping strategy, they enable users to connect and make their conceptual and procedural knowledge explicit. As reflective aid, they provide visual guidance for users rethinking and reasoning through their graphical representations. As visual language, they support users to make their argumentation clear for generating a coherent document outline.

When learners have acquired a certain level of inquiry competence, they are awarded badges, which make their performance visual for others and which may be used in their personal profiles within social networks.

III. Inquiry-based Learning and Technology

Inquiry-based learning can occur with or without technology. But technology can play a special role in supporting inquiry-based learning and in transforming the learning process. To better understand the context in which technology can support inquiry-based learning, two important aspects should be considered: technology can be viewed as the subject or tool for instruction, and can transform and enhance traditional practice. This is how technology is seen within the context of the weSPOT project.

To answer the question however, "Will technology has significant effect on learning?" one needs to determine the models of teaching and learning that underlie the instruction in the classroom. Pedagogy is the key element in applying the use of technology effectively. Looking at the interaction between pedagogy and technology so far, one can conclude that traditional pedagogy has not improved much by the addition of technology. Good pedagogy, on the other hand, can be made significantly more effective by appropriate uses of technology.

weSPOT adopting this approach does not recommend a one-size-fits-all inquiry-based learning model, but it takes the pragmatic view that the optimal level of inquiry is actually variable and it might differs between individual learners or groups. It has to reflect key factors in the learning situation, including the content, context, skill of the student, knowledge of the teacher, and the materials available. Students when compared to scientists are novices in scientific inquiry. When their current knowledge of the topic is limited, the intellectual demands of fully open inquiry may not generate effective learning and may even hinder learning by adding intrinsic or extraneus cognitive load. weSPOT's model will provide teachers and learners support and the technology tools to work 'up the ladder' to reach competence, progress and become able to find the optimal inquiry level to match the needs at hand.

IV. Related Work

The Personal Learning Environment (PLE) and the Cloud Learning Environment (CLE) have shown evidence of facilitating learning and addressing the current limitations of Learning Management Systems (LMS). Compared to a typical LMS, like Moodle or Sakai, where the learner is restricted by the lack of adaptability and responsiveness of the learning environment, the PLE follows a learner-centric approach. It allows the use of lightweight services and tools that belong to and are controlled by individual learners. Rather than integrating different services into a centralised system, the PLE provides the learner with a variety of services and hands over control to her to select and use these services the way she deems fit [6-8].

The Cloud Learning Environment (CLE) extends the PLE by considering the cloud as a large autonomous system not owned by any educational organisation. In this system, the users of cloud-based services are academics or learners, who share the same privileges, including control, choice, and sharing of content on these services. This approach has the potential to enable and facilitate both formal and informal learning for the learner. It also promotes the openness, sharing and reusability of learning resources on the web [9, 10].

Self-Regulated Learning (SRL) comprises an essential aspect of the PLE and the CLE, as it enables learners to become "metacognitively, motivationally, and behaviourally active participants in their own learning process" [11]. SRL is enabled within the PLE and the CLE through the assembly of independent resources in a way that fulfils a specific learning goal. By following this paradigm, learners are empowered to regulate their own learning, thus greatly enhancing their learning outcomes [12, 13].

In weSPOT, we are planning to apply at new level our experience from previous research projects. For example, in the Innovative Didactics for Web-Based Learning - IDWBL [14] project web-based learning comprised five forms: web referral, web quest, web exploration, e-mail project and collaboration. In such a way students were put in a situation to explore new methods and techniques, guided by teachers. They shared their innovative approaches which peers and teachers and in such way they enriched the traditional work in class. The teachers reported an improvement of the thinking process of their students and an increase in their motivation for learning.

In order to apply inquiry-based science education, teachers need to develop new practical methodologies, approaches and tools in their day-to-day practice. To address this need, an useful experience was the I*Teach methodology [15], which is based on active learning methods, with the student at the centre of the learning process and the teacher as a guide and a partner in project work based on didactic scenarios encouraging the creative thinking of learners [16]. This methodology focuses on the development of specific skills in the context of the ICT education: work on a project, teamwork, presentation skills, and information skills. This methodology was integrated in the TENCompetence pilot project [17], Share.TEC pilot teachers' training [18], and in the training of 750 VET teachers in Innovative Methods and New Technologies. It was integrated in the textbook for Information technologies teaching, used actively in the training of teachers for IBSE in Fibonacci project (http://www.fibonacci-project.eu/). In 2009 the I*Teach project has been awarded for best products results.

Another useful idea can be borrowed from WebLabs**,** European project focused on the development of a Virtual Learning Environment (VLE) and WebLabs learning model [19]. The VLE allowed students, teachers and geographically dispersed researchers to be involved in science and math learning and explorations. Students developed an understanding of mathematics as a science through partnerships in research activities. Additionally, students shared their results and collaborated with peers, thus gaining specific social experience [14].

On the base of all our experience from these projects we formulated the prerequisites for the successful implementation of inquiry-based science education (IBSE) in schools [20]: change teachers attitude and provide stronger support to students (at micro level), provide schools management support, form teachers team to share experience and best practices and provide the needed ICT support (at mezzo level) and national curriculum reform, constant training for teachers and provide rich set of resources based on ICT infrastructure (at macro level).

V. Technology Facilitating Personal and Social Inquiry

As we have learned from the European project ROLE (Responsive Open Learning Environments - www.role-project.eu), what is often missing from the PLE and the CLE, is not the abundance of tools and services, but the means for binding them together in a meaningful way. weSPOT will address this issue by providing ways for the integration of data originating from different inquiry tools and services.

We plan to realize this with the use of standard integration technologies, such as OpenSocial, which has become one of the de-facto protocols for data exchange between social applications on the web. Linked Data methodologies will also be employed in order to represent and connect the semantics of inquiry workflows. Most importantly though, weSPOT will enable the cognitive integration of inquiry tools by connecting them with the student's profile, as well as her social and curricular context. Individual and collaborative student actions taking place within different inquiry tools will update the learning history and learning goals of the student, thus providing them and their tutors with a cohesive learning environment for monitoring their progress.

The Web 2.0 paradigm offers new opportunities for social learning by facilitating interactions with other learners and building a sense of connection that can foster trust and affirmation [21]. Social learning, according to Hagel, et al. [22], is dictated by recent shifts in education, which have altered the ways we catalyze learning and innovation. Key ingredients in this evolving landscape are the quality of interpersonal relationships, discourse, personal motivation, as well as tacit over explicit knowledge. Social media offer a variety of collaborative resources and facilities, which can complement and enrich the individual's personal learning space, as shown in Figure 1.

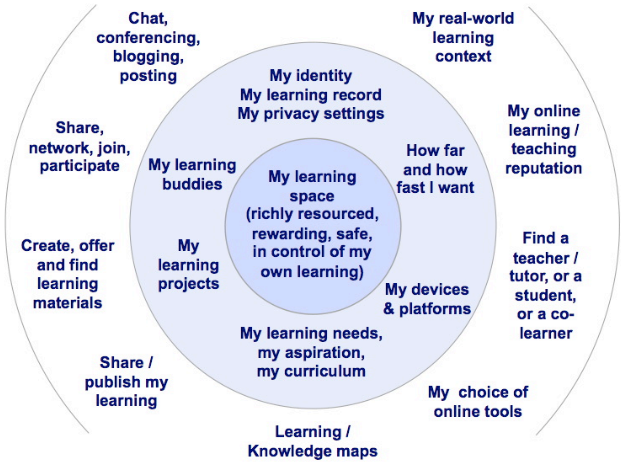

Figure 1. Personal learning space, resources, and social interactions [23]

weSPOT will provide students with the ability to build their own inquiry-based learning environment, enriched with social and collaborative features. Smart support tools will be offered for orchestrating inquiry workflows, including mobile apps, learning analytics support, and social collaboration on scientific inquiry. These offerings will allow students to filter inquiry resources and tools according to their own needs and preferences. Students will be able interact to with their peers in order to reflect on their inquiry workflows, receive and provide feedback, mentor each other, thus forming meaningful social connections that will help and motivate them in their learning. From a learner's perspective, this approach will offer them access to personalized bundles of inquiry resources augmented with social media, which they will be able to manage and control from within their personal learning space.

It should be noted though, that there is a significant distinction between the user-centric approach of the Web 2.0 paradigm and the learner-centric approach of weSPOT. This is because a social learning environment is not a just a fun place to hang out with friends, but predominantly a place where learning takes place and it does not take place by chance but because specific pedagogies and learning principles are integrated in the environment. Quite often, what students want is not necessarily what they need, since their grasp of the material and of themselves as learners, is incomplete [23].

In order to transform a Web 2.0 environment into a social learning environment, students need to be constantly challenged and taken out of their comfort zones. This raises the need of providing students with the affirmation and encouragement that will give them the confidence to proceed with their inquiries and investigations beyond their existing knowledge. weSPOT will address this issue through a gamification approach, by linking the inquiry activities and skills gained by learners with social media. In particular, this approach will define a badge system that will award virtual badges to students upon reaching certain milestones in their inquiry workflows. Students will then be able to display these badges in their preferred social networks. This approach will enhance the visibility and accrediting of personal inquiry efforts, as well as raise motivation, personal interest and curiosity on a mid-term effect.

Piloting the weSPOT inquiry tools with students and teachers in real-life scenarios in secondary education will be essential for collecting requirements and feedback from the end-users. The "Energy Efficient Buildings" pilot will concern the use of guided discussions to help students to identify disadvantages of the current building from the energy-efficiency point of view. Students will try to predict (providing evidence) future energy problems. Working in teams, they will develop reasonable ideas for future energy-efficient buildings. Teachers will be able to provide help by asking questions like:

- *What type of new materials for new energy efficient building components with reduced embodied energy to use?*
- *What technologies will ensure a high quality indoor environment, keeping in mind Ecology?*

In this way, students will learn better concepts and skills from the domain area, but will also learn new inquiry skills and competences.

VI. MOBILE SUPPORT

Mobile technologies enable the integration of inquiry project support into everyday life situations of learners. To support their individual or collective inquiry projects, several mobile services are foreseen within weSPOT:

1. A **mobile personal inquiry manager** supporting a self-directed approach for creating and managing inquiry projects and (the representation of) acquired competences (in badges).
2. A **context-aware notification** system that enables the contextualized sharing and notification of real world experiences. Learners can link inquiry projects to certain locations, physical objects, or combinations of contextual factors, i.e. the weather at a certain location at a specific time of the year. Furthermore, notifications can trigger the collection of data dependent on several parameters (location, time, social context, environment). This enables learners to easily link objects and locations of daily life to inquiry projects.
3. A **mobile data collection system** supports the direct submission of sensor data and manual measurements into the workflow system, to collect data to test a hypothesis. It also supports submission of annotations and multimedia materials, to enable reflection, peer support and collaborative inquiries.
4. A **mobile inquiry coordination interface** supports inquiry coordinators by giving them access to on-going multi-user inquiries and the contributions of all participants. It allows central dispatching of messages and management of tasks and data. In case of formal settings, teachers may use this service to keep an overview and to provide feedback, in informal settings

learners may use it to coordinate their self-initiated collaborative inquiry efforts.

VII. Conclusion

The weSPOT project will investigate IBL in secondary and higher education, aiming at supporting students in their scientific investigations through a cloud-based approach for personal and social inquiry. The project will explore technological ways towards lowering the threshold for linking everyday life with science teaching and learning. The specific added value in lowering this threshold will be investigated through pilots in real-life learning settings within secondary and higher education.

VIII. Acknowledgement

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement N° 318499 - weSPOT project.

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A Cloud Computing for the learner's usage tracks analysis

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***Abstract*—We present in this paper the definition of a collaborative and cooperative platform, exploited through the Cloud, for analyzing learners tracks and managing indicators in educational scenarios. This paper describes the architecture and the design proposed for the platform, then it evocates the related security aspect. Finally, a test scenario is described to demonstrate the platform functionalities.**

Keywords-CEHL (Computer Environment of Human Learning); pedagogical indicators; tracks analysis; Cloud Computing; web services

I. INTRODUCTION

In the context of distance learning, the assessment of the learner teaching activity becomes difficult due to the lack of feedback to the tutor. The analysis of the learner usage tracks generated by learning tools during training sessions is a way for supervising and monitoring the distant learners.

The tracks analysis is a process executed on multiple steps: (i) Collection of the observation data; (ii) Treatment of these data; (iii) Interpretation of the obtained data. The treatment and interpretation of the learner tracks can be performed by generating pedagogical indicators which have as main objective the improvement of the learner activity perception. These indicators would help the teacher to easily interpret the individual or the group educational situation and evaluate performed sessions. Indicators are dedicated to assist tutors in reengineering of their pedagogical scenarios. Actually, this reengineering means the improvement, the control and the reworking of the learning process according to learner's requirements and learning environment variations. Indicators are susceptible to give pertinent information about the pedagogical scenario execution.

Examples of indicators in literature are the following: the collaboration level indicator [1], the division of labor indicator [2], interests of a page indicator [3], and many others proposed by multiple works. Researchers operating in this domain have dealt with several aspects related to this type of indicators. These researchers are particularly interested by the aspects of reuse and capitalization of educational indicators. In order to implement these aspects, works (e.g. [1], [4] and [5]) have introduced the design patterns concept to describe the pedagogical indicator in a unified way by proposing a model reusable by others (tutors and institutional designers). So the design pattern approach comes to respond to the needs of sharing and reusing of the followings: knowledge, skills and expertise related to tracks analysis generating indicators in education and learning context.

Our research operates in this context precisely in the pedagogical indicators engineering which becomes an active research field. Indeed, a large number of indicators have been proposed in the literature (cognitive, social, educational, technical, etc. [5]). Each indicator, requiring expertise and knowledge in many areas that affect learning, is defined in different environments. Additionally, systems performing trucks analysis and indicators calculation require significant resources in terms of storage (a large amount of indicators), power calculation (a frequent and sometimes complex indicator's calculation) and cost (storage and computing resources, maintenance, etc.).

To respond to the above problematic, the idea was to regroup and capitalize these indicators into a unique shared platform available in the Cloud. This provides a way to exploit indicators with a collaborative and intelligent manner.

Our objective is to define a sharable platform for managing pedagogical indicators in the Cloud. It is a collaborative and a cooperative platform for sharing a set of indicators defined and integrated by several participants. This platform offers an indicators database integrated and exploited by several designers/tutors operating in different learning environments. A tool for managing this database is also provided by the platform.

In this paper, we present in the first part our approach proposed for the platform managing pedagogical indicators on the Cloud. Then we present the architecture and design for the platform, we evocate the related security aspect and we end by a test scenario demonstrating the platform functionalities.

II. TOWARDS A COLLABORATIVE AND COOPERATIVE PLATFORM FOR INDICATORS MANAGEMENT SHARED ON THE CLOUD

With the use increase of the Cloud architecture and its introduction into various areas, some educational organizations begin to migrate to this architecture. This is related to the fact that many schools or institutes do not have resources and infrastructure to integrate advanced e-learning solutions. Cloud computing is the basic environment and platform of the future e-learning [7]. It has become a high technology because of its scalability, availability, extensibility and efficient use of resources. "Blackboard" and "Moodle" which represent the biggest actors in E-learning world have now some application versions oriented Cloud [8].

The objectives of the migration of E-learning environments to Cloud architecture are to facilitate the learning, encourage openness, share and reuse the educational resources. In our case, the shared educational resources are the pedagogical indicators design patterns. So we propose to deploy a platform offering a database of indicator patterns and a tool for managing this database. These are accessible by a large number of users in different learning environments (CEHL[1]) as illustrated in "Fig. 1".

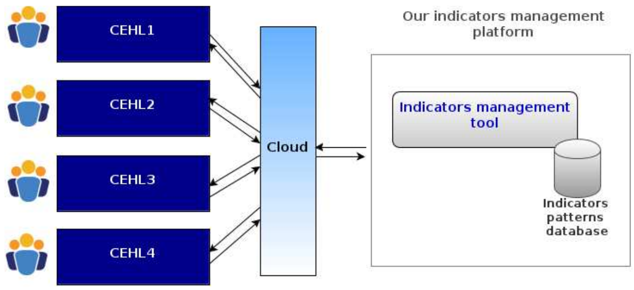

Figure 1. Approach for sharing the indicators management platform.

The indicators management platform is available on Cloud with SaaS mode, which means that it is managed and hosted in distant servers and its interfaces are available on the client side. The proposed tool is a browser-based application used as a service over the Internet, running on a flexible infrastructure.

This approach would support the aspect of reuse and sharing provided by the design patterns of educational indicators, and come out with other benefits. The main aspects we aim to attempt are the following:

1) *Share and reuse:* Ensure that the ressources of the platform are shared among multiple users in different CEHL by defining clear criteria for reuse. The shared ressources include the software (i.e. a tool for exploiting indicators and an indicator patterns database) and the hardware (i.e. computing power, large and secure storage, etc.).

2) *Interoperability and standardization:* Ensure that the platform components are interoperable. That means assigning the ability to function and to communicate with other systems by presenting uniform and standardized interfaces.

3) *Evolutivity and extensibility:* Define an architecture allowing the evolution and the extensibility of the platform. This encompasses the ability to easily extend the indicators database and also the ability to incorporate new features into the indicators management tool.

4) *High availability of resources and no servers maintenance:* Ensure the availability of the indicators database and the calculation tool to provide a good service quality. In addition the maintenance of servers is dedicated to the Cloud host.

5) *Simplicity and speed of access:* Provide speed and easy access to different features of the tool.

III. ARCHITECTURE AND DESIGN PROPOSAL FOR INDICATORS MANAGEMENT PLATFORM

We propose for our platform an open and a modular architecture shared on the Cloud. This ensures its reuse, interoperability, a high availability of resources and an easy way of use.

The architecture of the indicators management platform, shown in "Fig. 2", is composed of the indicator patterns database and the tool managing database, both deployed on the Cloud.

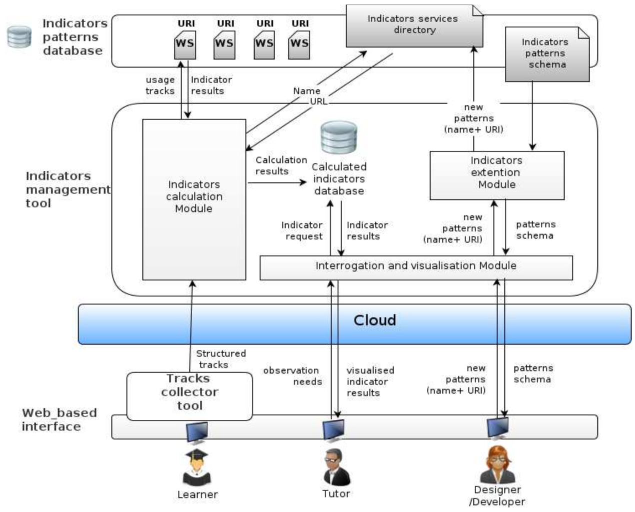

Figure 2. Detailed architecture for indicators management platform.

The platform's main objective is to exploit educational indicators facilitating the tutor perception of the situation of the monitored learner. This platform allows the indicators calculation and also the integration of new indicator patterns in an intelligent and collaborative way.

Three actors interact with the platform:

- *The Tutor:* transmits its observation needs to the tool which sends required indicator results;
- *The designer/developer:* adds new indicators to the platform according to a defined schema (the tutor and the designer/developer can be physically the same person);
- *The learner:* provides usage traces used by the tool (no access rights are granted to this actor).

The raw traces of the learner go through the "tracks collector tool" proposed in an existing work [9]. This tool is

[1] Computer Environment of Human Learning

responsible for collecting traces from educational devices and structuring them in the standardised format IMS-LIP[2].

A layer of RESTful Web Services (WS) is available on the Cloud forming the indicator patterns database. This consolidates the sharing, the extensibility of the database and its interoperability with other systems. The database contains the indicators managed by the platform stored as executable and capitalized patterns. So, a web service of an indicator pattern is an independent Cloud-based application able to execute the associated indicator function.

The indicators management tool is based on modules assisting actors in the exploitation of the shared indicators database. It allows accomplishing two main processes: The new indicator integration process and the indicator calculation process.

A. *New indicator integration process*

For the integration process of a new indicator pattern, the designer/developer begins by implementing the corresponding web service with any chosen programming language. He must follow the required indicator patterns schema provided by the platform. This schema describes exactly the format of requests and responses to WS that must be met by each new indicator pattern. This will enable the pattern to be integrated and used by the platform. After that, the designer deploys this web service on the Cloud and provides its name / URI [3] to the “indicators extension module” via the tool web interface. An “indicator services directory” accompanies the database for referencing available WS.

B. *Indicator calculation process*

For the process of calculating an indicator, the “Indicator calculation module” retrieves the structured traces provided by “traces collector tool”, and needed for the calculation process. These traces are sent to the relevant WS which performs the treatments. Then, the module retrieves the returned results and stores them in the “Calculated indicators database”. A tutor interrogates this database to obtain the indicators results.

C. *Indicator patterns schema*

The indicator patterns database is generic and can be grafted on any platform to generate educational indicators.

The “Fig. 3” models the "Indicator_pattern_webservice" interface and its related classes which describe the contract of an indicator pattern web service. This interface represents the schema that must be considered while implementing an indicator pattern WS.

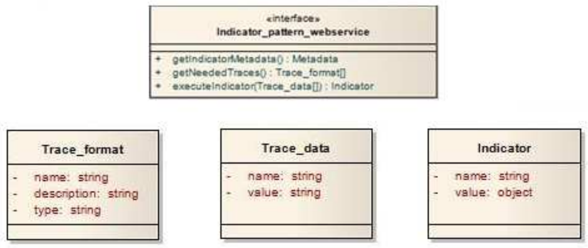

Figure 3. "Indicator_pattern_webservice" interface and related classes.

An indicator pattern modeled by a web service is called by a HTTP request containing the name of the method to invoke and the required parameters. After performing treatment related to the received request, the Web service can return a HTTP response containing:

- The metadata associated to the indicator pattern ***(getIndicatorMetadata():Metadata)***.
- The format of the learner usage traces needed to calculate the indicator ***(getNeededTraces():Trace_format[])***.
- The results of the indicator based on the trace data received on input ***(executeIndicator(Trace_data[]): Indicator)***.

Metadata, Trace_format, Trace_data and Indicator are a set of classes used by the interface.

1) Supporting indicator patterns proposed in existing works: The proposed platform is mainly characterized by openness and collaboration aspects. It is therefore conceived in a way allowing the acceptance of integration of different indicator patterns proposed by existing works. In this paper, we present an example which integrates the Reusable Indicator Patterns (PIR) proposed by Diagne [5].

Reusable Indicator Patterns are defined by an indicator function f() and a set of metadata [5]. We use these metadata to define the class *Metadata* (shown in "Fig. 4") forming the return type of the function *getIndicatorMetadata()*.

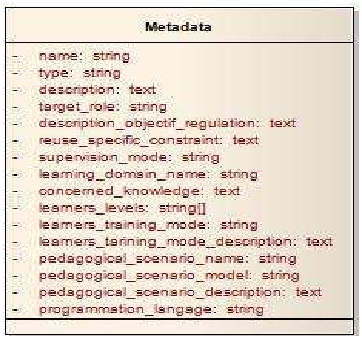

Figure 4. Metadata class based on Reusable Indicator Patterns.

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[2] IMS Learner Information Package: a standard based on XML, for exchanging learner’s data between several systems.

[3] Uniform Resource Identifier.

Other indicator patterns can be considered in the platform such as UTL patterns [10] and the collaboration indicator patterns [1]. Therefore our work is restricted to the PIR pattern.

IV. INDICATORS MANAGEMENT PLATFORM AND SECURITY

The choice to deploy our indicators management platform on Cloud led us to deal with the data security aspect. This is why we mainly focus on the data confidentiality.

The Cloud applications require strong confidentiality in the communication protocol used to access Web resources. Traces learners must be secured for reasons of confidentiality and protection of learner privacy.

The RESTful web services receive learner usage tracks in order to calculate the corresponding indicators. So it is necessary to ensure the confidentiality of these transmitted tracks. Many studies have worked on the security aspect of the RESTful web services. We propose to use in our approach the "REST security protocol" defined by Serme [11] which is a protocol designed to secure the RESTful services communications.

The "REST security protocol" ensures data confidentiality by encrypting their content. This protocol operates at the message level by adding HTTP-headers to transmit metadata.

V. FIRST TEST SCENARIO

We present in this section a test scenario of our indicators management platform in order to demonstrate the above mentioned features. At the moment of writing, our platform is still on the development phase.

For the implementation and the deployment of the platform in the Cloud, we use the "Google App Engine"[4].

The scenario consists of implementing a new indicator pattern as a web service deployed on the Cloud, integrating it into the indicators management platform and then using it by the tutor. To perform this scenario, we opt for the indicator "Participation Percentage (PART)" proposed by Dimitrakopoulou [2]. The PART function is mentioned in "Eq. (1)".

$$PART\ (ti) = Agents\ (ti) \,/\, TotalAgents \quad (1)$$

In our case, *PART(ti)* measures the participation level of a selected group of learners. *Agents(ti)* represents the number of different learners of a group have posted at least one message during ti time slot. *TotalAgents* represents the total number of learners collaborating on the group.

The "Fig. 5" illustrates the proposed process of the integration and the use of a new indicator pattern. This process matches the different phases of the scenario.

4 A platform offering users the ability to build and host web applications on Google's infrastructure

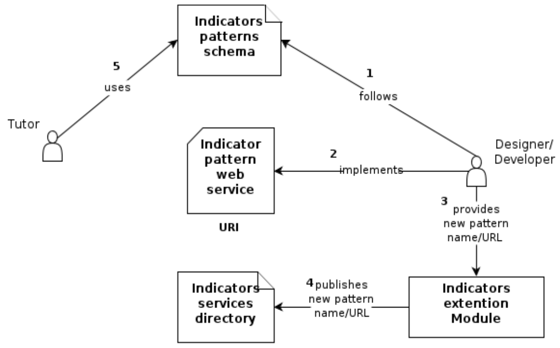

Figure 5. Process of the implementation and the integration of a new indicator pattern.

