Science of Computer Programming 88 (2014) 41–53

Contents lists available at ScienceDirect

Science of Computer Programming

www.elsevier.com/locate/scico

Implementation and design of a service-based framework to integrate personal and institutional learning environments

Miguel Á. Conde [a,*], Francisco García-Peñalvo [a], Marc Alier [b], Enric Mayol [b], Camino Fernández-Llamas [c]

[a] Computer Science Department, Science Education Research Institute (IUCE), GRIAL Research Group, University of Salamanca, Paseo Canalejas 169, Salamanca, Spain
[b] Services & Information Systems Engineering Department, UPC, Campus Nord, building Omega, Barcelona, Spain
[c] Department of Mechanics, Computer Science and Aeronautics, University of León, León, Spain

HIGHLIGHTS

- LMS and PLE are going to coexist and they should interact.
- Existing initiatives don't support a complete interoperability among these contexts.
- A service-based framework to facilitate this interoperability is defined.
- It includes several interoperability scenarios that are tested in the university.
- Interoperability between PLE and LMS is possible.

ARTICLE INFO

Article history:
Received 1 May 2013
Received in revised form 18 October 2013
Accepted 30 October 2013
Available online 7 November 2013

Keywords:
Learning platform
Personal learning environment
Interoperability
Web services
SOA

ABSTRACT

The landscape of teaching and learning has changed in recent years because of the application of Information and Communications technology. Among the most representative innovations in this regard are Learning Management Systems. Despite of their popularity in institutional contexts and the wide set of tools and services that they provide to learners and teachers, they present several issues. Learning Management Systems are linked to an institution and a period of time, and are not adapted to learners' needs. In order to address these problems Personal Learning Environments are defined, but it is clear that these will not replace Learning Management Systems and other institutional contexts. Both types of environment should therefore coexist and interact. This paper presents a service-based framework to facilitate such interoperability. It supports the export of functionalities from the institutional to the personal environment and