Phase 1 (follows): A designer/developer, detecting a new observation need on the participation of groups of learners, decides to implement a new PART indicator pattern. He begins by consulting the schema patterns of indicators that must be followed in the Web service implementation. This pattern is accessible via the web interface available for the designers. As shown in "Fig. 6", we choose to write the indicator patterns schema in SMD (Service Mapping Description) [12]. The SMD, which consists of a notation proposal based on JSON (JavaScript Object Notation), can be used for describing REST web services.

```
{
    "SDMVersion": "2.0",
    "transport": "REST",
    "envelope": "URL",
    "parameters": [...],
    "services": {
        "getIndicatorMetadata": {
            "type": "method",
            "transport": "GET",
            "_comment": "Returns the metadata of the indicator",
            "parameters": [ ],
            "returns": {
                "type": {
                    "name": {"type": "string"},
                    ...
                    "description ": {"type": "text"},
                    "domain": {"type": "string"},
                    ...
                }}
        },
        "getNeededTraces": {
            ...
        },
        "executeIndicator": {
            ...
           "parameters": [
                {
                    "type": {
                        "name": {"type": "string"},
                        "value": {"type": "string"
                    }}}
            ],
            "returns": {
                "type": {
                    "name": {"type": "string"},
                    "value": {"type": "JSONObject"}
          }}}}}
```

Figure 6. Extract of the indicator patterns schema.

Phase 2 (implements): According to the provided schema, the designer/developer implements the RESTful web service representing the new indicator with the preferred language. Subsequently, he deploys the developed web service on Cloud in the preferred host and keeps the service URI.

For instance, the following URI: **[http://part-indicator-webservice.appspot.com/rest/part/executeIndicator/20/1]** returns the following JSON result: **{name: PARTICIPATION PERCENTAGE (PART), value : 0.6}**

This result represents the value of the indicator PART equals to *0.6*. The URI returns also the equivalent result on XML. These various returned formats favorites interoperability.

Phase 3 (provides new pattern): To integrate this new indicator in the platform, the designer/developer adds the deployed web service URI through the available web interface (see “Fig. 7”).

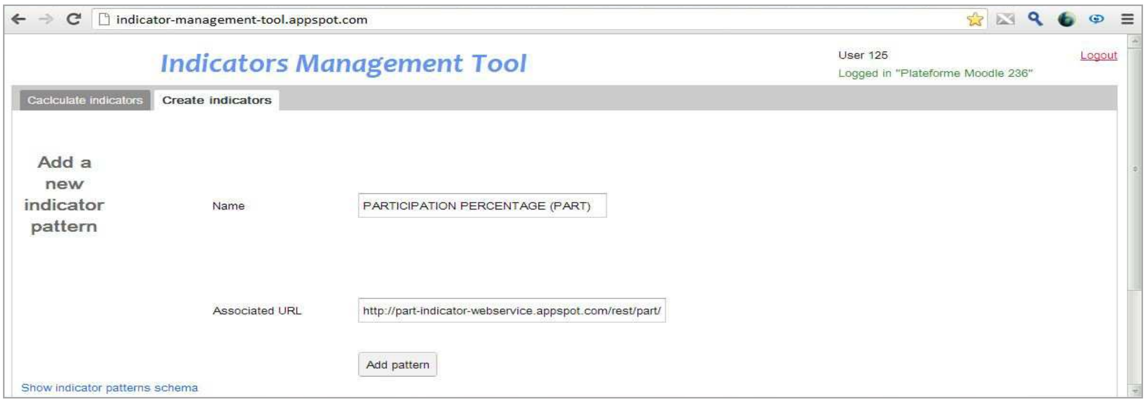

Figure 7. Web interface overview for adding new indicator.

Phase 4 (publishes new pattern): The “calculating module” publishes the Name/URI of the new indicator pattern in the services directory in order to be visible by the platform. An example of a services directory is shown in “Fig. 8”.


```
{"Entries": [
        {
            "name": "Collaboration level Indicator",
            "uri": "http://collaboration-level-indicator-
webservice.appspot.com/"
        },
        {
            "name": "Participation percentage PART ",
            "uri": "http://part-indicator-
webservice.appspot.com/rest/part/"
        },
        {
            "name": "Division of labor Indicator",
            "uri": "http://division-of-labor-indicator-
webservice.appspot.com/"
        }
    ]
}
```


Figure 8. Example of a services directory.

The JSON object in the red box shown in “Fig. 8” represents the entry of our added indicator. Except from the PART indicator URI that is useful, others are purely fictitious and URIs are added for demonstration purpose. The mentioned indicators names are extracted from an existing work [2].

Phase 5 (uses): A tutor can consult the list of available indicator patterns in the platform displayed in a web interface accessible via Internet (see “Fig. 9”). He selects the indicator PART from the list and provides the parameters needed for the calculation process. In our case, the parameter is the group of learners the tutor wants to observe.

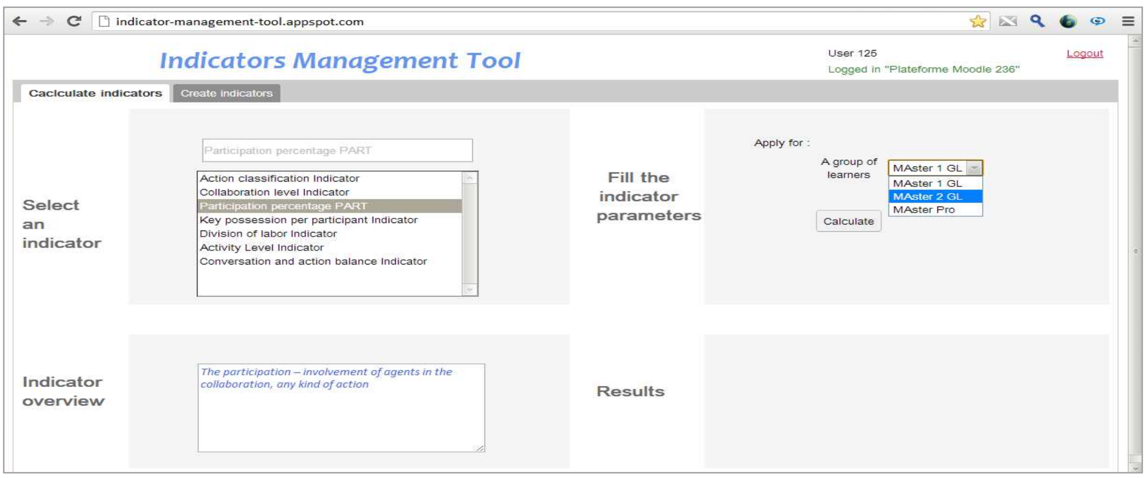

Figure 9. Web interface overview of the indicators search and calculation.

VI. CONCLUSION AND PERSPECTIVES

This work operates in the CEHL domain and particularly in learners tracks analysis performed through generating indicators. It aims to help designers/tutors in reengineering their pedagogical scenarios.

In this context, this paper presents a shared platform in the Cloud provided to the designers/tutors acting in various learning environments. This platform allows the designers/tutors to firstly gather a large number of indicators in a reusable, extensible and interoperable database, and to secondly equip them by a tool for managing this database. In other words, it is a collaborative and cooperative platform allowing the exploitation of a set of educational indicators defined and integrated by several participants.

Our proposal is a scalable and an open architecture for integrating indicator patterns by several designers/tutors in different educational environments. These indicator patterns are deployed in the Cloud and designed as reusable web services. This allows sharing experience, knowledge and expertise of the designers in various fields including computer literacy, education, psychology, etc.

The choice of Cloud architecture for the proposed platform provides the following benefits: (1) centralization of reusable indicators, (2) sharing and reuse of the hardware and software resources of the platform, (3) scalability and extensibility of the platform, (4) high availability of the platform resources, and (5) a quick and easy use of the indicators by tutors desiring to have a feedback on their pedagogical scenarios execution.

As perspectives of this work, we can envisage a set of improvements related to our indicators management platform like following:

- Integrate other indicator patterns proposed in the literature (e.g. UTL patterns [10], collaboration indicator patterns [1]).
- Provide advanced search functionalities for the indicators apart from the search by name. For instance, we can add a search by: type of indicators, operating domain, on-line publishing date, etc. These search functionalities are provided to the tutor through the web interface.

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Dynamic Customization of eTextBooks

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Abstract— **There is no reason eBooks should be monolithic containers of digital information, handled only with tools emulating their counterparts in paper. In this article, we propose to structure electronic text books (eTextBooks) as large numbers of low-granularity units that can be created, replaced and deleted independently by learning communities. We also propose a software service to dynamically deliver content units to eBook devices according to specified requirements. Our software service is deployed in public clouds infrastructure.**

eBook; ePublishing; learning as a service; cloud education accessibility

I. Introduction

The market for electronic books (eBooks) is rapidly growing and the publishing industry is constantly defining new concepts of eBooks. Consequently, eBooks content has evolved from text and images to richer multimedia assets. Nowadays, it is possible to customize eBooks in simple ways such as setting text size or adding annotations (bookmarks, highlights, notes, clippings) [1]. However, customization capabilities in eBooks are limited due to their treatment as monolithic entities. To overcome this constraint, we propose a new approach where eBooks can be handled as structures that can grow or shrink, and whose information units can be created, replaced, and deleted independently by users. Dealing with low-granularity units offers opportunities to collaborative publishing, which in turns allows customization guided by information needs. Thereby, each publisher community would produce content suited to their interest.

Our approach would benefit from using a cloud computing infrastructure due to the facilities that the Cloud offers both to service provides and users. In the Cloud, "service providers enjoy greatly simplified software installation and maintenance and centralized control over versioning; end users can access the service "anytime, anywhere", share data and collaborate more easily, and keep their data stored safely in the infrastructure." [2].

The proposed approach can be especially useful for educational and learning communities whose aim is to promote the construction of knowledge both individually and collectively. To this end, these communities must use mechanisms to guide and assess learners' progress. Our approach supports the teaching-learning process in two ways. First, by allowing collaborative publishing to physically distributed users. Secondly, by offering the possibility to customize eTextBooks as learning environments with learning assets (i.e., text, images, audio, video, 3D interactive objects) required by each student at any time.

The rest of this article is organized as follows: the background of the paper is presented at sections II and III. Whereas section II outlines the fundamentals of eBooks technology and its impact on education, section III deals with the use of cloud computing in learning environments supported by eTextBooks. Then, section IV presents a usage scenario of our proposal, and in section V, we describe the architecture of our eTextBook service (eTBS). Finally, we present the conclusions in section VI.

II. eBook current technology: Its impact on education

Publishers are preparing for the digital future of books in general and textbooks in particular. They are indeed attracted by the possibility to produce, modify and distribute their products cheaper by focusing in target customers. A main challenge is to avoid the proliferation of publishing formats generated by platforms of eBooks distribution, namely Kindle for Amazon, Nook for Barnes & Noble, iBook for Apple, Kobo and Sony Google. In this sense, the International Digital Publishing Forum (IDPF) is doing a successful effort to define a publishing standard: ePUB that is being adopted by the main. Only Amazon has not embraced the format yet. Apple belongs to the IDPF Forum but its file-format is not fully compatible with ePUB.

ePUB3 is the third major release of the open standard format of the IDPF for digital publications and documents. The specification is based on web-standards shaped to specific books needs. Briefly, ePUB3 is XHTML content with some additional structure and metadata packaged in a .zip file (see Fig. 1). It emphasizes the dynamic typesetting of content adapted to the reader consumption taking into account screen size, screen resolution, preferred font size. Besides, it enables structured and accessible content that is interoperable between devices both for downloaded and online consumption. ePUB, it provides video an audio support; text and audio can be synchronized and allows Java Script execution.

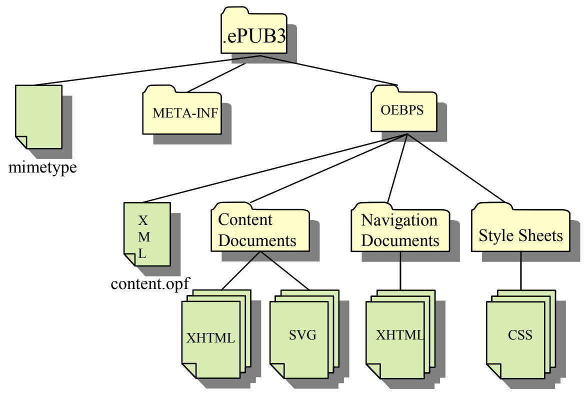

Figure 1. Structure of an eBook following ePUB3

From an educational perspective, traditional books are more suitable as tools for behavioral practices of education where students are passive consumers of information. Books act as close containers of organized information with limited possibilities of active learning. Among these possibilities is worth mention annotating, an effective and efficient study strategy which promotes learners' active involvement in constructing ideas [3].

eBooks ease lecture comprehension with the inclusion of dictionaries and the possibility of consulting other sources of information interactively via web. Comprehension is also facilitated by eBooks capabilities to provide multimodal information adapted to learners' perception preferences [4].

With the advent of eBooks, learners become active actors in the building of knowledge. Highlighting and annotation acquire a social dimension when combined with cloud computing and web services. For instance, these social features are already provided by Kindle and Kobo. These eReaders allow sharing eBook comments and highlights to Facebook and Twitter.

Learners' engagement is promoted by interactive capabilities of eBooks. Learners can manipulate virtual objects, simulation of experiments and on-reading testing receiving the feedback that stimulate active reflection. Apple has been the pioneers integrating interactivity into their iBooks textbooks.

Models of instructional design that promote deep learning establish that (1) learning is a product of understanding; (2) understanding occur best through performing tasks and (3) learning is a social activity [5]. These three factors can be fulfilled by eBooks with current technology. However, further efforts are necessary to turn the eBook into an integrated learning environment where students be guided in meaningful activities and the social construction of knowledge will be not only allowed but actively promoted.

The aim of this work is to contribute in the social aspect of building knowledge by a community of learners using eTextBooks as learning environments.

III. Considerations about the use of cloud computing in learning environments supported by eTextBooks

Internet and mobile devices have democratized the access to data; they have contributed to impose the culture of ubiquitous access to information. Meanwhile, a silent revolution was taken place in the scientific world, technology known as grid computing enabled sharing, selecting and aggregating of a wide variety of geographic distributed hardware and software resources to communities of scientists [6]. Pioneers of grid computing where following L. Kleinrock's vision: "As of now, computers networks are still in their infancy, but as they grow up and become sophisticated, we will probably see the spread of *computer utilities* which, like present electric and telephonic utilities, will service individual homes and offices across the country" [7] an cited in [8].

According to the National Institute of Standards and Technology (NIST) [9], the cloud model is composed of five essential characteristics: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured services; three service models: Platform as a Service (PaaS), Software as a Service (SaaS), and Infrastructure as a Service (Iaas) and, four deployment models: private, community, public and hybrid cloud. It includes market-based resource management strategies previously used in Grid computing to guarantee performance, availability, latency and quality-of-service (QoS) requirements. These requirements are constrained by the availability and capability of resources, performance measures and costs.

Cloud computing is a relative new phenomenon and large companies are still anxious about data failures, slow delivery of data over a network, and vulnerability of their confidential information. However, the most relevant eBooks sellers such as Amazon, Apple, Barnes & Noble, Kobo Inc. offer their eBooks services through the Cloud proclaiming the facilities to access the book any time, any where and, using any portable device. Using the cloud as a distribution platform has also reduced the books' prices. Finally, the cloud has also provided a medium to establish communities of readers as in Kobo Inc.

The educational sector is starting to embrace cloud computing. An initial overview of the use of cloud computing in education has been presented by N. Sultan at [10]. In the study, the Washington State University's School of Electrical Engineering and Computer Science and schools of Kentucky's Pike County district are mentioned as examples of institutions which use cloud platforms (cSphere4 and IBM data center respectively) to reduce costs. Amazon Web Services is been used to support peaks of workload of the course "Software Engineering for SaaS" of the University of California At Berkeley. Google Apps is been used at the University of Westminster and several African schools to rely on the latest technology and reduce costs. Thus, education institutions seem to be opened to this new paradigm.

IV. USAGE SCENARIO

Omar, María and David are starting the module "People and Societies" in their History course. They live in different districts in Madrid and belong to three different schools which are using our eTextBook service to support the course. Omar, María, and David are Muslim, Catholic, and Jewish respectively.

As a pilot experience, Omar's teacher coordinates the "People and Societies" module and customizes the eTextBook for all the three classes involved. She decides to include the basic content provided by the publisher along with multimedia assets produced by last year students about popular music of the three cultures involved. This year, these three classes will be deeply involved in learning about religions. Thus, Omar, María, and David will lead in their respective classes the organization of relevant information. Each school will augment their eTextBooks with the consensual information generated by their students. Finally, Omar's teacher will be responsible for customizing the final eTextBook for all the community.

Students work in their assignment in class using the eReaders provided by the schools, and at home using their smart phones. All devices have access to our service through a public cloud infrastructure which guarantees content accessibility.

Finally, education authorities in Madrid decide to use eTBS for this History course in all schools in Madrid. The scalability of the pilot is guaranteed by the use of a commercial cloud computing platform.

V. ETBS ARCHITECTURE

The eTBS architecture proposed herein is a four-tier architecture with a Presentation layer where the client is a eBook reader based on Readium, the eBook Layer allows users to access the eTextBook service, the Core Layer with a set of general-purpose services and the Data Layer to handle learning assets and students' records. This architecture is depicted in Fig. 2 and offers a complete service to customize eBooks using a public cloud infrastructure.

A. *Presentation Layer*

Students will access their electronic text books though the Readium eReader which is based on ePUB3, the third major release of the standard ePUB for digital publications and documents. ePUB3 has features to embedded audio, video, scripting and interactivity within eBooks that might cause a significant impact on learning.

B. *eBook Layer*

Users interact with the services of the application through the eBook Layer. Users might include new learning assets by using the Resource Allocation Service and customize the eBooks with the Integration Service.

System administrators grant users' permissions through the Administration Service whereas the Resource Allocation Service allows users to include new learning assets in the Data Layer. The type of assets that a user can include in the Data Layer will depend on permissions granted.

The Integration Service enables the customization of eBooks. An eBook will include not only learning assets but also information related to students' profiles, team organization as well as the context and particular needs of the course. Students' profiles refer to students learning style, perception style and special difficulties. Team organization will determine who should share what assets. Context will be useful to choose contents relevant to a student community. The Integration Service is possible thanks to the scripting capabilities offered by ePUB3, with previous ePUB releases, this service is not feasible.

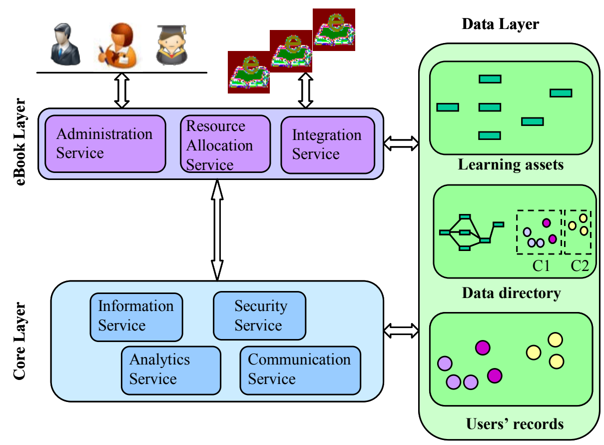

Figure 2. eTBS architecture

C. *Core Layer*

This layer provides essential cloud services for any eBook such as the Security, the Information, the Analytics, and the Communication services as well as a set of services required by the learning community.

Core Layer is also possible thanks to the scripting capabilities of ePUB3.

D. *Data Layer*

The Data Layer contains the learning assets that can be included in an eBook (Learning assets); data about the users of the application (Users' records) as well as the organization of the data (Data directory).

Learning assets encompass not only text and images as in any traditional book or eBook but also, multimedia elements such as video, audio, and 3D interactive objects that are beginning to appear in eBooks. Unlike current eBooks, learning assets are stored as low-granularity units along with metadata in the Learning assets area.

Data about users (students, teachers and editors) is stored in the User's records area along with metadata that allows for the structuring of the data as information for services. For instance, metadata includes users' security permissions and students' grading.

Data included in the Learning assets and Users' records areas are structured in the Data directory area in order to be recovered according to users' requirements in the context of core or eLearning services. For instance, learning assets are organized as dependency trees and all the assets referring to a specific learning topic can be accessed and then selected according their tags; students can be organized by courses and (or) working teams.

E. eTBS Architecture in the Cloud

We are using the ePUB3 standard for structuring the information in eBooks and Readium as eReader. ePUB3 supports a wide range of publication requirements, including complex layouts, rich media and interactivity, and global typography features.

The application development is been carried out at Universidad Carlos III of Madrid using Ruby on Rails as agile application framework. In a first step, the eTBS architecture will be deployed as a web service in our laboratories. In a second development step, we will use two public clouds that provide infrastructure as a service (IaaS). The services included in the eBook and Core layers (Fig. 2) will use the Amazon Elastic Compute Cloud (EC2) to configure the compute and network infrastructure. The eTBS's storage infrastructure (data layer in Fig. 2) will be configured using Amazon Simple Storage Service (S3).

VI. CONCLUSIONS

Electronic books allow adapting learning to new millennial learning styles, promoting the exploration and building of knowledge in group. The customization of books by specific communities intends to engage participants in the learning process.

Our approach is based on low-granular information, collaborative publishing, and customization of information according to specific needs of a community of readers. Cloud computing allows reducing costs and scaling the learning environment to bigger communities easily.

ACKNOWLEDGMENTS

This work was partially supported by the State of Madrid (Spain) under the contract number eMadrid S2009/TIC-1650 (e-Madrid) and EEE CICYT TIN2011-28308-c03-1.

We thank Florina Almenárez for encouraging us to write the paper and for comments that greatly improved the manuscript.

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Cloud computing for teaching and learning MPI with improved network communications

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***Abstract*—Nowadays, the teaching-learning processes are being supported by the development of new technologies. During the recent past, technologies such as email, chat, audioconferencing, videoconferencing and webconferencing were incorporated as new tools in the teaching-learning process. Currently, another step is being walked with the development and the popularization of cloud technologies that are arousing great interest in educational environments. There has been an actively development of cloud platforms with the release of several open-source solutions to build private, public and hybrid clouds such as OpenNebula, Eucalyptus, OpenStack and CloudStack. Each of them has unique features that are not found in the others.**

In the most basic cloud service model, Infrastructure as a Service, it is possible to provide computational resources as virtual machines. In Computer Science this model offers to teachers and students the possibility of managing virtual infrastructures in which system administration and programming languages practices can be performed without compromising the configuration of the underlying physical compute nodes.

In order to test a cloud infrastructure as a tool for learning MPI, two different scenarios were evaluated in this work using CloudStack: a virtual cluster as a MPI execution environment, and an improved virtual cluster whose MPI communication latency was improved. The results of this study are presented in this paper.

***Keywords*-cloud; CloudStack; OpenMPI; Open-MX;**

I. Introduction

Cloud technologies [1]–[6] are arousing great interest in educational environments as well as in business companies [7], and they are emerging as new tools that can be employed to support teaching-learning processes in a similar way that, in the past, technologies such as email, chat, audioconferencing, videoconferencing, webconferencing, virtual classrooms, and collaboration suites were incorporated to support these processes. As a result, there is an increasing number of open-source solutions to build private, public and hybrid clouds. Some of the most popular platforms are OpenNebula [8], Eucalyptus [9], OpenStack [10] and CloudStack [11]. All of them have unique features that are not found on the others.

In the teaching-learning processes, clouds, under Infrastructure as a Service (IaaS) model, could be very useful due to the fact that cloud users usually employ virtualized resources. Hypervisors provide the necessary abstraction layer and isolation in the same way as a sandbox. As a result, virtualized learning environments allow us to use the computational power of the compute nodes without the need of changing the physical host configuration, reducing the systems administration effort and isolating the physical host configuration from the student's virtualized environment. Furthermore, they allow users installing different guests operating systems and testing software that can coexist under the same physical hosts without compromising or modifying its configuration.

In this work, two different scenarios of a cloud infrastructure based on CloudStack for MPI learning are introduced: a virtual cluster as a MPI execution environment and an improved virtual cluster whose MPI communication latency was reduced. This paper is organized as follows. In section II the architecture and characteristics of the CloudStack platform are presented. Section III describes the two teaching scenarios deployed under CloudStack for learning MPI. In the first one a basic deployment is described, whereas the second one describes a scenario with improved performance. Section IV describes the benchmarks to evaluate the performance of both scenarios. The results obtained are presented in section V. Finally, the conclusions of this paper are drawn in section VI.

II. CloudStack

CloudStack is an open-source cloud management platform, owned by Citrix, whose software architecture is shown in Fig. 1. It is composed by five types of components: Compute Nodes (CNs), Clusters, Pods, Availability Zones, and a Management Server. The Compute Nodes are hypervisor-enabled hosts that have installed and configured the CloudStack agent. These hosts are the basic physical block that allow us scaling the platform. Additional hosts can be added at any time to increase the provided capacity for guest Virtual Machines (VMs). The hosts are not visible to the end users, therefore, they can not determine which hosts have been assigned to them to execute their guest

VMs. A Cluster is a collection of CNs that share the same hypervisor type and have also access to the same Primary Storage system. The Primary Storage stores the root filesystem of guest VMs. Clusters are not visible to end users and represent the second level of scaling. A Pod is a collection of clusters. It represents the third level of physical scaling in the CloudStack platform. As clusters, Pods are not visible to end users. The Availability Zone is a collection of Pods and a Secondary Storage that stores predefined VM templates and ISO images. It represents the fourth level of physical scaling. The Availability Zones are visible to the end user who must select one of those to start a VM for the first time. The Management Server manages the entire cloud.

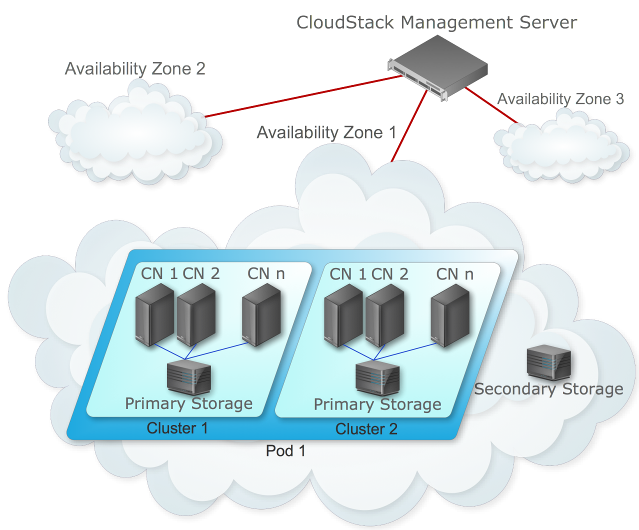

Figure 1. CloudStack architecture.

CloudStack supports three user roles: root administrator, domain administrator and not privileges users. The root administrator can manage the entire cloud. Domain administrators can perform the administrative operations for users who belong to that domain and do not have visibility into the physical CNs. The not privileged users can manage their own VMs.

The hypervisors supported by CloudStack are KVM [12], Citrix XenServer [13] and VMware vSphere [14].

This cloud platform can be managed completely through the Web management server. It also provides a RESTFUL API access to all its features. CloudStack also provides CloudBridge, which is a server process that runs in companion to CloudStack and provides an Amazon EC2 [15] compatible API to access to CloudStack using existing EC2-compatible tools. CloudBridge translates the EC2 API calls to the CloudStack's native API.

One of the most notable characteristics in CloudStack is the Web interface that provides a complete management of the cloud. We have observed very interesting options like the ability to define highly available VMs. They are kept operational by CloudStack without user or administrator intervention at all. Another interesting option for educational environments is the installation of an operating system using a standard ISO image. Its installation can be accomplished through the web interface without the need of using additional tools. This feature is very interesting because teachers or students can install their own VMs without the need of using predefined VM templates. Furthermore, teachers and students can create templates of their VMs that can be private, only visible for the users of a specific account, or public, visible for all users.

III. Teaching and Learning MPI with CloudStack

Message Passing Interface (MPI) is a language-independent communications protocol that has become a *de facto* standard for communication among processes that implements a parallel program using the message-passing model. Distributed memory supercomputer clusters often offers the use of MPI to their users.

The main goal of this article is to show how a cloud infrastructure can be used to teach MPI but following, at the same time, the Constructivism theory that allows students construct their own knowledge by means of their personal experience and interpretations. The role of the teacher is to be a help in the understanding, improving the learning quality and fostering the knowledge construction.

Students can deploy a safe infrastructure under CloudStack to learn the complete process including the installation of a VM, the configuration of the operating system, the installation of the MPI environment and the related development tools. Under this infrastructure, students must be able to carry out the performance analysis of their applications and testing and implementing different approaches to release a MPI solution for a given computational problem.

In order to test the CloudStack cloud infrastructure as a teaching-learning tool for MPI programming paradigm two scenarios were prepared and deployed. The first one is a basic testing setup scenario deployed as proof of concept, and the last one constituted an improvement from the first one, with the purpose of getting better performance. Both of them are described in the next subsections.

The purpose of these scenarios is to prepare the students for solving problems in complex environments. The Cloud technology will help to achieve this objective and thanks to the CloudStack Web interface, the teacher can assist the students easily and review their progress, focusing the attention on the most relevant topics. CloudStack provides flexibility to the teaching-learning process providing independence of time and space. The students can perform their activities without the need of being present in the computer laboratory.

The cloud infrastructure used is based on CloudStack 2.2.14 employing commodity hardware. CNs are Intel Core i5 nodes with 8 GB of RAM, employing CentOS 6.3 64 bits as operating system, and KVM as the CloudStack managed hypervisor. The NFS server, acting as CloudStack Primary Storage, is a Core 2 DUO 6600 @ 2.40 GHz, with 4 GB of RAM, 500 GB hard disk (7200 RPM SATA) and CentOS 6.3 64 bit. The interconnection network of this cloud is an Ethernet Gigabit Network with a MTU of 1500 bytes.

A. *Basic scenario*

In order to test the CloudStack cloud infrastructure as a learning tool for the MPI programming paradigm, it is necessary to deploy a virtual cluster. A virtual cluster can be defined as a cluster composed by Virtual Machines (VMs) where the parallel applications are executed.

In computer science, a cluster is a group of interconnected computers that work together, and which can be viewed as a single system. Typically, as shown in Fig. 2, two types of components can be part of a cluster attending the way that they are used: head and nodes. The head, or master, is the computer where the users connect. The nodes are intended as computational resources that will be employed to run user applications. Typically, users do not have direct access to nodes so they cannot log in. Users will launch applications from the head that will be executed on the nodes. Each computer that compounds the cluster runs its own instance of an operating system.

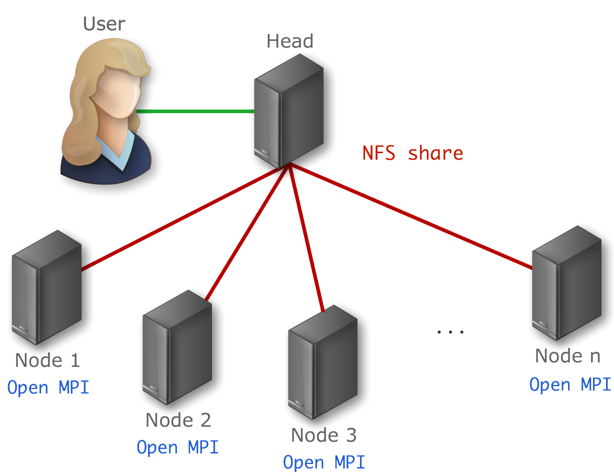

Figure 2. Cluster architecture.

The virtual cluster that students must deploy in CloudStack is composed by a VM configured as the head and two VMs configured as nodes. The deployed head is a VM employing a 10 GB hard disk, one core, 1 GB of RAM and CentOS 6.3 operating system. It also serves the home directory to the nodes that will compound the virtual cluster employing Network File System (NFS) as a distributed file system protocol.

The deployed nodes are VMs with a 10 GB hard disk, each one has one core CPU and 1 GB of RAM under CentOS 6.3 operating system. The nodes mount the head shared directories. A 1 Gb Ethernet network interconnection is being shared by the deployed virtual machines.

The deployed virtual cluster employs OpenMPI 1.6 [16] as MPI implementation. OpenMPI is an open source MPI-2 [17] implementation developed by a consortium composed by research, academic and industry partners. Its features include full MPI-2 standards conformance, thread safety and concurrency, dynamic process spawning, network and process fault tolerance, network heterogeneity support, and run-time instrumentation, among others.

B. *Improved scenario*

Due to the high latency of MPI communications over Ethernet networks using TCP, the performance obtained is limited. However, this latency can be reduced using Open-MX [18].

Open-MX is a high-performance implementation of the Myrinet Express message-passing stack over generic Ethernet networks. It implements the capabilities of the MX firmware running in Myri-10G NICs as a driver in the Linux kernel. For legacy applications, a user-space library exposes the MX interface to legacy applications. Open-MX supports Linux on any architecture and works at least on Linux kernels equal or greater than 2.6.15 version. It works on all Ethernet hardware that the Linux kernel supports and all connected peers, or compute nodes, must be on the same LAN. Therefore, any router can not be between them but switches. Open-MX is compatible with the IP traffic and can perfectly coexist on the same network and drivers. To setup Open-MX to be used by OpenMPI, it is necessary to take into account that OpenMPI must be compiled and installed enabling the Open-MX support.

The purpose of this scenario is to make students aware of the importance of the analysis of computer performance.

The virtual cluster employed in this setup has the same configuration as described previously but MPI communications are held by Open-MX, avoiding the overhead of TCP for communicating MPI processes.

IV. Benchmarks Description

In order to test the scenarios described previously, and making students aware of the importance of performance evaluation, three types of applications were executed: Intel MPI Benchmarks [19], the HEAT_MPI [20] example, and the Gadget-2 [21] application. The first one, the Intel MPI Benchmarks 3.2.3 (IMB), provides a concise set of elementary MPI benchmark kernels. It has several program parameters such as message lengths or selection of communicators to run a specific benchmark. IMB also provides a standard and an optional configuration. If standard mode is used, all parameters mentioned previously are fixed and must not be changed. The mode selected to test the virtual infrastructure is the standard ones. In this mode, message lengths varies from 0, 1, 2, 4, 8, 16 to 4194304 bytes.

The current version of IMB, contains different classes of benchmarks: Single Transfer, Parallel Transfer and Collective. The Single Transfer benchmarks are `PingPong` and `PingPing`. The Parallel Transfer benchmarks are `Exchange` and `Sendrecv`. The collective benchmarks are `Bcast`, `Allgather`, `Allgatherv`, `Alltoall`, `Alltoallv`, `Reduce`, `Reduce_scatter`, `Allreduce` and `Barrier`. `PingPong` is used for measuring startup and thoughput of a single message send between two processes. `PingPing` measures also the startup and throughput of single messages with the difference that messages are obstructed by oncoming messages. `Sendrecv` is based on `MPI_Sendrecv` and each process sends to its right and receives from its left neighbour in a chain. `Exchange` is a communication pattern often used in grid splitting algorithms, in which the group of processes is seen as a periodic chain, and each process exchanges data with both left and right neighbours in the chain. `Reduce` is the benchmark for the `MPI_reduce` function. It reduces a vector of length `L` float items employing the `MPI_SUM` operation. `Reduce_scatter` is the benchmark for the `MPI_Reduce_scatter` function that reduces a vector of length `L` float items employing the `MPI_SUM` operation. In the scatter stage, the `L` items are split as evenly as possible. `Allreduce` is the benchmark for the `MPI_Allreduce` function that reduces a vector of length `L` float items employing the `MPI_SUM` operation. `Allgather` is the benchmark for the `MPI_Allgather` function in which every process sends `r` bytes and receives a number of bytes that is equal to `r` multiplied by the number of processes. `Allgatherv` is the benchmark for the `MPI_Allgatherv` function that shows whether MPI produces overhead due to the more complicated situation as compared to `MPI_Allgather`. `Alltoall` is the benchmark for the `MPI_Alltoall` function in which every process inputs a number of bytes equal to `r` multiplied by the number of processes (`r` for each process) and receives a number of bytes equal to `r` multiplied by the number of processes (`r` from each process). `Alltoallv` is the benchmark for the `MPI_Alltoallv` function. `Bcast` is the benchmark for `MPI_Bcast` in which the root process broadcast `r` bytes to all. In this benchmark the root process of the operation is changed cyclically.

In the second place, we test the performance of the virtual cluster employing John Burkardt's HEAT_MPI [20], which is a C implementation of the 1D time Dependent Heat Equation employing a form of domain decomposition.

In the third place, we test the infrastructure employing the Gadget-2 software [21]. Gadget-2 is a freely available code for cosmological N-body/SPH simulations on parallel computers with distributed memory. It uses an explicit communication model implemented with the standardized MPI communication interface. Gadget-2 computes gravitational forces with a hierarchical tree algorithm and represents fluids by means of smoothed particle hydrodynamics (SPH). Gadget-2 can be used for studies of isolated systems, or in simulations that include the cosmological expansion of space, with or without periodic boundary conditions in both cases. In these types of simulations, Gadget-2 follows the evolution of a self-gravitating collisionless N-body system, and allows gas dynamics to be optionally included.

V. Results

This section shows the results for the three applications described in IV. They were obtained for the basic scenario, using TCP for communicating MPI processes, and for the improved scenario, using Open-MX for communicating MPI processes.

In the first place, we are going to show the obtained results for both TCP and Open-MX of the Intel MPI Benchmarks. The results obtained for both the `PingPong` and the `PingPing` single transfer benchmarks are depicted in Fig. 3. Notice that in all these figures the X-axis is in logarithmic scale. For the `PingPong` benchmark, the latency is reduced by around a 30% when Open-MX is used for communication in comparison to TCP, such as is shown in the square marks of the figure. The `PingPing` benchmark also gets its latency reduced, even in a bigger quantity (around a 36%) than `PingPong`, when Open-MX is used.

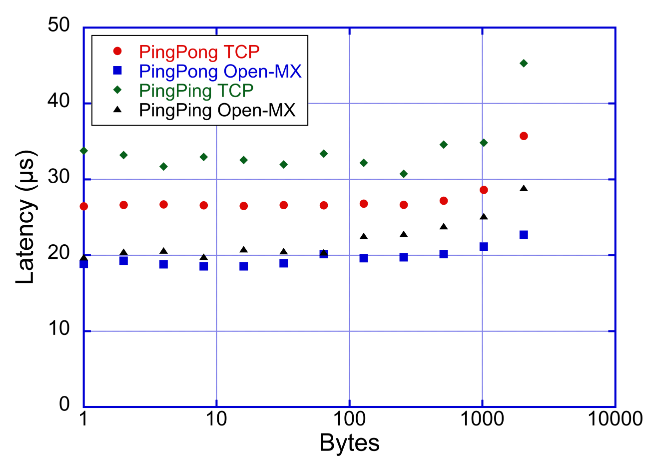

Figure 3. PingPong and PingPing single transfer benchmarks.

The results obtained for both the `Exchange` and the `Sendrecv` parallel transfer benchmarks are depicted in Fig. 4. For the `Exchange` benchmark, the latency is reduced by around 45% when Open-MX is used in comparison to TCP, such as is shown in the square marks of the figure.

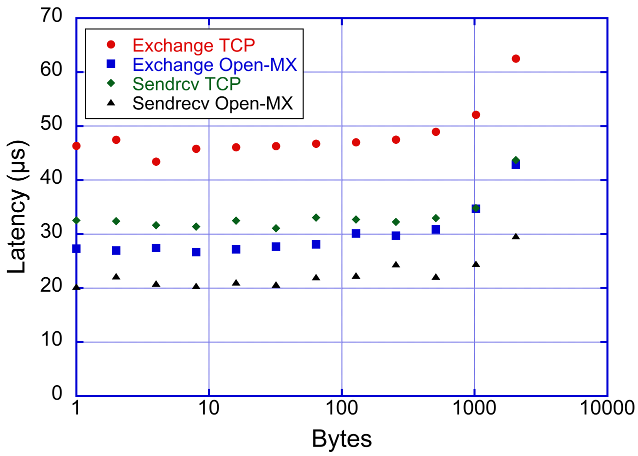

Figure 4. Exchange and Sendrecv parallel transfer benchmarks.

The `Sendrecv` benchmark also gets its latency reduced in 35% when Open-MX is used for communications.

The results obtained for both the `Allgather` and the `Allgatherv` collective benchmarks are depicted in Fig. 5. For the `Allgather` benchmark, the latency is reduced around 33% when Open-MX is used in comparison to TCP, such as is shown in the square marks of the figure. The `Allgatherv` benchmark also gets its latency reduced around 31% when Open-MX is used for communications.

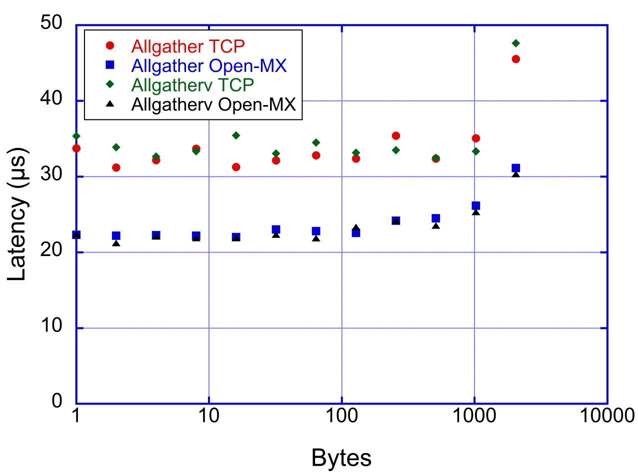

Figure 5. Allgather and Allgatherv collective transfer benchmarks.

The results obtained for both the `Alltoall` and the `Alltoallv` collective benchmarks are depicted in Fig. 6. For the `Alltoall` benchmark, the latency is reduced around 35% when Open-MX is used in comparison to TCP, such as is shown in the square marks of the figure. The `Alltoallv` benchmark also gets its latency reduced around 35% in a similar way as described previously when

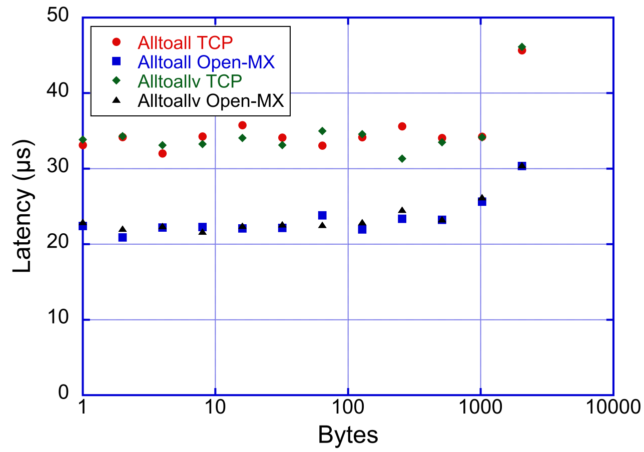

Figure 6. Alltoall and Alltoallv collective transfer benchmarks.

Open-MX is used for communications.

The results obtained for both the `Reduce` and the `Reduce_scatter` collective benchmarks are depicted in Fig. 7. For the `Reduce` benchmark, the latency is reduced around 35% when Open-MX is used in comparison to TCP, such as is shown in the square marks of the figure. The `Reduce_scatter` benchmark also gets its latency reduced around 32% when Open-MX is used for communications.

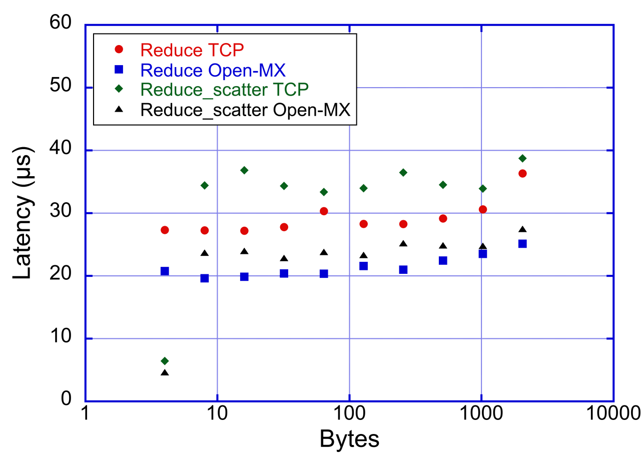

Figure 7. Reduce and Reduce_scatter collective transfer benchmarks.

In the second place, for the HEAT_MPI example, the performance is measured employing the computational elapsed time. When TCP is used to communicate MPI processes, employing two virtual nodes deployed under CloudStack, the elapsed time obtained was 22.708 milliseconds. When Open-MX is used, the elapsed time obtained was 15.878 milliseconds (a 30% better than TCP).

Finally, as a counter-example, Gadget-2 does not get a better performance when Open-MX is used for communicating MPI processes. This shows that the obtained improvements depend on a large extent of the problem.

VI. Conclusions

The development of cloud technologies are arousing great interest in educational environments. Cloud technologies are emerging as new tools to support teaching-learning processes in a similar way that, in the past, technologies such as email, chat, audioconferencing, videoconferencing, webconferencing, virtual classrooms or collaboration suites were incorporated to support these processes. Two characteristics of clouds are the use of virtualization technologies and the isolation between virtualized resources and the physical infrastructure. These characteristics convert this type of infrastructures into a very useful tool in teaching environments where teachers and students can perform experiments, avoiding compromising the configuration of the underlying physical infrastructure and reducing the effort of system administration tasks. As we have seen, teaching MPI on clouds, following the Constructivism theory, can be performed with the purpose of preparing the students for problem solving in complex environments. Therefore, two different scenarios, using commodity hardware and commodity interconnection networks, were deployed under CloudStack using KVM as hypervisor. The first one constitutes a virtual cluster for executing MPI applications. A virtual cluster can be defined as a cluster composed by virtual machines. The second one is an improved virtual cluster using Open-MX to get better latency of the MPI communications to make students aware of the importance of performing the computer performance analysis. Both virtual MPI infrastructures were tested employing the Intel MPI benchmarks, the HEAT_MPI example, and the Gadget-2 software. The obtained results show that executing MPI applications over the cloud were suitable and the latency of the MPI communications was reduced around a 30% using Open-MX in comparison to TCP. The elapsed time obtained for the HEAT_MPI example is also around a 30% better than TCP. However, depending on the implementation of the applications that will be executed using MPI, there are cases in which the improvements on the latency are not observed, as happened with Gadget-2. As it was shown, the experiments described can be performed by teachers or students as system administration, programming languages and performance measurement practices.

Acknowledgment

This work has been supported by FEDER funds and Xunta de Galicia under project 09TIC001CT, contracts 2010/28, and by Spanish Government (MCYT) under project TEC2010-17320.

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Render on the cloud: Using Cinelerra on virtualized infrastructures

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***Abstract*—Nowadays, the learning-teaching processes are being supported by the use of new technologies, including email, chat, online conferencing, online activities and videoconferencing. With the revolution of high definition television, video producers require more efficiency in the production and post-production tasks. There are several software available for this purpose including commercial solutions, often very expensive, and open-source ones, such as Cinelerra.**

This paper proposes a cloud infrastructure for using Cinelerra, a community developed version of non-linear video editor, and how educational institutions can use this. The main idea is to reuse its computational power for editing or creating educational videos without the need of acquiring a dedicated hardware infrastructure, employing non dedicated resources, such as the computer labs, or desktop computers to fix the most common time consuming problem: the rendering. The performance of the proposed infrastructure is also presented in this paper.

***Keywords*-Cinelerra; rendering; cloud; broadcast;**

I. Introduction

Recently, technologies [1] such as email, chat, online conferencing, online activities and videoconferencing were incorporated to support teaching and learning processes. Today we live the biggest revolution on computing, multimedia and TV, since the invention of color broadcast in the beginning of fifties decade [2]. Currently, teachers and students can watch videos on a variety of mediums, from mobile phones, computers and high definitions screens. These changes goes on the hand with the evolution of the information technology. They used the computing power of the new computers to create videos of superior quality and complexity from a bunch of source feeds.

It is well-known rendering is a time consuming task. Usually, the companies and training centers use expensive resources to reduce the edition time necessary to prepare the videos. In an educational environment, it could be better to create high quality videos without the need of incurring in license cost and without acquiring expensive dedicated hardware resources. This paper focus on how it is possible to reuse the existing computer hardware of educational institutions, such as schools, colleges and faculties to create educational videos, by implementing cloud and virtualization technology [3].

The cloud technology can be defined as some kind of parallel and distributed system [4], conformed by a lot of interconnected Virtual Machines (VM), or guest systems, providing dynamically computational resources on demand as a unified one. They are based on a Service Level Agreement (SLA) [5]. This technology is growing very fast as well as the computer resources that support it, specially the Service Oriented Architecture (SOA) [6] and the virtualization technology [3], using both hardware and software resources. The virtualization technology is the cornerstone of the cloud, as well known as Infrastructure as a Service (IaaS) [7]. The cloud technology can be used with different objectives. In our case we are interested to know the advantages of use it on video rendering process using the Cinelerra [8] application on a virtualized environment provided by a hypervisor layer.

This paper is organized as follows. The section II describes the implementation of the proposed infrastructure used to install Cinelerra and how use it to improve the rendering process. The section III describes two cases of study for the proposed infrastructure. The Section IV includes the performance evaluation of the proposed infrastructure performing several rendering tests. Finally, the conclusions of this paper are drawn in section V.

II. Proposed Implementation

The proposed infrastructure for executing Cinelerra, shown in Fig. 1, is composed by several types of components: physical compute nodes, a virtual master node, virtual render nodes and a Network File System (NFS), shared by the virtual cluster.

The physical compute nodes are an Intel Core I7-2820QM processor with a clock speed of 2.30 GHz and 8 GB of DDR3 RAM, with the VirtualBox [9] 4.1.14 hypervisor installed. This processor reports eight cores (with hyperthreading enabled). The master and the render nodes are VirtualBox VMs with two cores per VM, with 1 GB of RAM, taking advantage of the hardware virtualization extensions. The virtual cluster infrastructure (virtual master and virtual compute nodes) uses Ubuntu 12.04 LTS 64 bits as guest operating system, employing a Gigabit Ethernet interface. The NFS stores input and output video resources.

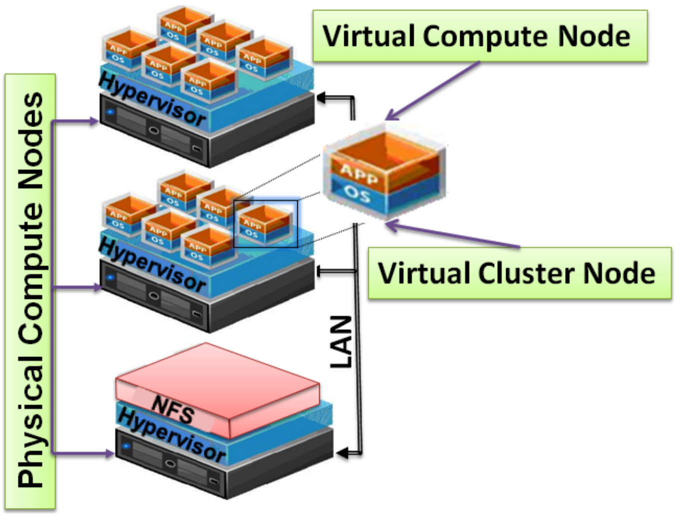

Figure 1. Schematic view of the implementation.

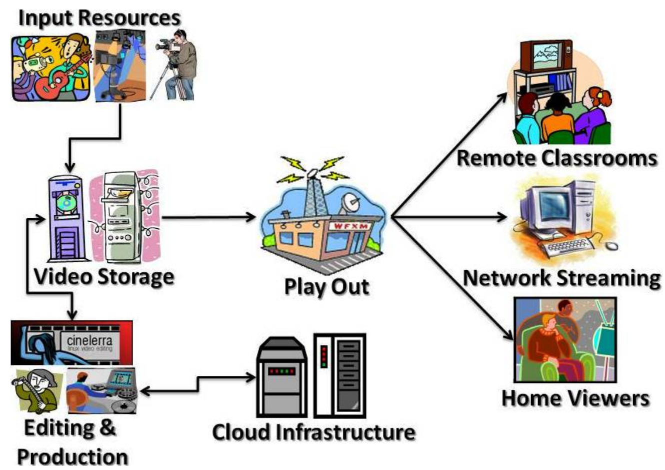

Figure 2. Use of Cinelerra at UNAH TV station.

III. Cases of Study

Two cases of study were proposed as examples of use of the infrastructure described previously. The first one is the implementation of Cinelerra over the infrastructure available at the National Autonomous University of Honduras (UNAH). The second one is using Cinelerra in a training center.

A. Cinelerra in the public UNAH TV channel

The infrastructure proposed previously can be implemented at UNAH in order to help the process of producing television content for broadcast on the public TV channel owned by the university, reducing the required time to obtain the final content for airing. This infrastructure takes advantage of the virtualization technology and the Infrastructure as a Service (IaaS) paradigm, allowing reusing the hardware available at UNAH for multiple applications.

Fig. 2 shows the work-flow that must be follow with the main objective to incorporate the advantages of rendering on the cloud. As shown in the figure, at UNAH TV station all the video and TV production starts with the introduction of the media content into the broadcasting system through a common point called *Input Resources* or *Ingest*. Here employing a serie of procedures, videos from a camera, studio, satellite, DVD, tape, etc. are converted in computer video files accompanied with a standardized metadata files that describes their content and properties.

As a result of the previous process, in first place, the video files are stored in the *Video Storage*, that is composed by a group of NFS servers configured with redundant arrays of disk drives. In second place, the metadata is stored in a database server. The *Video Storage* can be organized in hierarchical levels to distinguish videos of different origin, source, resources, media support and the edited ready to air videos.

In the *Editing & Production* department, the editors, equipped with powerful workstations, access to the hierarchical Video Storage to take the required resources that will be incorporated into the Cinelerra video project, including sounds, videos, images, and production scenarios. Once the video is edited, is ready for starting the rendering stage employing the computational power available at the *Cloud infrastructure* that is composed by non-dedicated hardware resources. The rendering stage ends with the creation of a final version of the ready to air TV program. The results of the rendering process are stored in the *Video Storage*, which can be taken by the operators of the *Play Out* department to be transmitted and make them available to final users. Those contents can be also accessed by the academic staff from the classroom using the existing university network, or to the general public employing Internet streaming.

B. Cinelerra as a tool in educational environments

This scenario proposed the use of Cinelerra as a tool in educational environments employing a cloud composed by non dedicated hardware resources. In this case, the cloud is employed as a rendering queue where the projects will be processed like in a batch system to get the ready to air videos. This case of study is shown in Fig. 3. As we can see, students create non-linear edition projects using Cinelerra in their workstations. Source videos, transitions effects, and the additional necessary media compose those projects. When the edition process is finished, the project is stored in the Master Node. This element shares the media directory employing the Network File System (NFS) protocol and has also Cinelerra installed as a render queue that manages the jobs pending of being rendered. These jobs are dispatched to the Virtual Render Nodes in which the ready to air video is created. The Virtual Render Nodes are Cinelerra enabled VMs that mount the NFS directories shared by the Master Node. The virtual Render Nodes can be executed in the

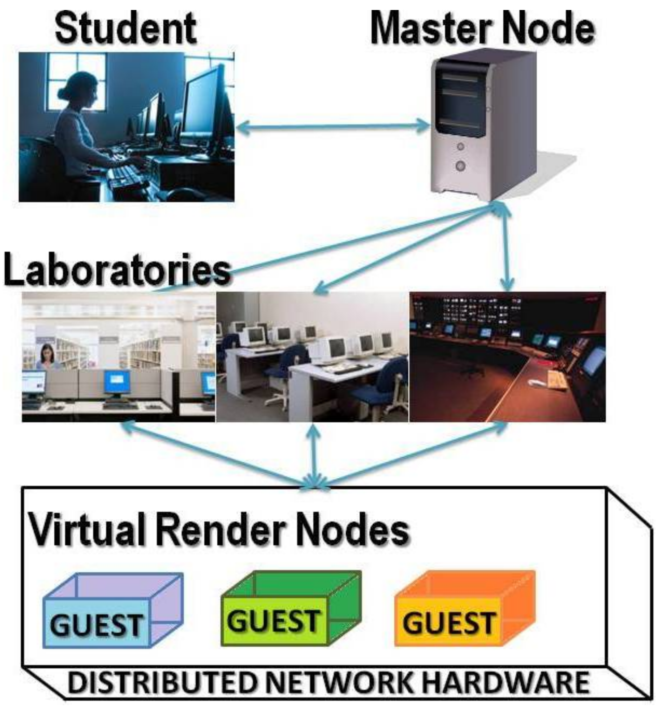

Figure 3. Use of Cinelerra by students with virtual render nodes located on remote computers on other rooms.

computer laboratories of the educational institutions. The video created by the rendering process is finally stored in the NFS shared directory of the Master Node. Notice that the student's workstations, the Master Node and the Virtual Render Nodes must be accessible and interconnected by a communications network.

The main goal of this scenario is the possibility to reuse the idle computational power available in the computer labs elastically, as they are available, to reduce the necessary time to get the rendering process finished.

IV. Performance Evaluation

In this section we included the performance analysis of Cinelerra over the proposed infrastructure, as described previously.

Cinelerra was used for editing and rendering video on resolutions of 720p and 1080i, with input/output streams used for high definition (HD) television. As a common standard for audio/video the codec MPEG4 [10] was employed. It has been on video editing world from last years of 90s decade.

To evaluate if the proposed cloud infrastructure could be considered as a good option for rendering, we prepare some tests. The first one was an output video of 40 seconds length with 1080/60p resolution. The second one was a video of 30 minutes at 720p. The third one was a video of 30 minutes at 720p, composed by thirty feeds of one minute without transitions or effects. We run the render tests only in the master with two cores, later with one and two nodes, employing two cores each one. The purpose of the tests is to know how much time is needed in every configuration and how the render process could be beneficed or penalized.

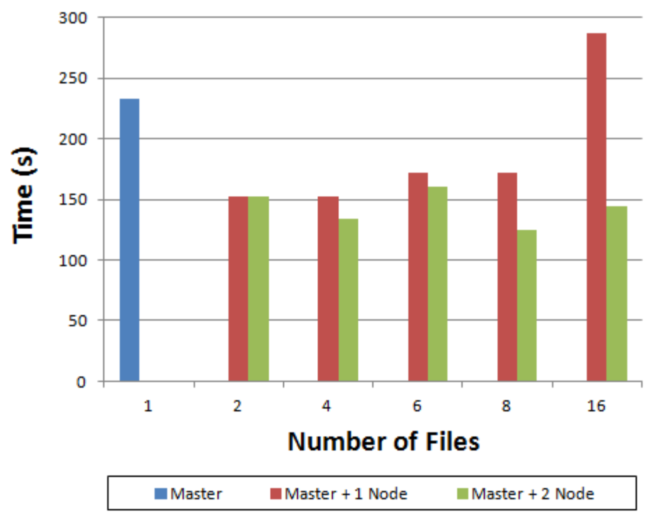

Figure 4. Performance with 40 seconds of video at 1080/60p.

When several nodes are used, we set the option in Cinelerra that allows to automatically dividing the job in several parts. Cinelerra itself splits the jobs trying to give the same number of render parts to all machines (including the master). In this way, the number of files generated scale with the number of nodes employed (from one when only the master rendering, two, four, six, eight up to sixteen). This method avoids that some rendering nodes were unused.

For the first test, the video of 40 s at 1080/60p, we can see the obtained results in Fig. 4. The master needed more time to finish than the other configurations, except when we used the master with one node and sixteen output files that required 287 s, the worst performance in this test. The best time was obtained employing the master and two nodes using eight files, requiring 125 s only. Employing the same combination with four files the time required was 134 s. Using the master and one node, the best result was quite the same using two and four output files; this was 153 s, this is 28 s more than the best result of all the present test.

Our second test was a project with an output video of 1800 s (30 minutes) at a standard resolution of 720p. In this project we joined some feeds and added transitions between every resource, applying basic effects. The rendering process took 6487 s for the master. This was the worst result on the present project. After adding one node to help the master, the efficiency was improved. The best result in this combination was 3605 s, allowing Cinelerra dividing the output render job in six files. After adding a second node, the shortest and best time was obtained employing eight output files that took 3072 s only. The results are depicted in Fig. 5. Because the previous video project are not homogeneous and contains

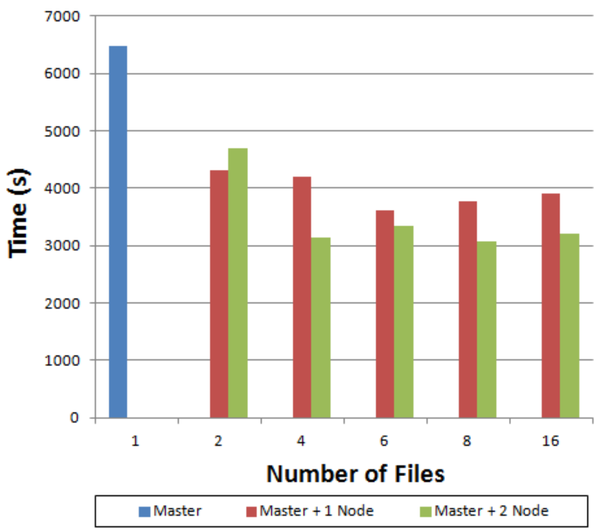

Figure 5. Performance with 30 minutes of video at 720p.

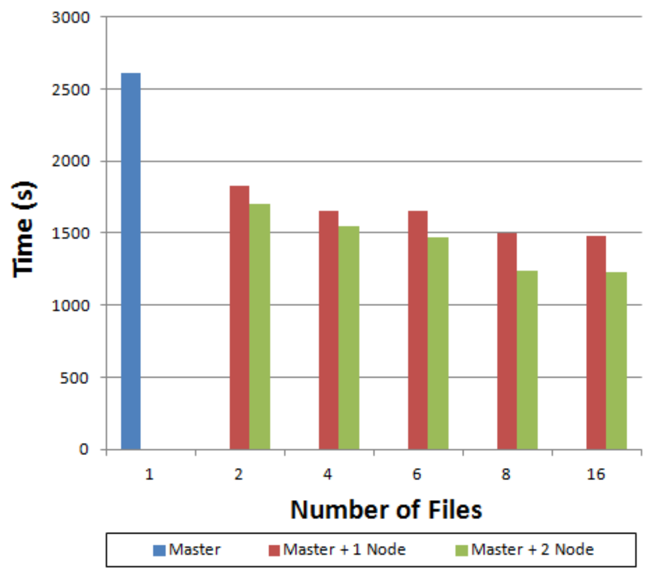

Figure 6. Performance with 30 minutes of video at 1080/60p. Shortest bars, better performance.

several types of effects and transitions, which mainly differ in complexity, we consider to be very interesting to know how the infrastructure proposed would behave to complete a project in which resources were homogeneous, allowing the nodes performing similar computational tasks. The third test, as shown in Fig. 6, was prepared employing 30 feeds one minute of video at 1080i without employing transitions. In this case, the better time was obtained with the master and two nodes, employing sixteen output files that required 1226 s The result is very similar employing eight files. The render using the master required 2614 s, the worst elapsed time in the present measures. Working with the master and one node, the best time was 1477 s, using with sixteen files. We got similar results when this configuration is used with eight output files as the difference was 24 s only.

V. Conclusion

The use of cloud technologies to create high quality videos in an educational environment is feasible without the need of incurring in license cost and without the need of acquire expensive dedicated hardware resources. This paper analysed a cloud infrastructure for using Cinelerra, a community developed version of non-linear video editor. As shown, this software could be used and employed by educational institutions for teaching video techniques and to create educational material. The main goal is to use, in a more efficiently way, the computational resources managing them as a virtual cloud infrastructure for rendering purposes. This avoids the need of acquiring a rendering dedicated hardware infrastructure allowing to reuse existing computer labs or desktop computers making them available to the students where they can easily render their videos.

The infrastructure and use cases proposed provide better performance when working with large projects. Therefore, if we want to render very small videos, the computing capacity available on workstation used by the students or editors will be sufficient to successfully complete the jobs.

It is important to mention that the proposed solution, based on cloud rendering, will be helpful in the process of creating multimedia for the TV station of the National Autonomous University of Honduras, Therefore, we can provide to end users, in a short period, large amount of quality television videos and multimedia using the idle computing power available.

The most important aspect of improving the rendering process is to have a greater chance to train better technical experts and to create fastest multimedia content, therefore, the students will have more computational resources to develop their projects and ideas, but without incurring in the cost of acquiring a dedicated infrastructure.

Acknowledgment

Part of this job was funded through the Fiduciary Fund of the Japan's government - UNESCO with the program Keizo Obuchi 2011-2012, and by FEDER funds and Xunta de Galicia under project 09TIC001CT, contract 2010/28, and by Spanish Government (MCYT) under project TEC2010-17320.

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Cloud Services for Learning Scenarios: Widening the Perspective

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***Abstract*—The term "Cloud Computing" does not primarily specify new types of core technologies but rather addresses features to do with integration, inter-operability and accessibility. Although not new, virtualization and automation are core features that characterize Cloud Computing. In this paper, we intend to explore the possibility of integrating cloud services with educational scenarios without re-defining neither the technology nor the usage scenarios from scratch. Our suggestion is based on certain solutions that have already been implemented and tested for specific cases.**

Keywords-Cloud Computing, Cloud Services, Scenarios

I. Introduction

Currently, Cloud Computing scenarios are often used to overcome certain limitations of mobile devices, desktop computers or server systems, especially to improve accessibility and interoperability. Hereby, Cloud Computing is usually subdivided into at least the three following parts [1]:

1. IaaS - Infrastructure as a Service: Virtual provision of computing power and/or memory. A prominent example of an IaaS service is the Amazon WS service.
2. PaaS – Platform as a Service: Provision of a runtime environment, like application servers, databases etc. In this area, Googles App Engine is probably the most prominent example.
3. SaaS – Software as a Service: Provision of usually browser based applications that can directly be used. Here, Google Docs or the Customer Relationship Management software of salesforce.com serves as examples.

One aspect that is common to these three levels is the high degree of automation that is pursued by these kinds of Cloud Services. On the IaaS level, Cloud Computing can be understood as virtualization technology along with a high degree of automation, whereas PaaS provides a flexible way for the deployment of applications and SaaS is able to provide applications directly to the end-user, again, in a flexible and highly automated way.

In this paper, we discuss possible contributions of Cloud Services to new forms of technology-enhanced learning and teaching. The term Cloud Services itself will be explained later on in more detail. Starting with an abstraction of the common understanding of Cloud Computing, transferring the abstracted features to other prominent internet services like, e.g., Twitter and Facebook (which we see as specific instances of Cloud Services in the context of this paper), we argue that in the context of learning scenarios a wider definition of Cloud Services is need to encompass possibly relevant new developments. Furthermore, this paper presents an architecture that allows the flexible usage of services that belong to the extended definition of Cloud Computing. We describe two examples of learning scenarios that build upon the presented architecture to demonstrate how these services facilitate innovative aspects of technology-enhanced learning scenarios. Finally, an outlook for future development of this understanding of Cloud Services is presented.

II. An Alternative Perspective on Cloud Services with Respect to Learning Scenarios

In abstraction, Cloud Computing increases the flexibility of modern applications while at the same time improving security aspects such as availability, data storage or communication. Furthermore, one major aspect in Cloud Computing scenarios is the accessibility of the provided services through a set of standardized services.

With respect to learning scenarios, a different perspective to these abstracted features of Cloud Computing services (referred to in this paper as Cloud Services) offers a new understanding of prominent services like Twitter or Facebook. These Cloud Services can then be used as entry points for value-adding functions both in formal and informal learning settings, remote and co-located situations and in synchronous or asynchronous scenarios. On the one hand using such services allows getting into contact with students on internet platforms where they spend a large amount of their time [2], and on the other hand, to use off-the-shelf software [3], which saves implementation efforts and development time, but allows for using contributions from the students via these different Cloud Services.

III. A Software Engineering Perspective on Cloud Services for Learning Applications

The reuse of software components is one of the building blocks of modern Software Engineering approaches. In [3] the authors state that the term "re-use" can be interpreted somewhat differently with respect to Software Engineering approaches for the field of Technology-Enhanced-Learning (TEL). On the one hand, there is the re-use of content, which seems to be fairly well accepted. On the other hand, there is the re-use of both single software components as well as the re-use of established and approved architectures. In contrast to the re-use of content, these two more technical aspects of re-use are not yet well accepted or used.

Here, the usage of cloud services might help to either increase the re-use of single software components, e.g., provided as Web Services, and the re-use of established and approved architectures.

Web Services, as one of the building blocks for modern Cloud Computing environments, provide in themselves the idea of providing re-usable software components. One view to Web Services is that the major idea of Web Services is to provide re-usable software components that are made available through a set of standardized protocols. These protocols support consumers of these Web Services through the complete development cycle from finding a particular service (e.g., in a UDDI repository), accessing the description of the service interface (e.g., described in WSDL) to consuming the service (e.g., by using protocols like SOAP or REST). Therefore, the provisioning of Web Services in itself already provides a big opportunity for re-using single software components and by using the mentioned standardized protocols, the re-use of these kinds of software components is even possible beyond the borders of a single organization, but the re-use of these services is, from a technology point of view, also possible beyond the borders of a single organization.

This is particularly interesting for learning scenarios, since in this area we do usually not have that many commercially oriented organizations or research groups. Instead, the different players are willing to share their content as well as their developed services among each other in order to foster collaboration among different learning communities. Of course, when it comes to content re-use, aside from the technological problems that are fairly easy to solve by using Web Services, other problems such as the ownership of the resulting learning outcomes and questions about the right to re-use these learning materials arise, as, e.g., discussed in [9].

From an architectural point of view, Web Services allow, due to their possibility of re-use, a completely new approach to the architectural development of the resulting software, and of course also for the resulting learning applications. Here, the development of new software can be performed based on an architecture that is usually referred to as a Service-Oriented-Architecture (SOA). The building blocks of a new software developed based on this architecture are services (in our context usually Web Services). The major idea of a SOA is to build new software based on a number of already existing services. The overall task that a piece of software should fulfill is usually split up into different subtasks that are performed by a number of different, and usually already existing, services. Later on, after completing all the subtasks, the results of these subtasks are aggregated into the solution of the overall task. The combination of the different services that fulfill the subtasks and the combination of the results if often referred to as "orchestration" and the produced code is often referred to as "glue code". Using a SOA based architecture nowadays changes completely the usual software development process from writing yourself every piece of code (even with the help of already developed API's) that is necessary in order to fulfill the task at hand, to finding services that support the developer in solving the special task, the orchestration of these services and providing/implementing the glue code that allows to solve the current task. In this sense, the Cloud Computing paradigm itself provides already a new approach for the architecture of learning scenarios.

Cloud services may also lead to an enrichment on the content level: The matching of user (learner) needs to available materials may draw on existing learner profiles, e.g. in social or professional networks, in addition to content-related of resources, possibly using semantic web technologies. The added value over conventional learning metadata approaches would be the open-ness and free connectivity of the environment.

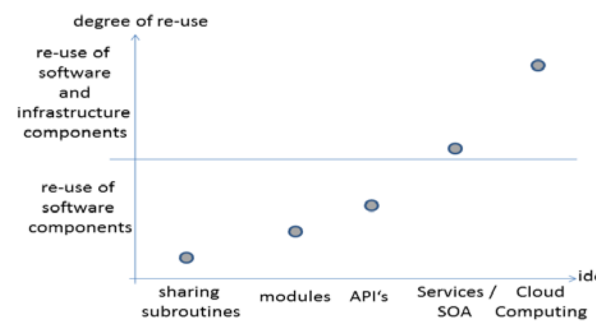

Fig. 1. Different degree of re-use with different software engineering approaches

From a technological point of view, Cloud Computing could be seen as the next consequent development step from a SOA to an architecture that does not only allow the re-use of content and services (in the terms of single steps in a process), but additionally as the re-use of computational resources. E.g. in an SaaS scenario a complete software stack would be re-used, which is pretty close to the idea of a SOA where basically single services are the major goal of re-use. On the next level, in a PaaS scenario, not single services are the target for re-use, but the infrastructure for running these services can be shared by different consumers. Last but not least, IaaS scenarios allow for re-using infrastructure on the lowest technical level, e.g., the re-use/sharing of computational resources (like virtual servers), network resources and/or storage resources. Hence, Cloud Computing allows to overcome the limitations that usually exist within SOA's, e.g., that the re-use is still limited to the content and/or the services in terms of process steps, and allows to provide re-use for the complete stack from single software services to the technical layer of the network and the storage.

The idea of understanding Cloud Computing as the consequent next step of software engineering in order to extend the re-usability to the level of not only re-using software components but also infrastructure components, is shown in Fig. 1.

IV. EXAMPLE SCENARIOS INCLUDING CLOUD SERVICES

Keeping in mind the previously mentioned benefits of Cloud Computing, services such as, e.g., Twitter and Facebook, provide similar benefits to computer-supported learning environments, e.g., by increasing flexibility, availability and the accessibility of services through standardized methods. Therefore, services as those described above can also be understood as cloud services and can then be used in learning scenarios in order to exploit the described benefits of Cloud Computing based services. Integrating cloud services as input channels.

Our suggestion does not primarily aim at defining new cloud environments for education. The idea is rather to connect specific educational environments, e.g. around virtual or face-to-face classroom scenarios, with existing Cloud Services. A technical infrastructure to support this is outlined in Fig. 1. The major task performed by this infrastructure is to provide a certain abstraction for the messages received through the different input channels, store these messages and later allow a flexible message visualization to be used in learning units.

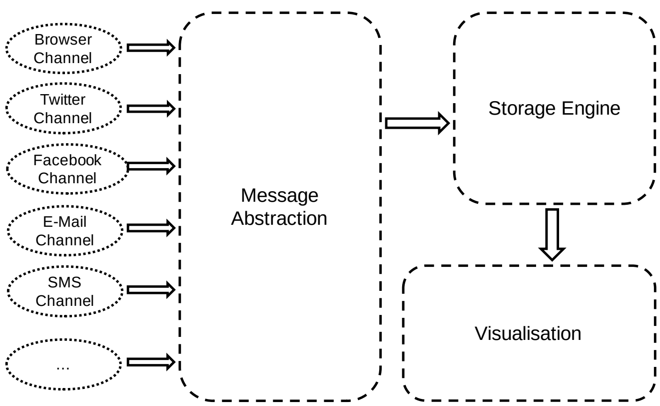

FIG. 2.ARCHITECTURE TO SUPPORT MULTICHANNEL INPUT

This architecture is a generalization of an approach that has been implemented and tested with certain specific cases [4]. In the sequel, we describe some example scenarios illustrating our understanding of the benefits that Cloud Services might bring to learning scenarios. Here, we see advantages in both, formal and informal learning settings. A differentiation can additionally be made with regard to synchronicity – contents can be generated and directly used in class, e.g., to support face-to-face scenarios, to replace moderation cards and flipcharts in individual and group work. Contents can also be generated in class and used in a future session.

One particular strength of integrating this kind of cloud services is that in addition to supporting and enabling the scenarios described here, it also supports seamless transitions between those scenarios. For example, it is intended to motivate the learners in informal learning scenarios, to contribute and make use of this content in a face-to-face classroom situation in a fully integrated way. The following subsections describe two scenarios which can be carried out with the help of the mentioned Cloud Services in more detail. Our basic approach is to use existing services to create, collect and visualize students' contribution in various educational settings and scenarios. These scenarios build upon established learning and teaching scenarios; their realization with the help of the before-mentioned Cloud Services and the proposed architecture add flexibility in time, space, synchronicity and re-usability of technology and data.

A. One-Minute Papers

One-minute-papers are a flexible and efficient way of collecting feedback from small and large groups of learners in seminars or lectures (also refer to, e.g., [5-7] for details and empirical findings on the method). Students are handed a piece of paper with questions they have to answer in (typically) one minute.

Example questions may focus on the contents of the seminar lesson, e.g., "What did I like?", "What was new to me?", "What do I consider important?", "What have I learned?" Furthermore, they may also ask for topics and relationships that are still unclear to the learner. In doing this, a personal dialogue is established between student and teacher, which can be especially difficult to establish in larger groups. According to Stead [7], this may improve student motivation.

With the help of our approach and architecture, these scenarios can be brought about by using any kind of computational device (e.g. notebook, smartphone, tablet) and the students' favorite input channels. Providing an environment that enables a computer-supported variant of the One-Minute Paper method brings relief to teaching staff by saving time and material compared to the pen and paper version. Students' comments can be easily organized, compared, visualized and stored. Especially for larger amounts of students, this is expected to ease the handling of learners' feedback. First experiences on the use of a web-based input service (available to smartphones, tablets and notebooks) to realize the One-Minute paper method have been recently described by Bollen et al. [10].

B. Supporting Self-Learning Phases

Another application scenario is the support of self-learning phases between classroom sessions. It is important for students to be able to transfer the newly acquired knowledge to situations in their everyday life. The discovery of one's own examples, together with a sensitivity for similarities and applicability, does also ideally lead to a deepening of knowledge and makes learning contents more easily retrievable when needed.

Tasks like this can appear in almost every domain at every stage of a lecture, seminar or student project. Results can be collected and visualized for an in-class usage. Besides this, as mentioned before, students are regularly prompted to report on situations and examples that illustrate the learning content. Therefore, the learner would be able to contribute and share examples for future sessions.

As an example, which originates from first experiences and trials, the learners' task was to relate a new topic in a seminar with everyday life's experiences. The teacher prepared sentence opener questions to guide the learners, who had one week time to collect and communicate their findings - using tablets, notebooks or smartphones and wherever and whenever appropriate.

Again, the proposed architecture allows for a flexible generation and accumulation of students' contribution over time, together with a visualization support that helps teachers and students likewise organize and share results.

C. Group discussion support

As a third application scenario, we present a situation that utilizes the described architecture in a synchronous, co-located manner. In a classroom situation, the proposed system can be used to visualize textual contributions that have been created by the learners and sent from various sources. These contributions are received and processed immediately and can be presented with the help of a large, shared display, e.g. by using a video projection. Similar approaches have been described, e.g., by Liu and Kao [11] and by Bollen et al. [12].

By these means, classroom discussions can be supported in a way that can be beneficial in a number of ways:

- contributions can be formulated and submitted without interference and influence from peers
- contributions can be submitted anonymously, which can raise participation in controversial topics or for more introverted persons
- the course and structure of a discussion can be made explicit in a shared visualization
- discussion results can be stored for later (re-)use, review and comparison

Scenarios like those described above benefit from the integration of Cloud Services by increasing interoperability of peripheral devices. Heterogeneous Cloud Services like Twitter and Facebook allow participation independent of both location and time.

V. Interoperability and Scalability of Scenarios

Important features of computer-supported learning environments are interoperability and scalability towards educational scenarios. Is a learning environment (or a set of a interoperating environments) scalable a) against an advancing number of different scenarios and b) against a varying number of involved students? Is a learning environment (or a set of learning environments) providing interoperability between different education scenarios, i.e. does it support smooth transitions between varying scenarios?

Most notably, computer-supported learning scenarios can be categorized along the dimensions of

- time: Is the user's interaction within the scenario considered synchronous or asynchronous?
- location: Are participating learners are co-located or are they in remote places?
- Group scale: How many learners are interacting in the given scenario?

To give two examples, in this scheme, a classroom discussion would be considered a synchronous, co-located scenario in a large group. A collaborative modeling activity between two learners using a shared workspace environment would be a remote, synchronous scenario in a dyad. Fig. 3 illustrates the dimensions described above:

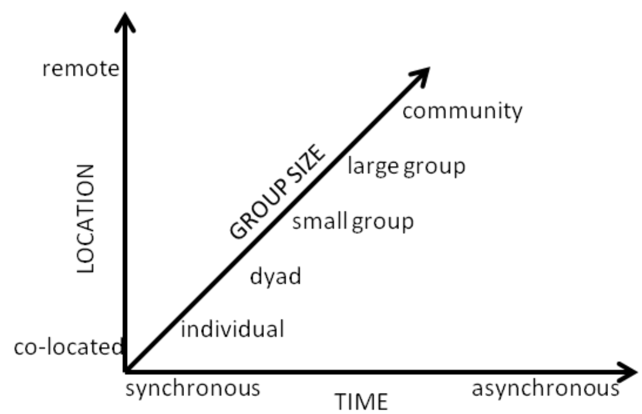

Fig. 3. Dimension of educational scenarios

Along these dimensions, we can further explain the aspects of interoperability and scalability of computer-supported learning environments. We can regard an environment being scalable, if it allows the realization of scenarios along instances of the dimensions mentioned above. We consider an environment being interoperable between scenarios, if it allows smooth transitions between instances of various scenarios.

As an example, if an environment allows the collection of learner's contributions individually over a period of time, and is able to present these contributions using a shared display in a classroom context, this environment is capable to scale over time and group scales, and we may consider it as being interoperable, if the transition between those scenarios requires little or no effort (concerning the use of devices, different software or configurations).

Here, we claim that the use of Cloud services (especially in a way presented in the architecture above), is a means to gain high scalability and interoperability, not only between hardware devices, operating system and software applications, but in particular between educational scenarios. From the point of view of cloud services in educational scenarios, which we are presenting in this article, cloud services are regarded as being advantageous in the context of this section, as they denote a very high accessibility in terms of time, devices, and platforms.

VI. Outlook and Future Work

The presented approach for the integration of Cloud Services into educational scenarios will in the future be used for the implementation of more flexible learning scenarios in which students can participate independent from time and location and by using their favorite communication channel.

Informal learning scenarios can particularly benefit from this kind of participation, as it allows for an easier contextualization of the learner, which is still a hot topic, in mobile learning scenarios for example.

Furthermore, this research allows empirical investigations in areas such as ease of use and usefulness of mobile devices in educational contexts, of relations between user traits and technology usage, or in uncovering usage patterns in this innovative field of computer-supported education. Also, the use of such services increases the possibilities for integrating analysis and context-awareness mechanisms, e.g., by using social network analysis or educational data mining techniques.

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Personal Learning Environments and Embedded Contextual Spaces as Aggregator of Cloud Resources

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***Abstract*—This paper presents how advanced social media platforms can be exploited as personal learning environments, thanks to the core concept of shared spaces. The usefulness of open plugins to collect resources from the cloud in such dedicated contextual spaces is discussed. The mechanisms for the personalization of spaces from an interaction point of view once populated with resources and their sharing across platforms are also detailed. Results are illustrated with the case of the *Graasp* platform developed in the framework of European research projects.**

Personal Learning Environments (PLE); Social Learning; Creative Commons; Online Shared Spaces; Cloud

I. OpenSocial Spaces

A personal learning environment (PLE) is a recent and evolving concept yearly discussed in the framework of the PLE conference[1] and in workshops related to Technology Enhanced Learning (TEL). Enabling technologies are developed in a few research projects and initiatives such as the ROLE European project[2], which focuses on defining and validating sound pedagogical framework for self-directed and informal learning, as well as sound technical framework for Open Web 2.0 PLE [1]. The investigations in ROLE rely on participatory design and social requirement engineering conducted in academic and professional test beds. Currently, the definition we propose for a PLE is *Any open environment or social media platform combined with interactive devices and exploited by users for learning and knowledge management*. In this definition, *Open* means coming from the cloud in contrast to proprietary institutional resources. *Devices* are mentioned to emphasis the ubiquitous and sometime tangible nature of the resources gathered in a PLE. In addition, when dealing with knowledge artifacts and online communities, there is a blurring distinction between their exploitation for *knowledge management* or *learning*, as the latter often occurs without noticing when practicing the former. The following properties of a PLE can be listed: i) Any digital ecosystem repurposed for learning is a PLE, i.e., it is the intention of use and not the design of the platform which makes it a PLE [2]; ii) Constructing the environment is part of the learning process, i.e. constructionism is finally extended at the level of the environment; iii) PLE are personal but not individual, they may integrate peers, coaches, teachers or even relatives [3]; iv) Each PLE is designed for a single context or purpose.

Participatory design activities carried out in recent years have demonstrated that, to be complete, a PLE should integrate a contextualizing entity we define as a shared *activity space*, each space integrating itself *people* (members), *resources* (shared digital artifacts), *apps* (tools or applications offered as widgets or OpenSocial gadgets to enable the realizing of contextual actions or visualization), as well as subspaces. As such, a space is the instantiation by an individual of a PLE constructed to support a dedicated learning activity [4]. As a space usually gathers from the cloud people (enabling interaction), resources (enabling knowledge acquisition and consolidation) and apps (enabling environment plasticity), it strongly relies on advanced *search*, *recommendation* and *aggregation* features.

In order to enforce the personal nature of a PLE and to enable its sharing indifferently of user preferences, a space should not be captive of a single platform. As a consequence, we are standardizing [3] this concept in the OpenSocial framework to enable integration and portability between exiting and future OpenSocial containers.

II. *Graasp*: A Social Media Platform for Collaborative Learning Across Boundaries

Graasp is a social media platform developed through participatory design in the framework of the Palette and the ROLE European projects to enable the support of communities of practice and the creation of personal learning environments without any intervention from institutions or managers. *Graasp* enables the creation of learning spaces shared between people belonging to different communities and networks. Embedded shared resources are gathered across institutional and corporate boundaries. Unlike dominant social media, *Graasp* enables a fine definition of the audience, as well as the associated rights and roles to ensure trust construction and privacy enforcement. In *Graasp*, people map their personal and shared projects, interests, and activities into public or private contextual spaces integrating invited members, relevant resources and necessary apps which can be tagged and rated. Any space or resource in *Graasp* integrates its own discussion thread to enable contextual interaction. In addition to an innovative

[1] http://pleconf.org
[2] http://www.role-project.eu
[3] http://docs.opensocial.org/display/OSD/Space+Proposal

relation-based recommendation engine, one of the core features of *Graasp* is the *GraaspIt!* bookmarklet which supports an easy aggregation of cloud resources as detailed in the next section.

III. *GRAASPIT!* AND CLOUD AGGREGATION API

GraaspIt! is a simple JavaScript bookmarklet that can be activated from the browser bookmark bar at any time when surfing the Web (Figure 1). It relies on the embed.ly library which recognizes more than one hundred web sites and enables the integration of their content in one-click as embedded objects in *Graasp* spaces through the *Graasp* clipboard. In addition, the open *Graasp* plugin architecture enables open content providers to add support for their own repositories or platforms. Thanks to this feature and a dedicated plugin, educational OpenSocial gadgets available in the ROLE widget store[4] can be added in one-click to *Graasp*. In the case the content of a Web site is not recognized or supported, a simple snapshot of the Web page is taken, providing in such a ways a combined bookmarking and archiving feature.

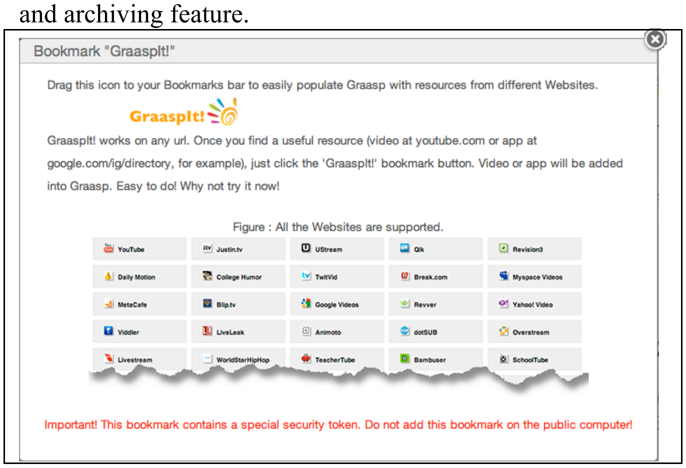

Figure 1. The *GraaspIt!* feature integrated as a bookmark script enabling a one-click gathering of any online resource when surfing the Web.

IV. SPACE PERSONALIZATION AND SHARING

Once a space is created in *Graasp*, the core part of the interface (the Pad) enabling authorized users to interact with the embedded resources can be further personalized. In addition to the standard view (called the *Graasp* view) provided to populate spaces and to visualize their full content and members (Figure 4), an extension mechanism is introduced to adapt the interaction and visualization mode through functional skins [5]. A functional skin is an XML file with some JavaScript code. It can be created by any user and added in a space at runtime without the intervention of developers. The functional skin feature can be seen as a client-side plug-in. *Graasp* offers two built-in functional skins that can be selected using a popup menu: The Resource view (Figure 2) and the App view (Figure 3). The Resource view displays the list of all resources existing in a space and provides links for individual or full download. In addition, previews of resources can be displayed. The App view displays and activates all app instances from a space as a mashup. In this view, apps can be resized and their position order can be modified.

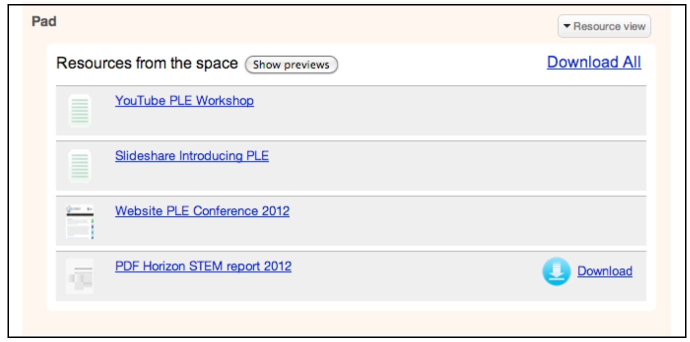

Figure 2. Resource view for a space.

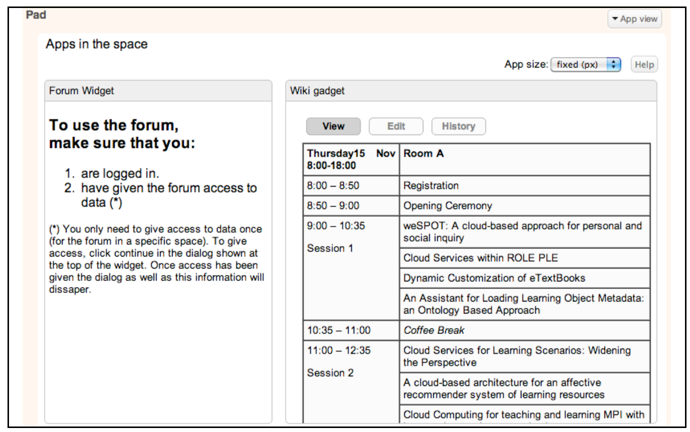

Figure 3. App view for a space.

A space created in *Graasp* can be shared with other people and with other platforms [6]. The space can be extracted from *Graasp* as a private or secret URL. This URL can be shared with other users and open in any browser window. Alternatively, the space can be embedded into another Web environment as an iframe.

In order to facilitate the open sharing of resources and awareness, *Graasp* automatically proposes creative commons[5] licenses when content is made available in public spaces. This mechanism is extendable to code of OpenSocial gadgets when shared publicly to enable the repurposing of apps for personalization to other contexts.

V. CONCLUDING REMARKS

The usefulness of the space concept and the associated aggregation mechanism to populate them with resources gathered from the cloud have been demonstrated in this paper. Besides, the space personalization providing alternative interaction modes with content and the sharing mechanism have been introduced. The permeability (ability to absorb content from the cloud) and the plasticity (ability to

4 http://www.role-widgetstore.eu

5 http://creativecommons.org

adapt the interaction mode to users' needs and add features through apps) of the spaces introduced in this paper pave the way for personal learning environments [6] fully constructed by the users for the users. Thanks to this agile personalization scheme, the *Graasp* platform introduced in this paper not only enables the instantiation of a PLE, but also enables the creation of dedicated spaces for project management, knowledge sharing or community support.

ACKNOWLEDGMENT

The research work described in this paper is partially funded through the ROLE Integrated Project; part of the Seventh Framework Programme for Research and Technological Development (FP7) of the European Union in Information and Communication Technologies, and the Personal Learning Environment (Phase 3) project of the Swiss AAA/SWITCH programme.

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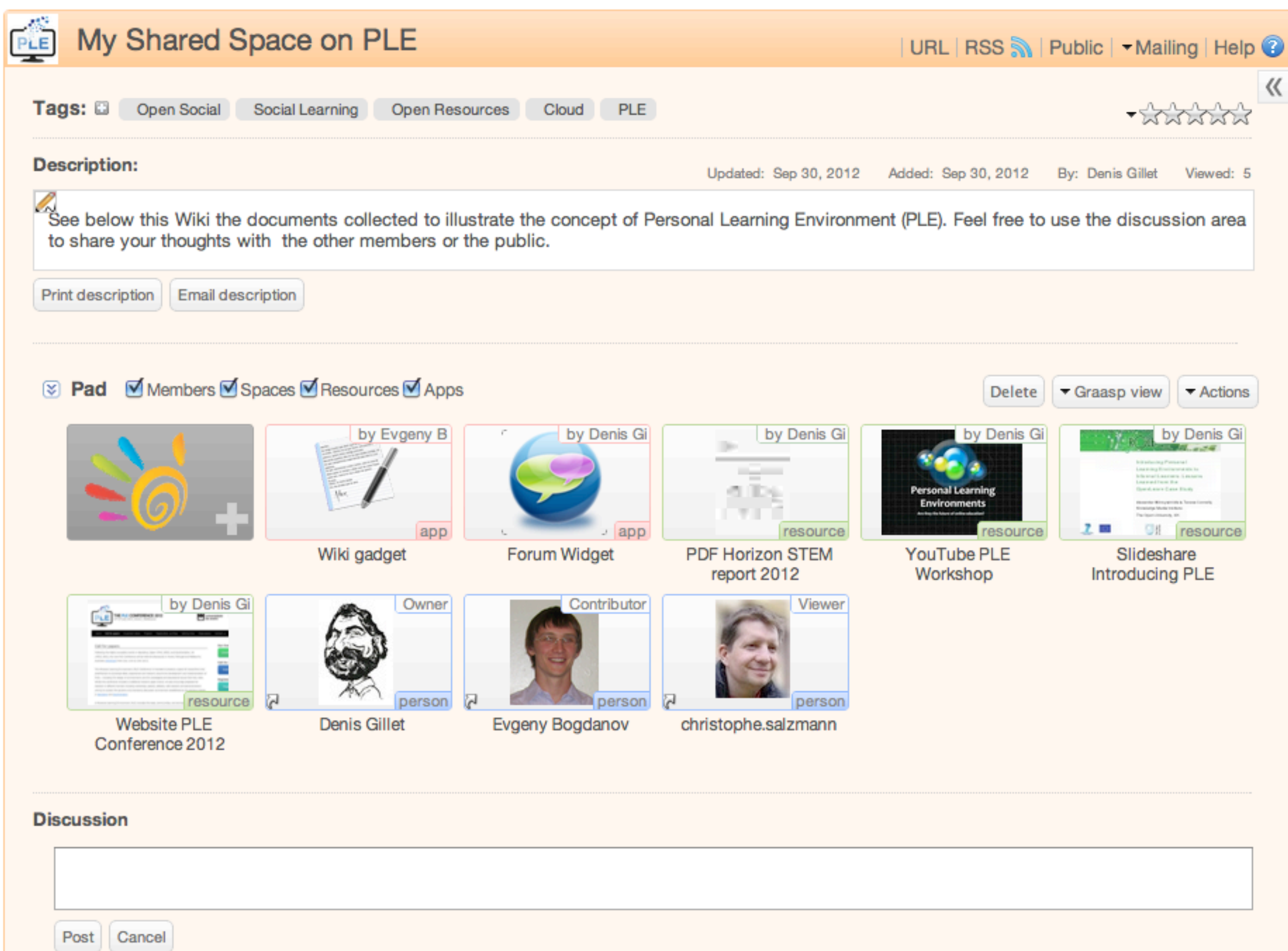

Figure 4. Shared contextual space created in *Graasp* and integrating resources gathered from the cloud in one click using *GraaspIt!*, such as YouTube videos, SlideShare presentations, ROLE Widgets, Web pages or pdf documents with previews.

A cloud-based architecture for an affective recommender system of learning resources

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***Abstract*—One of the most common functionalities in cloud-based learning environments is the recommendation of learning resources. Many approaches have been proposed to deploy recommender systems into an educational environment. Currently, there is an increasing interest in including affective information into the process to generate the recommendations for the learner. In this paper, we propose a cloud-based architecture for a system that recommends learning resources according to the affective state of the learner. Furthermore, we provide the details of an implementation of the architecture along with a discussion on the advantages and disadvantages of the proposal.**

***Keywords*-cloud educational environment; learning resource recommendation; affective recommendation**

I. Introduction

An important characteristic of learning environments in the cloud is the personalization of the environment according to the learner needs, objectives and current situation. Thus, the learning environment can adapt its interface, content, and capabilities according to personal characteristics of the learner: current learning objectives, learning achievements, skills, preferences and affective state. In addition, contextual information is another input for personalization: current location, time of the day and available technology.

Recommender systems are among the instruments used to provide learning environments with personalization. Manouselis et al. [1] provide a review of the approaches followed so far to implement and deploy recommender systems in Technology Enhanced Learning (TEL). More recently, some approaches are including affective information of the learner, such as the case of the Semantic Affective Educational Recommender System proposed by Santos and Boticario [2].

In this paper, we present an improvement of the architecture presented in [3] of the Learning Resource Affective Recommender (LRAR). The most relevant change for the cloud context is the deployment of the recommending engine as an auto-scaling service, which allows to serve several clients with reasonable response time and performance. Thus, the recommender engine is transformed into a recommending service based on cloud technologies. The migration to the cloud allows us to improve the scalability of the recommender system, given the high level of computational power required by this kind of processing.

The rest of the paper is structured as follows: section III describes the proposal of a cloud-based architecture for an affective recommender system of learning resources, Section IV provides the details of an implementation of the architecture, and section V presents some points for discussion.

II. Related works

Most systems on the internet are currently supported on cloud computing. This trend also is observed in the educational arena. The interest of researchers on cloud in learning technologies has increased in last few years. In this section we present some of the most recent works regarding the application of cloud technology into the learning domain.

Cloud technologies are a set of easily accessible and virtualized resources that can be dynamically adapted allowing an optimum resource utilization [4]. A cloud technology allows users access onto different services on internet through diverse devices. It also provides service providers with several advantages, such as availability, integration of multiple services, flexibility and scalability [5]. This makes cloud technology an attractive option for deploying applications that require a high level of computational power. Hence cloud technology has taken into account to support services that offer educational resources to academic communities.

In this sense, in [6] Mikroyannidis states that the cloud offers a lot of services for building adaptive and customisable Cloud Learning Environments (CLE). He also explains how CLEs extend the borders of the learning environments beyond of educational organization. Additionally this work proposes a learning scenario based on the use of cloud learning services. Thus, to take advantage of these features educational institutions are also moving towards providing their services by using cloud technologies. However, in the educational domain, services are scarcely adapted and offered in cloud.

Several approaches of cloud architectures promote improvements to services in the e-learning area by using cloud technologies. Thus, they try to overcome challenges faced by educational institutions. In [7] Masud and Huang propose an e-learning cloud architecture to allow the migration of e-learning systems from schools to a cloud computing infrastructure. They describe an e-learning cloud architecture made up of five layers: infrastructure, software resource, resource management, service and application. This proposal describes a general architecture for e-learning; nevertheless it does not focus on how to implement an e-learning service in a cloud architecture.

As CLE appears as a set of available tools on the internet that allows ubiquitous access to an academic community, it is evident that the existing of Personal Learning Environments in the cloud are in an early stage of its developing. Currently the CLE has dealt in offering an environment that allows students and teachers easy access to different tools for producing and consuming academic content. A related work is also presented by Al-Zoube in [8], where he proposes a cloud computing based solution for building a virtual Personal Learning Environment (PLE). This proposal consists of allowing the learner access to different tools offered on internet such as iGoogle, Google docs, YouTube, etc. however such as Stein et al. state in [9] public clouds generally meet the common base of user requests, but they may not be designed to meet educational needs. In addition, today learners are demanding specialized learning services in order to improve the learning results. Hence, the educational domain requires design and deploy services in order to built a true educational Cloud.

Following the above approach, in [10] Madan et al. present a cloud-based learning service model. This proposal describes comprehensively the cloud computing services as a key aspect of cloud computing model. The authors focus on services and available models to be deployed into cloud architecture. They claim that institutions should use the existing cloud infrastructure offered by companies such Google, Amazon and others. Then educational institutions should focus on defining the cloud service layer to implement it into the cloud architecture.

There is a known necessity of building a CLE based on specialized services rather than the traditional tools found in PLEs. However as the necessities of learning resources and services for learners and teachers are variable, we must offer a service to adapt the PLE in the cloud according to these necessities. In other words, CLE needs a recommender system to fill this gap. Recommender systems have been extensively deployed, however few systems operate in the education arena [11]. Then in this work we propose a cloud-based architecture for a system to recommend learning resources according to the affective state of the learner. Thus learners will be able to adapt their PLE and CLE. Additionally we provide details of the architecture implementation of this specialized service.

III. Description of the architecture

The purpose of the proposed architecture is to deliver a set of learning resources meta-data following a Software as a Service approach. The architecture is composed by two layers: a service layer that executes the storage and recommendation tasks, and a client layer embedded in a learning environment. The details of each layer and their communication are described as follows.

A. Service layer

The service layer is in charge of receiving petitions from several clients and doing the requested tasks. The available tasks are to update the affective information of a learner, to update the information of a learning resource, and to recommend learning resources for a given learner. The first two tasks represent an administration interface for the management of learners' affective states and learner resources. The third task is the main one in the service and also the one that consumes the most resources.

The service layer includes two storage elements to keep the information of the learning resources and the learners' affective states. The storage of learning resources only includes their meta-data and not their content. This decision relies on the fact that the recommendation service is not meant to act as a repository of learning resources but just as a referrer. The format of the database can be any usual specification such as Learning Object Meta-data (LOM), but this is decided by the implementation of the architecture.

The storage for learners' affective state is updated by requests from the client layer. The service is ready to create a new learner profile which consists of the learner identifier, current affective state and the record of the used resources and the affective state presented when using those resources. The format used to define the affective state is decided by the implementation of the architecture as well. The specification EmotionML should be strongly considered because, although still being a W3C Candidate Recommendation, it allows flexible and complete definitions of affective states.

Besides the storage elements, the service layer has a recommendation engine cluster. The engine is designed as a cluster because the task to generate recommendations is the most expensive in terms of computational resources, which makes it the critical process to scale. The cluster contains as many instances of a recommending engine node as needed to support the service demand at the moment. Each node is in charge of analyzing the resources, the affective states of a learner and generate assign a relevance score to each resource not yet seen by the learner.

The recommendation process within a node follows the method known as user-based collaborative filtering. In this approach, when a recommendation has to be done for a given learner, it first finds a set of the learner's *neighbors*, learners with similar patterns of access to resources. The level of similarity is to identify the neighbors of a learner is defined by a similarity function. In the case of the affective recommendation, the similarity of two learners is proportional to the amount of resources accessed by the learners when indicating the same affective state.

As the recommendations must take into account the affective state of the learner, the collaborative filtering process had to be extended to include that contextual information. The set of resources available for recommendation are a combination of the learning resources with the affective states. Thus,

$$R = L \times A$$

where R is the set of recommendable resources, L is the complete set of resources meta-data and A is the complete set of affective states. The recommendable resources are a tuple of a resource and an affective state.

After the learner's neighborhood is defined, learning resources are sorted based on how relevant they have been within that neighborhood of users. The resulting list must be filtered because it contains recommended tuples *(resource, affective state)* and the affective state might be any stored one. Thus, the list of recommended resources are only those that appear in a tuple where the affective state is the same one the learner presents at the moment.

B. Client layer

In the presented architecture, the client layer is represented by the learning environment that includes recommendations to provide adaptation. The inclusion of recommendations is done by an embedded element deployed within the learning environment. The embedded element communicates with the service layer to send and request information related to the recommendation based on affective states.

The embedded element sends update information such as the learner identifier and any change of her affective state. The element also informs when a learner accesses a learning resource. Optionally, the embedded element can also be in charge of detecting the learning state of the learner and updates the affective state database. Other optional information to send is any action done by the learner; this allows to keep track of the learner actions for further analysis.

There can be two moments when the embedded element requests information from the service layer. First, when accessing the learning environment the first time the client requests the last known affective state and the last recommended resources. The second moment is right after the affective status of the learner is updated. This is because a modification of the affective status implies a new set of recommendations for the learner, so the embedded element requests the list of recommended resources. After fetched, the list is displayed showing the title and description of each resource. Then, the learner is able to select a resource based on its description or on the relevance score given by the recommendation engine. Figure 1, shows a diagram of the proposed architecture. The layers are displayed from bottom to top.

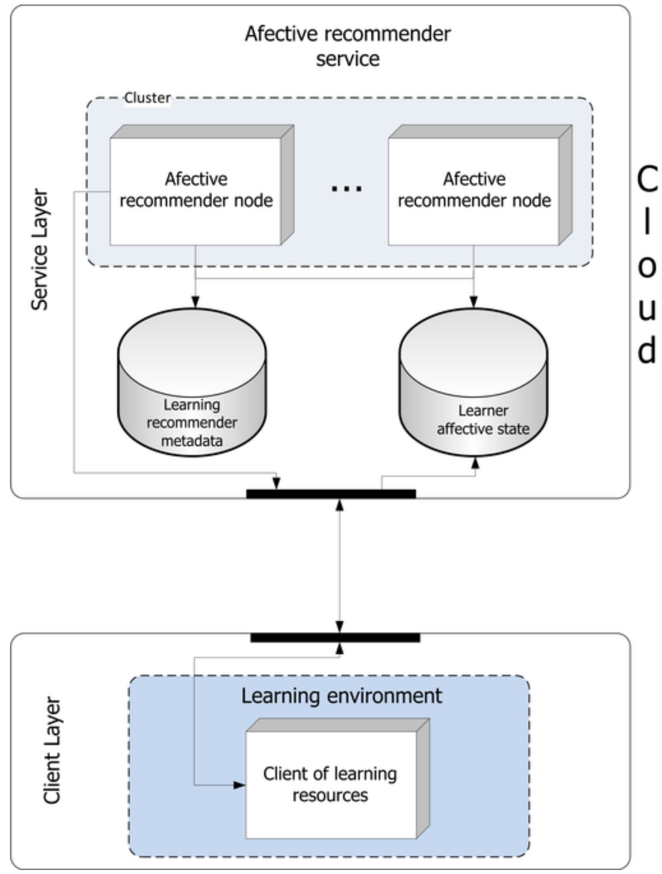

Figure 1. Architecture of affective recommender system based on the cloud.

IV. Explanation of the implementation

The environment where we have implemented the affective recommender service is Amazon Elastic Computing Cloud (EC2), which is part of Amazon Web Services (AWS). EC2 allows us to define an image that acts as a blueprint to generate several instances of a computer with the same software configuration. Each one of these instances is what in the definition of the architecture we have called a node.

In our implementation, the storage element for learner resources meta-data is implemented as a database deployed in the engine MySQL. The same database implements the learner affective state storage element. Since the data might be accessed from many nodes of the cluster, the database engine is installed in an independent node, not meant to be part of the recommendation cluster. In order to manage the information stored in the database, the database node implements a RESTful web services, while the technology supporting the web application is J2EE.

The recommendation engine is developed on top of Apache Mahout machine learning engine. Mahout provides a set of libraries to implement machine learning models such as collaborative filtering, recommender systems, clustering, pattern mining and classifiers. Mahout is implemented in Java and this allows a straightforward integration with a web application developed with J2EE. As explained in [12], Mahout is conceived to be scalable through the framework for distributed processing Apache Hadoop, which allows the definition of clusters of computers with computational and storage capabilities.

The algorithms for collaborative filtering use the map/reduce paradigm. This paradigm consists in two processes that can be parallelized and distributed among several computers to increase their speed. The *map* process generates a sequence of pairs where usually the first element is an entity identifier and the second element is an entity characteristic that will be needed in a further computation. The *reduce* process receives the pairs generated by the map process and computes an incremental value associated with the entity. For example, the first step to identify the neighbors of a learner is to identify the most frequent occurrences of a pair *(affective state, learner resource)* for each user. In this case, the map process returns a pair with the syntax *(user identifier, (affective state, learner resource))*. Thus, the entity to identify is the user and the other item to include is the pair or affective state an resource. The reduce process receives the same pair and create an array for each received user. The elements of the array are complex structures with the syntax *((affective state, learner resource), count)*, so that by sorting the array in descendant order by the second element we obtain the top occurrences of pairs for the given learner.

The advantage of using the map/reduce paradigm is that both process can be done in parallel and in several computers. This allows the implementation to scale by just creating a new node with the same characteristics of a previous recommender node. Hadoop keeps control of the nodes that are available in the cluster to perform computational and storage tasks. Thus, we are provided with a simple way to auto-adjusting the size of the recommender cluster by just adding or removing nodes according to the service demand.

For the implementation of the client layer element, a widget has been developed as a proof-of-concept of a tool that interacts with the affective recommender service. The widget has been developed using the Software Development Kit (SDK) provided by ROLE Project [13]. ROLE aims to provide the learner with a framework to build her Personalized Learning Environment. The widget is implemented in JavaScript and HTML, and it follows the OpenSocial Gadget specification.

The widget interface has two functional sections represented by the tabs. Resources, the main tab, allows the learner to state her affective state from a static list provided by the recommendation service. Currently, the list is based on the affective states used by D'Mello et al. in [14]; these include frustrated, confused, bored, enthusiastic, motivated and the normal state, meaning that there is no relevant affective state at the moment.

Resources tab also presents a list of learning resources ordered by relevance for the learner in her current state. Thus, once the learner submits a change on her affective state, the widget send a recommendation request to the affective recommender service. When the response is received, the client analyzes the list of resources and embed their information as the list of recommended resources.

Second section is the *Profile* tab, where a time-line of the affective states reported by the learner is embedded. Its objective is to provide the learner with a visualization of her emotional changes during the learning activity being performed. The log of affective states is also provided by the learning resource service.

Finally, the Settings tab allows the learner to set her learning objectives. These might be changed during the learning activity, which also triggers a change of the learning resources that are recommended. Figure 2 presents a screen capture of the widget deployed in ROLE environment, with emphasis on the resources recommended to a frustrated learner.

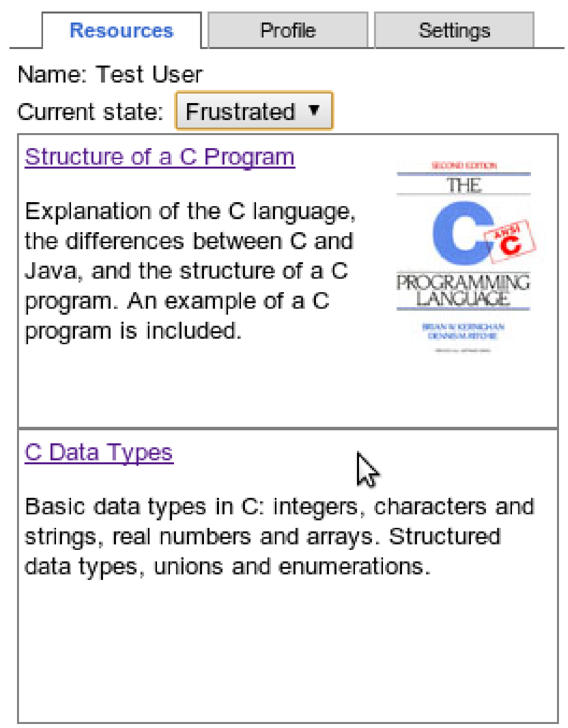

Figure 2. Implementation of the resource visualizer in the ROLE PLE.

A use case that exemplifies the use of the widget is the following. Alice, a university student whose major is

Computer Science, is trying to complete a C programming task that she was assigned as homework. She starts working highly motivated on the initial details of the program and she reflects be selecting the *Motivated* option among the affective states available in the widget. The widget communicates the affective state to the recommender service and this returns a list of resources suitable for Alice, such as C programming references and the user's manual of the compilation tool. Alice finds the resources helpful and uses them to write her code more quickly. As Alice advances she realizes that the task is not as easy as she first thought and that she might even encounter some programming errors that she was not expecting, this causes her affective state to change. When she find that she cannot fix a compilation error she starts feeling frustrated. Thus, she updates her affective state to *Frustrated*. Again, the widget communicates the new affective state to the recommender service, obtains the list of suitable resources and displays them as part of the widget content. The new list of recommended resources includes basic programming concepts and common programming errors with their respective solutions (see Figure 2). Alice accesses the resources and solves the error of her program. After seeing that the widget helps her along the task, Alice recovers her positive mood and continues her work to finish the homework.

V. Discussion

Throughout this paper we have pointed the advantages of a cloud-based affective recommender system of learning resources. We have emphasized that the main benefit of using cloud technologies to deploy an affective recommender system is the gain of scalability. Nevertheless, there are some issues that must be taken into account as possible disadvantages of the architecture such as approaches to caching and privacy issues.

The first issue is the difficulty to cache results in the presented architecture. Given that in a cloud recommendation service the computational workload is distributed among the nodes of the cluster, one node cannot cache the recommendation calculate in another node. This issue can be addressed either at the client layer, where the client itself would be in charge of caching the information of the recommended resources. Another possible approach to solve this issue is through the inclusion of a middle layer that caches and dispatches the recommendations; this layer would be between the recommendation cluster and the interface of the service.

Another concern is related to privacy issues, since the affective state of the learner is stored in a database accessible from several recommender nodes. The key in this issue is that the recommending nodes are the only elements with permission to access the affective state information. Furthermore, the recommender service does not require to store information that identifies the learner immediately, such as the full name or email. Instead, the service can use a hashed identifier of the learner and that would not interfere with the process of recommending learning resources.

Future work consists on evaluating the performance of the implementation presented in the article. The evaluation objective is to analyze the improvement on the response time of a recommendation request to the server. Part of this work includes to analyze the correlation between the service performance and the amount of recommender nodes in the cluster; this would lead to a set of guidelines for deploying the recommender service in a real learning scenario.

Another line of work consists in the development of plug-ins to include sensors as a method to populate the affective state database. Specifically we are working with sensors for galvanic skin response and the recognition of face gestures through a video camera. These sensors have been proven to detect affective states with accuracy [15] and thus might be improve the recommendation process. They would also allow the learner to focus on the retrieval and use of resources rather than constantly informing her current affective state. On the same track, it is also intended to improve the interface for the learner to provide her affective state. Several approaches will be taken in order to obtain contextual information about what provoked a given emotion in the learner and how did the recommendation of resources affect her affective state.

Acknowledgment

Work partially funded by the EEE project, "Plan Nacional de I+D+I TIN2011-28308-C03-01", the "Emadrid: Investigación y desarrollo de tecnologías para el e-learning en la Comunidad de Madrid" project (S2009/TIC-1650), and "Consejo Social - Universidad Carlos III de Madrid".

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Supporting Self-Regulated Learning in Personalised Learning Envrionments

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***Abstract*. The advantage of Personal Learning Environments (PLEs) is to empower a learner in taking control over his/her own learning process. The shift from just being controlled by a teacher towards taking control by oneself in a self-regulated learning (SRL) way can be basically initialised by providing learning environments that can be personalised and individually adapted or created instead of using 'one size fits all' learning environments. A lot of research and development on this subject has been done in the EU-Project ROLE (role-project.eu). In this context extensive experiments have been conducted with widget-based PLEs. Scenarios have been created, implemented, tested and evaluated in real world settings. The contribution of this paper is the presentation of a) three widget-based PLE scenarios, b) evaluation results on comparing the value of the presented PLE scenarios and c) evaluation results on comparing students and teachers point of views against the presented PLE scenarios including SRL aspects.**

Keywords; personal learning environments, self-regulated learning, open educational ressources, widgets, evaluation results

I. INTRODUCTION

Responsive Open Learning Environments (ROLE) are based on the idea of Personal Learning Environments (PLEs) by exploiting Cloud Computing Technology (examples are presented in chapter III). Instead of using traditional learning environments which provide tools and content by one single provider and are often owned by one specific educational organization ROLE exploits all existing and developing open educational sources including all popular Web2.0 resources such as Wikipedia, YouTube or Flickr. Historically the idea of PLEs is based on the fact that most learning takes place informally, in different contexts and scenarios, and that content is not provided by one single provider. Following this idea ROLE provides a framework essentially consisting of “enabler spaces” on the one hand and tools, content, services on the other hand [1]. Using this equipment everyone is invited to individually create his/her PLE. In PLE research it is seen as essential to have a learner challenged by offering him/her to create their individually controlled and preferred learning environment in order to trigger and motivate more self-regulated learning. Moreover this approach has the potential to enable and facilitate both informal and formal learning.

The paper presents three PLE scenarios which have been developed in the ROLE project. In real world testbeds learners are confronted with new ways of learning by working with the provided PLE scenarios. While the use of any PLE should trigger self-regulated learning it is especially the third and last PLE scenario which has been implemented a consequent mechanism to support SRL.

This paper investigates the attitudes and reasons for acceptance of PLE technology by students and teachers.

II. THE CHALLENGES OF SELF-REGULATED LEARNING IN PERSONAL LEARNING ENVRIONMENTS

A. SRL in Technology-enhanced Learning Environments

In the field of self-regulated learning (SRL) research it is often pointed to the important role of learners’ strategic use of cognitive and metacognitive strategies to regulate their learning [2], [3], [4]. Still many learners show difficulties in applying concrete metacognitive strategies such as planning, goal setting, monitoring, evaluating and as a result perform less successful [5]. For this reason, much work has been focused on the assessment of students’ SRL strategies to support the learning behaviour accordingly. This work is usually bound to highly controlled learning environment such as intelligent (tutoring) systems [5], [6], [7]. However, understanding, scaffolding or/and facilitating students’ SRL skills is especially important in (responsive) open learning environments. In such open environments goals are less clear and obvious; therefore students might not necessarily be able to predict the outcome of the learning activity or the optimal learning path.

Nevertheless, it could be found that PLEs provide opportunities to enhance SRL skills, especially metacognitive skills, but learners need additional help and guidance [5] during the learning process. In this regard the concept of freedom and guidance comes into play. The concept of freedom and guidance is important, because highly motivated learners attain a better learning performance if they have more control over their learning, but lower motivated learners attain better learning performance if they get more guidance [8]. Issing noted that this is also applicable to hypermedia learning environments.

In this regard it should be envisioned to develop services and learning environments that can be adapted to the individually degree of guidance and freedom according to the learner's needs and therefore offer the learner an optimal balanced level of control and responsibility for his or her learning environment [9].

B. A Self-Regulated Learning Process Model Procedure

In PLEs learners are in the position to create their own learning environment and shape it to their personal needs and learning objectives. In order to provide support in such an open learning approach an underlying and psycho-pedagogical sound model which represents the theoretical backbone of open environment learning has been defined, the Self-Regulated Learning Process Model (SRL PM). The SRL PM builds on the cyclic self-regulated learning model proposed by Zimmerman [10], which describes the learning process via three learning phases, namely forethought, learning and self-reflection. In open learning environments this three learning phase model was extended to reflect the need of selecting web-based learning resources, mostly widgets, to build and mash-up a PLE.

This extension leads to the four phase SRL PM including the phases of: (1) learner profile information is defined or revised, (2) learner finds and selects learning resources, (3) learner works on selected resources, and (4) learner reflects and reacts on learning strategies, achievements and usefulness (see Figure 1) [9].

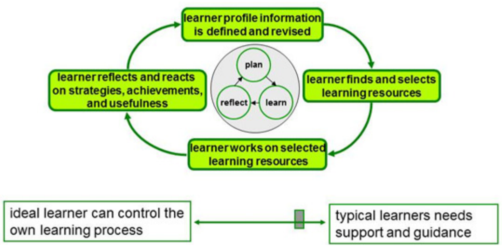

Figure 1: Self-Regulated Learning Process Model (SRL PM)

According to this model, especially meta-cognitive activities are supported by focusing on the recommendation of learning activities which can be performed through the usage of learning resources and therefore enhance self-regulated learning.

ROLE services such as the Mash-Up Recommender Widget (see Figure 7) offer guidance and help learners by presenting recommendations and according explanations, without limiting the degree of freedom, as the learner can freely choose between the recommendations made by ROLE services or other alternatives. This concept is based on an ontology that builds on a connection of learning phases of a SRL PM to learning strategies, techniques and activities [11]. In addition, it is shown how these SRL entities are linked to tool functionalities and therefore bridge psycho-pedagogical information and learning tools like widgets in our presented case studies.

III. SCENARIOS

This chapter describes three widget-based PLE scenarios which were evaluated (see chapter IV to VI).

In the ROLE project the basic equipment for creating PLEs has been developed according to the idea of an easy drag and drop system of widgets. Browser-based prototypes have been developed like sketched in Figure 2.

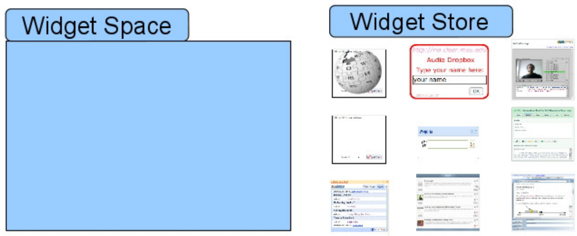

Figure 2: Browser- and Widget-based PLE concept

On the one hand a repository (widget store) is necessary to store and administrate useful widgets. On the other hand an enabler space (widget space) is necessary to have learners their individually preferred widgets integrated, used and managed in their personal style.

Starting from this provided prototype essentially consisting of Widget Store and Widget Space the creation of PLEs has been tested in real world use cases and scenarios which are described in the following sections.

A. Scenario I

In the first scenario learners were provided with the ROLE Widget Store [12] but they could also make extended use of widgets by using iGoogle gadgets [13]; (iGoogle gadgets: here the Google term for widgets). Furthermore, learners had the choice to either use iGoogle [14] or the ROLE sandbox [15] as an enabler space.

In the following the ROLE widget store is described as well as an example how ROLE widgets have been integrated and used in iGoogle.

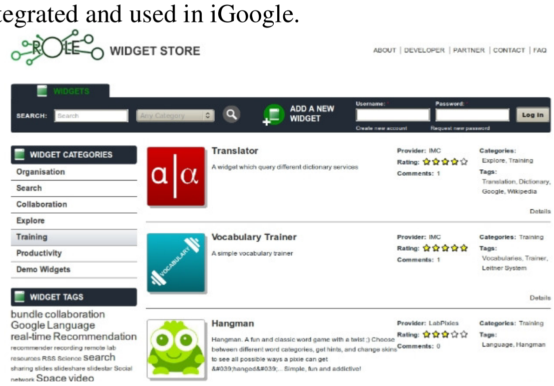

Figure 3: ROLE Widget Store

The ROLE Widget Store (Figure 3) is a living system and repository of open educational resources. It hosts and offers all kind of learning widgets. For registered developers and users it is possible to "add a new widget" (see icon on the upper navigation in Figure 3) whenever they have found or created a useful widget with pedagogical value. Everyone interested in these kinds of open educational resources can make use of it.

Figure 4: Widget Space iGoogle filled with ROLE widgets

Figure 4 [16] shows one example of a browser- and widget-based PLE. In this example the iGoogle environment hosts a PLE. The widgets were added from the ROLE Widget Store.

This scenario had already been tested by students in 2011 at an early stage of development. Results of this evaluation were already presented and discussed at PLE2011 conference [17], [18].

B. Scenario II

The following use case is not an implemented prototype, but a mock-up which has been created as a consequence of early stage evaluations [17]. A result of these early evaluations was the desire of some users to not be constrained to a browser-based widget-space, but to use single widgets wherever and whenever they want, e.g. on a desktop and offline.

The mock-up scenarios presented in Figure 5 and Figure 6 have been used to discuss and evaluate taking into account teachers' and students' perspectives (see chapters IV to VI). Both mock-up scenarios are designed with the idea to be not restricted to use the widgets within a browser-based widget space like iGoogle. Moreover instead of using a collection of widgets at the same place it should also be possible to select and use only one very specific widget.

Thus, choosing between several means of (personalised) integrating and using the offered widgets should be one distinctive added value of all widgets in the ROLE Widget Store.

Figure 5 presents the use of the ROLE translator widget which accesses and displays the results of different popular resources such as LEO.org, dict.cc, Wikipedia, Google translator all at the same time for comparisons of translations [12].

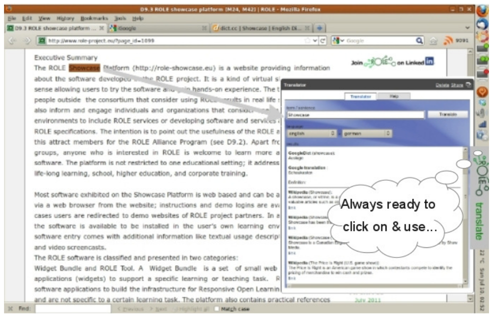

Figure 5: ROLE Translator Widget embedded in the Desktop-Sidebar

This kind of PLE is created to efficiently work on a text document. While reading or writing a text in a foreign language the ROLE translator widget is always visible and usable in the desktop-sidebar. A click on the sidebar-widget-icon will open the widget like sketched in Figure 5. The widget will stay in the front while copying a term from the document in the background to transfer this term to the translator widget. The translation is shown including the resource of translation (dict.cc, Wikipedia, Google, etc.). This mean of widget integration should ensure a very efficient way of learning and working. It enables the user to learn new terms by using the widget but without losing sight of the text document. Moreover, using several resources of Web2.0 based translations stimulates the user to have a more critical reflection of the offered translations.

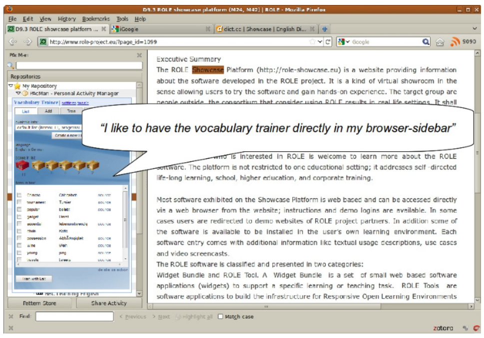

Figure 6: Vocabulary Trainer Widget embedded in the Browser-Sidebar

Figure 6 presents the use of a vocabulary trainer widget which can be opened in the browser sidebar right next to the text a user is working on. While reading the text in a foreign language terms might appear a user is not familiar with and wants to systematically train them. Then the terms can be added to the vocabulary trainer widget.

The widget has been implemented a slightly modified Leitner system [19]. Thus, vocabulary can be trained efficiently by using this widget. For translations the same Web services are used as in the mentioned ROLE

Translator widget. Moreover Flickr is used to suggest pictures for visualising the terms. The widget has four functionalities represented by four tabs: "Add", "List", "Train" and "Stats". A detailed description of this widget and further widget bundles can be found at the ROLE Showcase Platform [20].

Important for the presented evaluation is the fact that these mock-up scenarios give ideas of some other ways how to use the offered widgets from the ROLE Widget Store.

C. Scenario III

Scenario III presents an implemented prototype to mash-up PLEs which is called "Mash-Up Recommender" (MR, see Figure 7).

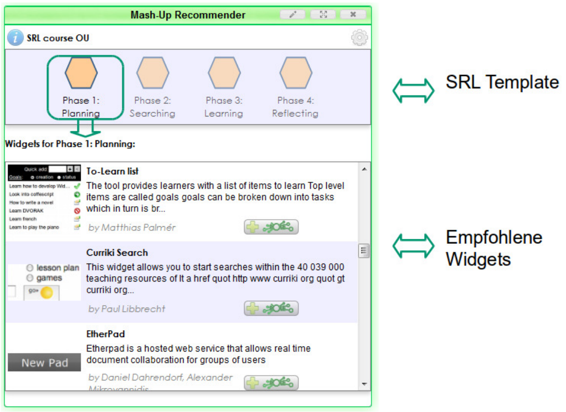

Figure 7: Mash-Up Recommender Widget (MR)

The unique aspect of the MR is the fact that it services as a gate and a guide to access the large number of widgets and gadgets available on the web in a reasonable self-regulated way. For this purpose the MR templates are based on learning activities related to the SRL Process Model described in chapter II.

The main purpose of the MR is to support the self-regulation of learners in mashing up their learning environments. Therefore, psycho-pedagogical information is transferred into applicable recommendation by using the MR widget. The MR widget can be seen as a filtering system that provides more or less widgets that can be added to the PLE depending on the used template. The MR contains a predefined template called SRL template. The SRL template can consist of the four basic SRL phases "Planning", "Searching", "Learning" and "Reflecting" which are displayed in the upper navigation of the MR (see Figure 7). Each category contains a number of relevant widgets, e.g. the category "Reflecting" contains widgets such as recording tools, writing tools, mind map tools etc. To have the SRL template adequately working according these four SRL phases a ROLE ontology [11] service has been implemented for the respective functionalities of the SRL entities (learning strategies, techniques and activities). The ontology predefines associated widgets which will be returned by the ROLE Widget Store. Instead of the four SRL phases, the template can also consist of learning activities on a finer granularity level, namely learning strategies and learning techniques. Such templates can be created using a special authoring tool [21].

The MR can be used to provide guidance on different levels and for different stakeholders (e.g. teachers, workplace learners, students, beginners, and advanced students or experts). A high level of guidance is necessary for instance for beginners and can be prepared by a complete predefined PLEs based on a specific template by a teacher or tutor. Later the tutor can share this PLE with her students who can use it or modify. A lower level of guidance can be provided if the teacher just shares the template with the students, so that they have to create their own PLE. For example, a teacher could select the SRL entities goal setting, resource searching, note taking, and reflecting for a template. Teachers or learners using this template could easily search these SRL entities for widgets and include them in a PLE. In this way the PLE consists of widgets for each SRL entity. Learning strategies are on a higher abstraction level, which results in an increased number of widgets that can be recommended. Learning techniques are on a lower abstraction level, which leads to a smaller number of related widgets that can be recommended. While in the first case the learner gets more widgets recommended and thus less guidance, in the second case the level of guidance is higher because of the smaller number of recommended widgets. For a detailed description of the MR and its technical background see [22].

IV. Focus Groups and Evaluation

The evaluation took place equally in two **focus groups**:

- **Teachers:** The three scenarios were presented, tested and evaluated in a teacher workshop taking place at the Aha-Conference 2012 in Vienna [23]. In total 8 participants (4 male, 4 female) from Austria and Germany took part. The age ranged from 27 to 55 (Average age: 40.43). Most of them were teachers at schools or universities. But there were participants who also worked as consultant or technical support at higher education institutions.
- **Students**: The three scenarios were evaluated in the same way in a test bed at the University of Vienna within a course called "Didactical Design" (Sylvana Kroop). The course was for 25 Master at the Faculty of Informatics in summer semester 2012. 22 students (11 male, 11 female) regularly participated in the prototype evaluation. The age of students ranged from 23 to 48 (Average age: 28.48). They all studied in the field of computer science. Some of them were teachers who already taught at schools but still enjoyed their academic training. Thus, in the discussion some students evaluated the scenarios from a teacher's point of view.

Although quantitative as well as qualitative data were collected in the evaluation with both focus groups this paper only presents the quantitative results due to page limits of this paper.

Quantitative data were essentially collected by a short questionnaire in the end of testing and discussing the three scenarios. To investigate the main research question if and why these PLE scenarios will be accepted or rejected by students and teachers two more concrete questions were ask to think about while testing and discussing each of the three scenarios:

- The first question was on *worsening / improvement of learning outcome*;
- the second question on the technical including cognitive and time-wise *burden / ease of personal learning process*.

The answer categories ranged on a six-point-Likert-scale from 1: worsening to 6: improvement resp. 1: burden to 6: ease, which means: the higher the value the better the acceptance of the respective scenario.

V. RESULTS OBTAINED BY TEACHERS

Figure 8 presents the results obtained through the questionnaire teachers filled out after finishing the group discussions at the end of the workshop.

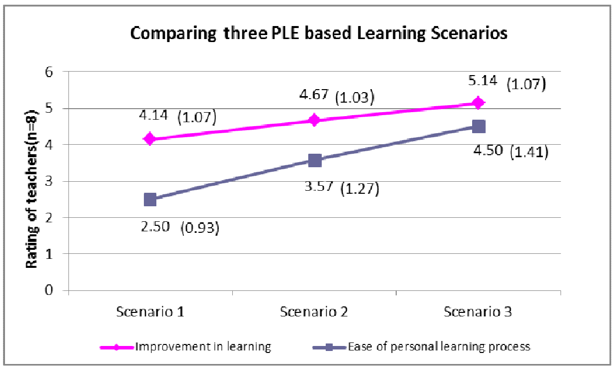

Figure 8: Results of Teacher Workshop (n=8)

The graphic shows the mean values and the standard deviation (in brackets) for the three scenarios. Each of the scenarios was rated by eight teachers according to the two evaluation criteria described in chapter IV. Due to the small number of participants no inference statistical analyses were conducted.

The question regarding a possible *improvement in learning* was answered most positive in scenario 3: Mean value of improvement of learning increased from 4.14 in scenario 1 to 4.67 in scenario 2 up to 5.14 in scenario 3. The standard deviations show that respondents do not differ very much in the assessment of the three scenarios concerning improvement in learning; it ranges from 1.03 to 1.07. It tends to be consensus in this question.

The question regarding a possible *ease of the personal learning process* was altogether also rated most positive in scenario 3: The mean value is 4.50. But at the same time there is also the highest standard deviation of 1.41 revealing a wider disagreement among the respondents in this question. In contrast to scenario 3 the worst result is displayed for scenario 1 with a mean value of 2.50. Moreover in this case respondents do agree most indicated by the lowest standard deviation of 0.93. In other words: While the teachers come to the agreement that scenario 1 will tend to be an additional burden instead of easing the personal learning process scenario 3 is rated much better by teachers but with a broader variance of opinions.

Altogether the results in both questions show a coherent picture for the three evaluated scenarios: While scenario 1 can be assumed to be potentially rejected by teachers scenario 3 tends to be accepted.

VI. RESULTS OBTAINED BY STUDENTS

Figure 9 presents the results obtained through the questionnaire which was filled out by 19 students after finishing their group discussions.

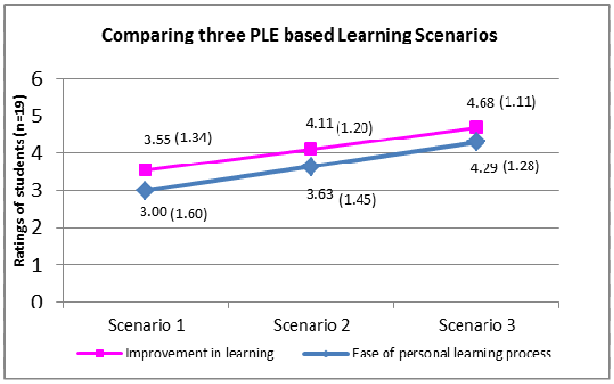

Figure 9: Results of Students Workshop (N=19)

The question regarding a possible *improvement in learning* was again rated best in scenario 3: The mean value increased from 3.55 in scenario 1 to 4.11 in scenario 2 up to 4.68 in scenario 3. The standard deviation (sd) shows that the respondents differ most in rating scenario 1 (sd=1.34) followed by scenario 2 (sd=1.20) and scenario 3 (sd=1.11). In other words: Students not only rated scenario 3 best but also agreed in the answers of this question in scenario 3 most.

The question regarding a possible *ease of the personal learning process* was also rated best in scenario 3 with a mean value of 4.29. Students also agreed in the answers of scenario 3 most (sd=1.28) while they had the broadest variance of opinions in scenario 1 (sd=1.60) which was rated lowest with the mean value of 3.00.

Considering a significance test scenario 3 is significantly better than scenario 1 in both questions (*Improvement*: F2,36 =5.48, p=0.008; *Ease*: F2,36 =4.52, p=0.018). Due to the small sample this can be randomly and thus is not further discussed.

Altogether the results in both questions show again a coherent picture for the three evaluated scenarios: While the results of scenario 1 neither show a clear tendency to be rejected nor to be accepted scenario 3 clearly tends to be accepted by students in this comparison of PLE scenarios.

VII. Conclusion

The use of widgets within a widget space such as iGoogle was evaluated positive in its easy technical handling but negative in the challenge to efficiently support daily learning activities. Thus there is neither acceptance nor a clear rejection of scenario 1.

Better accepted was the use of single widgets wherever and whenever learners wants them to use (e.g. in a desktop-sidebar or browser-sidebar, online and offline) sketched in scenario 2

Best accepted was the idea to support self-regulated learning (SRL) by using a four-phases activity model while learners are challenged to select widgets from a wide variety (scenario 3). The idea to connect different stages of SRL (Planning, Searching, Learning, Reflecting) with corresponding widgets was seen most needed and most useful.

Acknowledgment

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 231396 (ROLE project).

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Measuring emotional responses to experiences with Cloud-based learning activities

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***Abstract*— Cloud Education Environments consider all the cloud services, whether they are applications, content providers, infrastructure services, as large ecosystem that can be used as an e-Learning ecosystem which can be built upon the learning objectives of a course. Any web 2.0 application might be used for learning purposes, and many of those applications that reside on the cloud have already opened the APIs for having an orchestrated integration of them. In this paper we present the design and deployment of learning activities using cloud applications and services. The experiences presented here are from Galileo University in Guatemala, with students from three different countries in Central America and Spain. In this study we present results of an instrument that measured emotional aspects and opinions about the tools and cloud-based learning activities. Several cloud-based tools were used for the different learning activities required for the courses, some featuring collaborative actions, knowledge representation and schemes, publication of information, research activities, storytelling activities and social networking. The results obtained demonstrates that students are eager to use and have new and more interactive ways of learning, that challenges their creativity and group organization skills, while professors have a growing interest on using new tools and resources that are easy to use, mix and reuse.**

Cloud-based tools, Cloud Learning Activities, Cloud Education Environments, Web 2.0, Social Networking, e-Learning.

I. Introduction

There is great potential to maximize innovation through the use of multiple cloud-based tools for learning activities and to create a new learning environment, applications, and learning experiences. Therefore there is a tendency that Virtual Learning Environments (VLE) will move from a monolithic paradigm to a distributed paradigm. Some call it the next generation of cloud-based e-Learning environment [1][2][3]. It is clear that VLE need to be more scalable and improve the real innovation they bring to education, but actual work has a focus on infrastructure layer rather than application layer [4][5]. Still VLE is a simple conversion of classroom-based content to an electronic format, retaining its traditional knowledge-centric structure. [6]

Cloud computing application technologies are a major technological trend that is shifting business models and application paradigms; the cloud can provide on-demand services through applications served over the Internet for multiple set of devices in a dynamic and very scalable environment [7]. Thus, the significance of the technology for this study lies not only in cloud computing, but in the application that reside in the cloud that can be used for learning purposes, although as it will be presented, many of them have not been intended for learning in the first place, the applications used in this case study are actually used for learning. Likewise social networking technologies provide easy pathways for sharing these kinds of cloud applications and their related data and activities and of course for socializing and possible collaborative experiences at the same time. [8]

We aim to create a Cloud Education Environment, where a vast amount of possible tools and services can be used, connected and in the future orchestrated for learning and teaching. [9]

II. The Experience

A. The Galileo University Test-bed

In this section we present our cloud-based learning experience in Latin-American countries following other successful experiences [2][3].

The experience happens in the Institute Von Neumann (IVN) of Galileo University, Guatemala. IVN is an online higher education institute. It delivers online educational programs across the country and those programs are open for other countries.

B. Experience description

The student population at IVN is mostly adult learners who have a job; this is something quite common in the entire University students. The courses are similar to any other University course; most of the students do their learning during the evening or in weekends because of work.
It is a complete online learning degree, the topic of the course is an e-Learning certification that consists in several modules that specializes the students into e-Learning from an instructional design reference. The course do not have

asynchronous sessions, although the use of chat with professor and other peers is possible, and students are expected to work 10 hours/week for studying materials, doing learning activities and doing collaborative activities. The courses within the e-Learning certification are designed in learning units that usually last for 1 week each unit having a diversity of online material such as video, audio, animations, interactive content, forums, assignments and a wide diversity of learning activities specially designed for enhancing learning acquisition. The course uses the institutional LMS that currently is .LRN LMS (www.dotlrn.org), although some module are alternative given using Moodle. The students have the advice and help from professional instructional designers to build their online course. The Certification is targeted to university professors, e-Learning consultants, instructors that want to enhance their knowledge about teaching with technology.

The presented experience has two groups of more than 60 students, most of them university professors, from different countries: Guatemala, Honduras, El Salvador and Spain. The courses titles are: course 2: Introduction to e-Learning; course 3: e-Moderation and course 4: Online activities design.

In this experience, students were assigned to cloud-based learning activities for the first time, most of them were not technology savvy, but they had a preliminary course that introduced them into the use of the institutional LMS and related technologies.

The course professor introduced these cloud-based learning activities as *innovative and powerful tools for learning*, with the objective to elaborate all the benefits that can create mindset change, guiding the students through the benefits that these type of activities will have in their learning process [3], something that proved to be very helpful to avoid resistance and possible fear to new and seen as complex tools. We collected information form students in a pre-test and post-test through an online survey. Each group did two four-week courses, between the courses there was a one-week off that we used to do telephone interviews and gather further information about the experience.

C. The Learning Activities and Scenarios

We designed learning activities based on instructional objectives, using as a base the past standard non-cloud-based activities from previous editions of the courses, and transforming them to leverage the potential of the cloud ecosystem. The designed and tested activities are presented, it is important to mention that each activity was carefully designed using a custom made instructional design template that contains all activity related information such as: learning objectives, instructions, classification using Bloom's revised taxonomy [1] and grading. Each single step on the activity has a clear and explicit grading. With a clear design of the activity, the professor and instructional designer proceed to select the most suitable tool based on previous knowledge and experience with the tool, in the presented experience most of the proposed tool has been already used for other learning activities in other courses.

Course 2 "Introduction to e-Learning", had the following learning activities:
Activity 2.1: Students had to do a research of a given topic, then writing collaboratively an essay in groups of four students. This activity was prepared with a comparison group setting, where we divided the whole class in three parts, first two parts using cloud-based learning activities and the last third part using traditional desktop applications.
The first two groups were asked to use cloud services, Google Docs [14] and Wiki Spaces [15] and one of the group used traditional word processor. Then students were invited to represent the information with a time-line tool, the cloud-based time-line tools used were Dipity [16] and Timetoast [17] and the traditional tool was Power Point. Finally students had to comment and discuss about other groups results in the LMS online discussion forums.
The group parts used tools are describe in Table I.

TABLE I. COMPARISON SETTING

Number of Groups	***Tools used for the learning activity***
3	Google Docs and Dipity
3	Wiki Spaces and Timetoast
3	Word and PowerPoint

Activity 2.2: Students had to do a research and present knowledge gained through mind map tools, the cloud application used were MindMeister [18] and Cacoo [19]. Finally they were invited to discuss about other peer contributions on the LMS forum. It was designed as an individual activity.
Also a comparison setting is presented in Table II.

TABLE II. COMPARISON SETTING

Number of Students	***Tools used for the learning activity***
10	Cacoo
10	Mindmeister
16	PowerPoint

Course 3: "e-Moderation", had the following activities:
Activity 3.1: Students had to synthetize information learned in the course and publish it using the cloud-tool Issuu [20]. Then discuss other peer contribution on LMS forums.

Activity 3.2: Students had to do a research, create a storytelling script and represent it using one of the following cloud-based tools: GoAnimate [21], Xtranormal [22], Pixton

[23]. Publish it in the social network Facebook [24] and comment other peers' contributions.

Course 4: "Online activities design", had the following learning activities:
Activity 4.1: the whole group of students will build a collaborative bookmarking based on a research assignment, using a base taxonomy provided by the professor to classify the links provided by the students. The Delicious bookmarking site [25] was used for the activity.

Activity 4.2: Students had to create online satisfaction survey for courses, synthetize a method and requirements for these types of surveys using a mind-mapping tool and publish a sample survey using Google forms [14].

Activity 4.3: The third learning activity focused on modeling a process for creating visually attractive digital posters with educational intentions, first by using a mind-mapping to elaborate the concepts, and then reflect them in an cloud-based tool for online poster called Gloster [26].
In all activities, students were required to learn about the tool in order to perform their assignments.

D. Instruments Used

We used standardized instruments to measure this experience [10,11,12,13], through online surveys sent to the students with a pre-test and post-test that measured emotional aspects and opinions about the tools and cloud-based learning activities. Pre and post-test were evaluated with instructional designers, professors and students to observe and verify its validity, some enhancements were introduced after conducting an interview with survey testers.

III. RESULTS AND DISCUSSION OF THE EXPERIENCE

From a total of 36 students, 25 of the students gave their consent to participate in the study (Participation were equally distributed with 48% of female and 52% of male participants, M=37, σ =14) by filling out at least one out of the two presented questionnaires. Participants were asked about the experience and some of the more interesting positive and negative impressions are presented with the emotional aspects evaluation:

A. Positive impressions

- "I liked to know new activities and tools in the web for more interaction with the student"
- "I learned about many great tools that will help me with my teaching activities, the experience showed me that the activities can be very interactive and innovative"
- "The use of new tools for learning was fun and can be applied with creativity to teach scientific content."
- "What I liked is that I started using the tools in my current courses."
- "I liked that the activities awaken creativity and obtained interesting results and products."
- "The activities promote meaningful learning, learning by doing so you will not forget, allows flexibility in learning and I feel very satisfying to achieve something new and different."
- "The tools used for the activities are pretty dynamic and will make courses more interactive."

B. Negative impressions

- "I needed more time to get to know the tools and how to use it"
- "The work load was increased for activities within the new tools with an overhead with learning the tools"
- "I needed a lot of more time to achieve the results with tools like Gloster, and I felt frustrated"
- "The instructions were not clear"
- "With some of the tools you need to purchase a membership to upgrade and enable some functionality"
- "Some of the tools are not accessible and you can't use it in all operating systems, e.g. Flash based tools"

C. Emotional aspects evaluation

In the experience evaluation the results of the pre-test showed about the motivation, the instrument was based on the Computer Emotion Scale (4pt. scale) [12] developed by Kay and Loverock to measure emotions related to learning new computer software/learning tools in general, then the post-test measured the motivation after using the tool proposed for the learning activities with the following comparison in Table III.:

TABLE III. COMPUTER EMOTION SCALE COMPARISON

Emotion	Pre-test results	Post-test results
Satisfied	2.50 (σ = 0.65)	2.48 (σ = 0.65)
Anxious	1.42 (σ = 0.97)	1.24 (σ = 0.78)
Irritable	0.28 (σ = 0.45)	0.44 (σ = 0.51)
Excited	2.33 (σ = 0.72)	2.16 (σ = 0.85)
Dispirited	0.31 (σ = 0.47)	0.28 (σ = 0.46)
Helpless	0.47 (σ = 0.56)	0.52 (σ = 0.65)
Frustrated	0.39 (σ = 0.55)	0.32 (σ = 0.56)
Curious	2.33 (σ = 0.68)	2.12 (σ = 0.83)
Nervous	0.47 (σ = 0.56)	0.60 (σ = 0.65)
Disheartened	0.32 (σ = 0.42)	0.35 (σ = 0.46)
Angry	0.19 (σ = 0.40)	0.32 (σ = 0.48)
Insecure	0.47 (σ = 0.70)	0.40 (σ = 0.58)

The summary with the four variables of the CES [12] scale is presented in Table IV:

TABLE IV. SUMMARY COMPUTER EMOTION SCALE COMPARISON

Emotion(4pt. scale)	Pre-test results	Post-test results
Happiness	2.39	2.25
Sadness	0.30	0.28
Anxiety	0.71	0.69
Anger	0.29	0.36

The evaluation of emotional aspects from the participants, shows little difference in the results between pre-test and post-test measures. Results with a 4pt. scale show a positive reaction to “Happiness” and low levels of “Sadness”, “Anxiety” and “Anger” while working with cloud-based tools used for learning activities.

Some of the main results of the post-test were:

- 35% of the participants think that it was difficult to complete the learning activities
- 50% of the participants think that they would need more information and instructions to complete the learning activities
- Only 10% of the participants expressed the learning activities were boring
- 95% of the participants liked the idea to use innovative learning online tools to represent new knowledge
- 70% of the participants considered that the time for the activity was appropriate
- 80% of the participants were positive about the expression that sharing results within groups and comments about other participants helps to learn new concepts related to the activity.

IV. CONCLUSIONS AND FUTURE WORK

The presented learning experience showed the main impressions from professors while they are doing and planning learning activities using innovative cloud-based learning tools. The impressions from participants showed the interest in this kind of activities highlighting the interaction, innovation, flexibility and creativity.

Still there are many open questions that will be explored about the experience with measures of previous experiences, motivation, usability and new cloud-based learning tools.

ACKNOWLEDGMENT

This works was prepared thanks to our group of researchers, e-tutors and instructional designers for collaborating enthusiastically during the experimentation.

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On the use of cloud technologies to provide remote laboratories as a service

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Abstract— **Cloud computing is a new paradigm that provides many features with regard to the efficient management of computing infrastructures. Thanks to it, scalable computing infrastructures can be developed, and lower power consumption can be achieved this being called *green computing*.**

Distance education is a solution to the constant necessities of knowledge our society requires. In order to acquire practical competences in engineering education, the use of remote laboratories becomes a necessity more than just an option in the case of distance learning.

RELATED framework has been developed to permit structured development of remote laboratories. It presents a structured methodology of remote/virtual labs development and also provides common facilities as user management, booking, or basic visualization.

In the case that a high number of laboratories and students use RELATED, handling such amount of information becomes a major issue for the proper functionality of RELATED. This paper proposes the use of cloud technologies to enhance RELATED and to tackle these issues, and describes the cloud- based architecture under development at UNED.

Keywords-virtual remote laboratories; cloud; scalability;

I. INTRODUCTION AND MOTIVATION

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [1]. This new paradigm provides many benefits, among others [2] [3], lower cost of ownership, more efficient use of technical staff, cloud computing saves time, money and shortens production cycle, organizations can store more data than on private computer systems, or cloud computing offers much more flexibility than past computing methods.

The cloud represents a shift from the previous computing architectures in which computers had static software features, thus making users of such resources "fit" into those features. For example, if a shared computer has a Linux operating system installed along with some programs and libraries, users willing to run their applications on it had to make sure that their applications could run on such system. Hence, the use of computing systems could be considered as "computer guided", since users had to fit their applications to meet the features of the computer.

The cloud allows systems to dynamically provide the computing resources their users need, reducing expenses, energy consumption and improving on their scalability [4], [5]. Hence, if users want to run some applications in a cloud, it is the computer which has to "fit" into the needs of the users. In the example above, Virtual Machines (VM) can be instantiated dynamically to meet the requirements of the users. The cloud system can thereof be considered as a "user guided" system, since it is the computing resource that is adapted to the users' needs. Furthermore, an appropriate cloud infrastructure manager (such as OpenNebula [6] or Eucalyptus [7]) can provide on demand instantiation, monitoring, and live migration of VMs. Consequently, fault tolerance and scalability are provided.

Another important point to keep in mind is the power consumption of the computers [5]. According to [8], datacenters now drive more in carbon emissions than both Argentina and the Netherlands. Thus, cloud infrastructures should be managed trying to reduce the power consumption of the computers, along with keeping efficient utilization of machines – this being called green computing.

The evolution of education and the increase in the knowledge necessities our society requires have created significant changes with regard to the way how the learning process takes place. Nowadays, there is a constant need to improve, to keep our knowledge up-to-date or to obtain knowledge on new topics – this being specially true in the case of technical studies, where technology is constantly evolving. Distance education is a solution to this problem, since it allows students to obtain practical knowledge without the space and time constraints of classical face-to-face education thus allowing them to fit their studies into their possibly tight schedules.

In our case, the National Distance Education of Spain (Universidad Nacional de Educación a Distancia, UNED), is the largest university in Spain, with more than 200,000 students. We provide totally distant education, so the use the use of remote laboratories to obtain practical knowledge on technical topics becomes a necessity more than just an option. For this, RELATED framework [9] has been developed to permit structural development of remote laboratories. It presents a structured methodology of remote/virtual labs development and also provides common facilities as user management, booking, or basic visualization. In the case that a high number of laboratories and students use RELATED, handling such amount of information and such workload becomes a major issue for the proper functionality of RELATED. Besides, the use of cloud computing allows the adaptation of the RELATED infrastructures in order to fit it to the current or forecasted workload, thus allowing us to reduce expenses in terms of power consumption.

This paper proposes the use of cloud technologies to enhance RELATED and to tackle these issues. The structure of this paper is as follows. Section II briefs the RELATED framework, Section III presents the extensions harnessing cloud technologies under development at UNED, and Section IV presents conclusions and future work.

II. RELATED FUNDAMENTALS

RELATED framework [9], [10] proposes a structured methodology of remote/virtual labs development and, also, provides common facilities as user management, booking, basic visualization (trend graphs and direct interaction using interactive variables), data logging and experimental session's control. A RLAB (Remote LABoratory) system is defined using a formal specification (which is LEDML, based on XML).

The RELATED structure is based on the module paradigm that leads to a structured development strategy. This way, laboratories are developed in a more rational way, reducing development times and optimizing human resources. With RELATED there is no need to start from scratch in the process of remote laboratory development.

The main component in RELATED is an experiment, which is defined on the laboratory XML specification. Experiments are composed of modules and views.

Modules are developed by the lab designer in order to provide local access to laboratory equipment. These modules, which are run-able entities, are started by the RELATED facilities in order to get/set data from/to the laboratory equipment. This data will be sent over the Internet to the RELATED client too.

The other basic entity of a RELATED laboratory (RLAB) is the view. A view provides a Graphical User Interface (GUI) to the final user. These views use data from modules to update the experiment visualization. It is possible the updating of the modules values from the view entity.

Java is used to develop modules and views. In the case of views there are several utilities that simplify the programming process. Easy Java Simulations (EJS) [11] is a free authoring tool that helps non-programmers to create interactive simulations and GUI in Java. GLG Toolkit [12] is another option to simplify the development of the view modules.

Once every module is developed, the next step is to prepare the XML file that is the definition of the laboratory. There are tags for experiments, views and modules. Inside a <module> tag there should be an <implementation> tag that specifies the coded entity of the module.

Figure 1 show an example of the XML laboratory definition where it can be seen how a module is defined. The <var> tag defines the laboratory variables that can be modified in the RELATED Experiment Control Panel.

Once the XML file is ready, the last step is the publishing of the laboratory. For doing that a RLAB Publish Application is provided. This application parses the XML file then uploads to RELATED Server the files needed for running the lab, and then, the application keeps running on the lab machine to provide access to lab equipment. Figure 2 shows the publish application.

```
<module name="PIV_MODULE">
   <var name="current" type="double" initial="0" max="3" min="0" units="I">Current applied for
electomagnetic field</var>
   <var name="position_sp" type="double" initial="0" max="3" min="0" units="mm">Position setpoint
measured from MAGLEV</var>
   <var name="position" type="double" initial="0" max="3" min="0" units="mm">Ball position</var>
   <var name="SP_OffsetPosition" type="double" initial="0" max="9" min="-5" units="mm">Position
setpoint sent to levitator</var>
   <var name="Kff_b" type="double" initial="142.9291" max="10000" min="-10000" units="A/m">PIV
Controller parameter for ball position</var>
   <var name="Kp_b" type="double" initial="-229.0363" max="10000" min="-10000" units="A/m">PIV
Controller parameter for ball position</var>
   <var name="Ki_b" type="double" initial="-192.3205" max="10000" min="-10000"
units="A/s/m">PIV Controller parameter for ball position</var>
   <var name="Kv_b" type="double" initial="-3.7808" max="10000" min="-10000" units="A.s/m">PIV
Controller parameter for ball position</var>
   <var name="Kp_c" type="double" initial="182.875" max="10000" min="-10000" units="V/A">PI
Controller parameter for current</var>
   <var name="Ki_c" type="double" initial="24801.5625" max="100000" min="-100000"
units="V/s/A">PI Controller parameter for current</var>
   <implementation type="JAVA" jarfile="../examples/MAGLEV/code/MAGLEVClientJavaApplication.jar"
     classname="es.uned.scc.rlab.modules.maglev.MaglevPIVModule">PIV Feedforward Controller: Ball
position</implementation>
  </module>
```

Figure 1. XML example

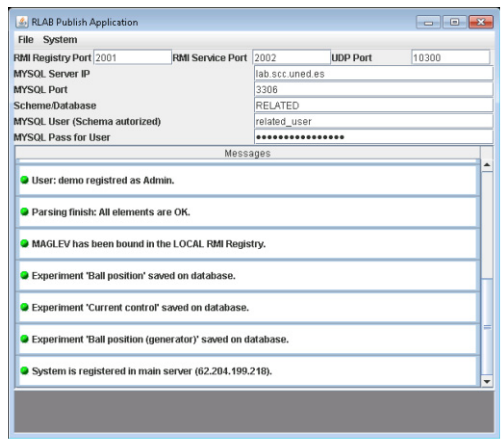

Figure 2. RLAB Publish Application

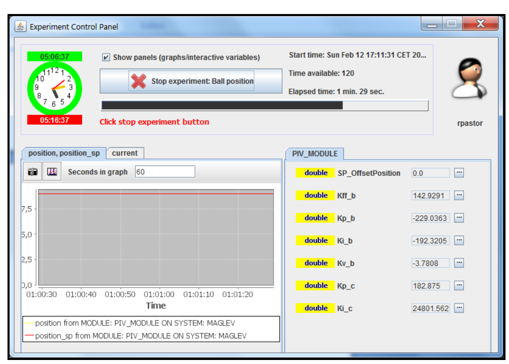

Figure 3 Experiment Control Panel

The Experiment Control Panel is the place where most of the activity of the remote lab takes place. To get this panel is neccesary to login in the RELATED Server, select one of the experiments available for the user and then, login into the experiment.

Not all of the experiments registered on the RELATED Server are available to every user. When the student logs into the experiment, he/she reserves a time slot, this slot time is assigned to avoid multiples concurrent users and can be set using the booking system provided for RELATED so a start and a finish date is assigned to the running experiment and the user. The experiment control panel shows a clock to indicate to the student the time remaining to do the experiment.

Also RELATED log into the server all the events done during the experimental session this way, a concrete experimental session can be perfectly reproduced in future. This is specially useful in a learning environment in which the experimental sessions must be evaluated. As a counterpart, all these facilities lead to high server loads.

In a environment with lots of laboratories and lots of students, could be difficult to manage such high quantity of information so cloud technology could be used to enhance RELATED, optimizing university resources.

III. Remote Laboratories as a Service

UNED is working on harnessing cloud technology to manage its technological infrastructure, so that fault-tolerance, scalability, and low power consumption are achieved. In order to provide the before mentioned benefits, a cloud based architecture is under development at UNED. Similarly to [13], a cloud based architecture can be implemented to improve on the scalability of RELATED. This architecture will rely on cloud and virtualization principles to provide efficient and scalable use of RELATED.

This architecture is presented in Figure 4, and has the following components:

- RLab component servers: One for each laboratory. Provides access to the lab it is connected to (as described in [9]).
- Data base: Keeps information on the labs, and their available time slots.
- RLab control web server: Works as a reference server, grants access to the labs based on permissions (as described in [9]).
- Load balancer: Balances the incoming connections from users between the servers available at each moment. An example of load balancer could be Nginx [14].
- Monitor: Performs the monitoring of the servers. It checks several parameters such as their CPU or memory usage. An example of monitor could be Ganglia [15].
- Virtual Infrastructure Manager (VIM): Performs the deployment of virtual machines (VMs) running the web server. It adapts the infrastructure (by means of deploying VMs in a public cloud provider such as Amazon Elastic Compute Cloud, EC2 [16]) in order to meet the current workload. An example of VIM is OpenNebula [6].

In order to provide scalability, a sharding architecture [15] can be implemented for the database, in which it can be split into a number of databases. Each database would hold a subset of the data (the shards), where shards can be replicated to provide fault-tolerance and scalability. Besides, concerning the load balancer, load monitor and the VIM, other machines could be set to back them up in the case of failures. Even more, data in our local premises can be de-duplicated [18] so that no data are lost in the case of local failures.

On the other hand, in order to provide efficient quality of service (QoS), a load forecasting technique could be implemented, similarly to [13]. This way, resources could be allocated based on the expected workload we plan to receive so that the system is adapted to it. This way, the system could be made of as less machines as possible (thus saving power), but at the same time it could be providing efficient service to its users – thus providing green computing.

IV. Conclusions and Future Work

Thanks to cloud computing, a number of benefits can be obtained with regard to the management of computing infrastructures, such as lower power consumption and improved system utilization. This paper

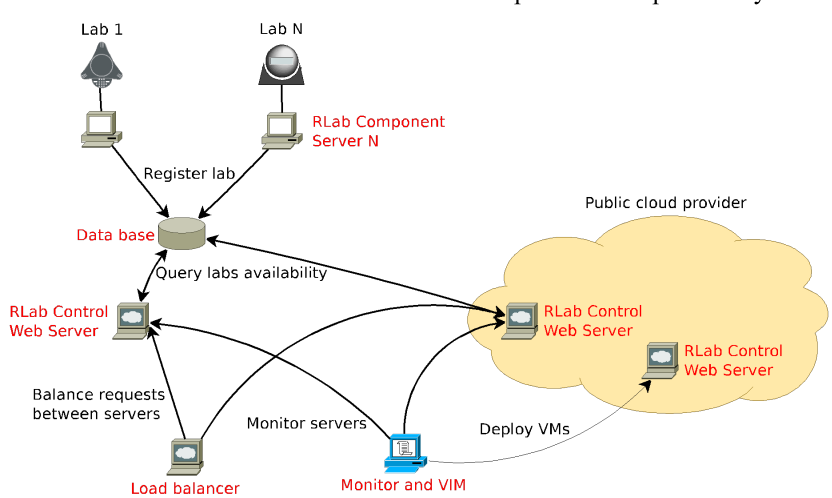

Figure 4. Proposed Architecture

presents the efforts carried out at UNED, the largest university of Spain, aimed at extending a remote laboratories technology with cloud principles. This remote laboratory technology (called RELATED), has been in use in our university for several years with satisfactory results. The current paper explains the developments being made in our university in order to extend RELATED with cloud technologies in order to allow it handle large workloads and minimize its power consumption. Among our future work, a full implementation of the architecture presented in this paper is one of the main research lines.

ACKNOWLEDGMENT

The authors would like to acknowledge European Union Leonardo Project 142788-2008-BG-LEONARDO-LMP, and Spanish Ministry of Science and Innovation for the Project TIN2008-06083-C03/TSI "s-Labs – Integración de Servicios Abiertos para Laboratorios Remotos y Virtuales Distribuidos". We also thank Erasmus Program RIPLECS – Remote labs access in Internet-based Performance-centred Learning Environment for Curriculum Support (517836-LLP-1-2011-1-ES-ERASMUS-ESMO), PAC- Performance-centered Adaptive Curriculum for Employment Needs (517742-LLP-1-2011-1-BG-ERASMUS-ECUE). We also thank Community of Madrid for the support of E-Madrid Network of Excellence S2009 TIC-1650.

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Cloud Services within a ROLE-enabled Personal Learning Environment

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***Abstract*— The ROLE project (Responsive Open Learning Environments) is focused on the next generation of Personal Learning Environments (PLE). In this paper, we first describe the engineering process used to create either a new widget bundle, a group of applications or service widgets. The widgets integrated in a ROLE PLE consist of two cloud-based services, a social networking and a mind-mapping tool, where learners can perform and collaborate on learning activities. We also modified other widgets to create a complete learning experience. The whole platform is running on a cloud-computing infrastructure and one of the services is using a cloud-based database. Additionally, we describe the initial experiences from using this cloud education environment in Galileo University, Guatemala, in a web-based course with students from three different Latin-American countries. We measured emotional aspects, motivation, usability and attitudes towards the environment. The results demonstrated the readiness of cloud-based education solutions, and how ROLE can bring together such an environment from a PLE perspective.**

Keywords- Responsive Open Learning Environments, Personal Learning Environment, Widget bundle, Cloud-based tools, Cloud Learning Activities, Cloud Education Environments.

I. INTRODUCTION

Cloud computing is a major trend nowadays, with recent studies positioning it as one of the short-term adoption technologies for education [2]. Cloud computing is essentially about expandable and on-demand services, tools and content that are served to users via the Internet from specialized data centers. Cloud computing resources support virtualization, grow on-demand, collaboration and many applications now rely on cloud technologies.

Cloud-based tools for collaboration have the potential to engage students, by allowing them to interact and brainstorm solutions, elaborate reports, and create conceptual designs. This approach has the potential to enable and facilitate both formal and informal learning for the learner. It also promotes the openness, sharing and reusability of learning resources on the web [16].

In this work, we foster the potential of cloud-based tools into a Personal Learning Environment (PLE). The PLE enables an individual learner to access, aggregate, configure and manipulate assets of their own current educational experiences. The PLE has a student-based orientation where the learner is provided with the facilities to incorporate the use of new services and tools in a simple manner while at the same time has the control over the environment. It is opposed to the monolithic approach on integrating all the services into a single architecture [1].

The ROLE project aims to enable learners to assemble and re-assemble their own learning environments which become advanced Personal Learning Environments (PLE) [3]. ROLE technology is centered around the concept of Self-regulated learning, aiming at creating responsible and thinking learners that are able to plan their learning process, search for the resources independently, learn and then reflect on their learning process and progress. Using ROLE's techno-pedagogical infrastructure, we have built a psycho-pedagogical setting adapted to the specific needs of our course and our students.

II. CLOUD SERVICES WITHIN ROLE INFRASTRUCTURE

In this section, we briefly discuss the key points of the technical realization of the widget bundle that was specifically designed for this experience. This widget bundle involved the development of two new widgets: the mind-mapping widget that integrated the cloud service MindMeister [12] and the Facebook discussion widget, both of which are compliant with the OpenSocial specification [7]. We also proposed a number of improvements to the specifications of two existing widgets: ObjectSpot [8] and MediaList. The improved specifications regarded the addition of Inter-widget Communication and Monitoring and the testing of a fresh ROLE SDK installation.

In order to address the requirements of our course and provide a complete learning experience to our students, we offered them a widget bundle consisting of the following 6 widgets: ObjectSpot, Binocs Media Search, MediaList, EtherdPad, Mind Map and Facebook.

The ObjectSpot search widget allows learners to find online resources from a variety of bibliographic sources, including CiteSeer and Google Scholar. Binocs focuses on media search, allowing users to search for learning content in various Web 2.0 platforms like YouTube, SlideShare, and Wikipedia. Additionally, both widgets provide access to repositories of Open Educational Resources (OER), containing free learning material of high quality. Some of these repositories are OpenLearn (http://openlearn.open.ac.uk/), OpenScout (http://learn.openscout.net/), and Globe (http://www.globe-info.org/).

The Media List Widget allows the user to create custom media lists based on the search results from the Binocs widget.

The EtherPad widget is a text editor that allows users to write a document collaboratively with their peers in real-time. When multiple authors edit the same document simultaneously, any changes are instantly reflected on everyone's screen. This is particularly useful for meeting notes, drafting sessions, education, team programming, and more.

The Mind Map widget is a tool that delivers the functionality to create collaborative mind maps and reuse previously created maps as learning resources. The Mind Map widget uses the OpenSocial specification, as well as the MindMeister embed API [10].

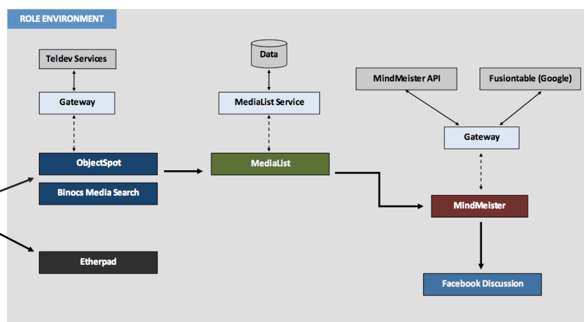

Figure 1. The widget bundle architecture.

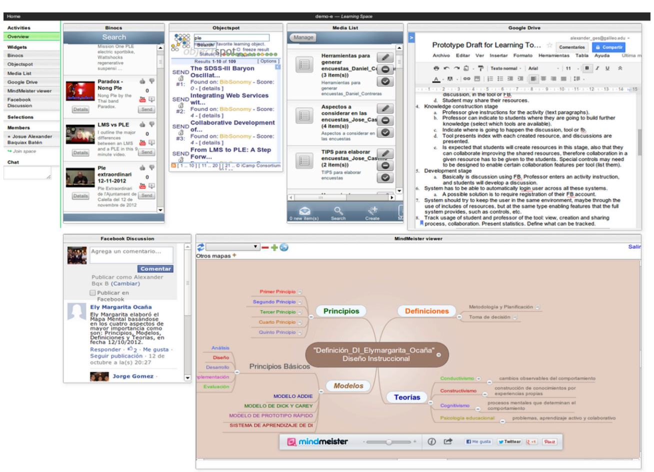

Figure 2. The widget bundle in action.

The mind-mapping editor enables the user to create and edit maps, ideas, nodes, and other different actions. To achieve the desired operation and to receive elements from other widget and incorporate them automatically into the map the Open Application specification was utilized [11]. For the publication and listening of widget events (i.e. add an item to a map, a map published for discussion, etc.), we used the MindMeister RESTful services provided by the cloud-based application, and to be able to use them was necessary to create a middleware (gateway) web service for access the aforementioned services. Additionally, the Facebook discussion widget was implemented according to OpenSocial Gadget specification.

To push forward the envisioned ROLE real-time communication and collaboration infrastructure, it was necessary to provide communication between widgets, especially to send events originating in various widgets (ObjectSpot, Binocs Media Search, MediaList, EtherdPad) to the mind-mapping widget. Likewise in the case of the ObjectSpot widget, it was necessary to add communication through events according to the Open Application specification. In the case of MediaList widget, however, it was hoped to be able to add a new broadcast event to send items stored in a list to the mind-map and reflect them as new nodes in the map. Figure 1 shows the widget bundle architecture and Figure 2 a screenshot of the widget bundle in action.

Finally, it is worth mentioning that a complete cloud-based education environment was enabled, both at the infrastructure and the application level. The cloud-computing infrastructure of Amazon's Elastic Compute Cloud (EC2) [5] and the Google Fusion Tables [6] was used to store and manage token identity across multiple services.

III. THE TEST-BED

A. *The Galileo University Test-bed*

In this section we present a different test-bed for the ROLE technologies, compared to previous experiences [1]. This is the first one in Latin-American countries, and it also represents a different cultural context.

The test-bed was set up in the Institute Von Neumann (IVN) of the Galileo University, Guatemala. IVN is an online Higher Education Institute (HEI) that delivers educational programmes across Guatemala. These programmes are also available for other Spanish speaking countries around their hinterland.

B. *Test-bed description*

Students at IVN are mostly adult learners who also are in employment at the same time. The IVN courses are similar to any other University course, although the most significant difference is that IVN students do most of their learning during the evening or at weekends. IVN offers fully online learning programmes, which generally do not contain any synchronous sessions. Thus students are expected to spend around 10 hours for studying the supplied materials. This also includes carrying out any learning activities as well as interacting online with other students. All the courses are organized in weekly units, based on a variety of online materials (e.g. multimedia, interactive animations, etc), downloadable material in addition to the learning activities. All the course material is delivered to IVN students using a customized version of the LRN Learning

Management System (LMS) [9]. Student-to-student communication is also supported through dedicated online forums. Teachers and instructional designers are able to create and upload all teaching and learning material into the LMS.

In this test-bed, a series of experiments were deployed with respect to ROLE and a specially developed widget bundle, that was designed to support the learning activities for the course *"Building online activities"* was made available. This course is part of the e-Learning certification programme of the university. It is particularly targeted to meet the needs of practitioners, i.e. university professors, and instructors who want to create and deploy their experiences using e-Learning delivery methods. The students participating in this case study originated from three different countries: 15 from Guatemala, 6 from El Salvador, and 9 from Honduras. All students had previously used cloud-based learning activities and tools in other courses, thus they were quite familiar with online services and tools.

The Professor teaching the course introduced the students to new concepts, including the PLE, self regulated learning (SRL) and the ROLE project, with the purpose of raising awareness about the benefits of them with a premise of potentially engendering mindset change amongst them. The students were then guided to engage in an interactive learning process that was presented as having benefits for long term knowledge acquisition. It also was relevant for their forthcoming assessment in relation to the assigned learning activities [3]. This also helped to encourage them to use the ROLE system. Observation of the students' usage of the PLE and collected feedback from both the Professor and the students, through interviews and questionnaires, also took place. It is important to note that the "students" in the group were mostly active HEI Professors in their home universities rather than conventional undergraduate students. The course lasted for four weeks.

C. Scenario

The following scenario was designed to test the ROLE cloud-based learning activities that had been defined. The Professor assembled the widget bundle for each student as shown in Figure 1. The first row shows the search widget "Binocs Media Search" and also the "ObjectSpot" widget. The third widget is the media list. The second row had the mind-mapping tool and the EtherPad widget, and the third row contained the social network widget for discussion. It had been decided beforehand to use a social networking site for discussion, based on previous experiences [13]. No further ROLE collaboration features were used in this part of the case study because of the short time available to deploy the learning activities.

During the first learning activity assigned to students, the PLE and related concepts were introduced to the students, with supportive material such as: step by step instruction, video-tutorials and user manuals custom made for this experience. All learning activities required a research part first, therefore, the students were asked to search using the previously mentioned search widgets, then collect relevant resources in the list widget. They were then asked to create a report using the EtherPad widget, select relevant terms, and their relations then represent them in the mind-mapping widget. Finally, the "students" published their mind-maps in the dedicated course LMS space and then discussed their use of them using the social networking feature that had been provided.

D. The Learning Activities

Four learning activities were assigned to the students. The first one was searching for web services that enabled the creation of learning material or use of tools for learning activities. This task was followed by summarizing the characteristic and potential educational benefits and classifying them using an initial taxonomy given by the Professor in a shared mind-map. In addition all the "students" (who were Professors themselves) were also given the opportunity to discuss each others contributions and how they, as individuals, might apply the pedagogical approach in their own classrooms.

The second learning activity contributed to the overall research about how to measure course quality through online surveys with a target group of students. In this case study, it was decided that each student would search, list, summarize and reflect knowledge by recording them in a mind-map. This included a link to relevant (and provided) Google forms representative of the forthcoming online survey but based on a design previously proposed for the actual course survey. In this instance the mind-map to be created would be individual, and could be shared without the intervention of administrative permissions to the rest of the students. At this stage the students were asked to discuss two or three of their published mind-maps using the social network widget.

The third and fourth activities were similar in process to the second. The objective of the third learning activity was to summarize a proven process for the creation of storytelling educational activities and then to present one set of learning materials based on that process by using one of the following online tools: goanimate.com, pixton.com, xtranormal.com. The fourth learning activity focused on modelling a process for creating visually attractive digital posters with educational themes. Each student had to present his or her work and discuss an aspect of that work with each other.

E. Specific Technical Deployment

In order to facilitate the adoption and usage of the system, we decided to allow students to use Google accounts to register to the PLE, and also to the MindMeister mind-mapping tool. The Google accounts were provided by the professor to the students, and were created only with the purpose to be used on this specific course. The Facebook authentication was done with the students' personal accounts.

F. Evaluation results

The participants to the evaluation of the ROLE-enabled PLE were asked to answer a short online survey. The purpose of this survey was to gather user feedback both specifically about the ROLE widgets, as well as more generally about the perceived usefulness and ease of use of PLEs, via questions based on the Technology Acceptance Model (TAM) [14, 15]. Since all of the participants were also teachers, the survey contained questions about the perceived usefulness and ease of use of PLEs both from the perspectives of the learner and the teacher. A total of 19 participants responded to this survey.

With relation to the perceived usefulness and ease of use of PLEs from the learner's perspective, the responses were generally positive. Interestingly the groups' strongest opinion related to the statement "*I would consider using a PLE useful for my work*" where 68% of the participants registered an agreement to this premise. Other strong opinions were also voiced in respect of the statements "*Using a PLE would improve my motivation for learning*" where some 42% agreed and "*Using a PLE would enable me to learn in an independent manner*" invited a 42% agreement to be recorded, with an additional 10% expressing strong agreement to the statement.

A negative opinion towards PLEs, however, was recorded in the statement "*I think the system was easy to use*", where 42% of the participants expressed disagreement and 21% strong disagreement. This would suggest that many of the participants recognised that using a PLE required some effort initially along with a discerning thought process but such effort would offer individuals greater benefits in the long run. The remaining statements in this question invited a more evenly spread set of responses.

With relation to the perceived usefulness and ease of use of PLEs from the teacher's perspective, the responses were much more varied. Some 42% of the participants disagreed with the statement "*I would expect a ROLE-based PLE to be useful for my students*". Similarly, 36% disagreed and 31% strongly disagreed to the statement "*I would expect that my students would accomplish their work more effectively with a ROLE-based PLE than with the learning technology they are currently using*".

Nevertheless, 42% agreed to the statement "*I expect that it would be easy for my students to use a ROLE-based PLE*", in addition to 47% disagreeing to the statement "*I expect that my students would find interacting with a ROLE-based PLE requires a lot of my mental effort*". Additionally, 42% agreed and another 10% strongly agreed to the statement "*I predict that my students would frequently use a ROLE-based PLE if they had access to it*". It can be concluded from this set of responses that the participants would expect their students to adopt and use a PLE with ease. On the other hand, the same teachers do not think that the use of a PLE would enhance effective learning for their students, and, consequently, they were reluctant to replace the learning tools their students are currently accustomed to and actively using.

IV. Lessons Learned

Observations of the prescribed activities and the use of the ROLE tools indicated that the participants were somewhat overwhelmed with this new learning scenario. The reason being that this was a totally new setting for the participants - they had not previously used such an environment. Additionally, the type and style of the learning activities were also new to the participants. Unfortunately no time was made available to them to become acquainted with the ROLE technologies before executing the learning activities either. Consequently this was reflected in the participants' negative responses in the survey. In retrospect, it would have been better if the participants were introduced to PLEs and the ROLE tools ahead of the activities and be provided with sufficient documentation and guidance before attempting to complete the learning activities.

V. Conclusions and Outlook

This paper has described a test-bed of cloud-based services within a PLE. The widgets integrated in this PLE consisted of two cloud-based services, a social networking and a mind-mapping tool, where learners can perform and collaborate on learning activities. A complete cloud-based education environment was enabled, both at the infrastructure and at the application level.

The experiences of the authors in setting up this test-bed have shown that the technologies provided by the ROLE project enable the development a truly cloud-based PLE. Initial results from evaluating this PLE with students from three different Latin-American countries have shown that this is generally perceived as a useful learning platform. However, given the novelty of this approach, the need to provide guidance and scaffolding to new users was clearly outlined.

VI. References

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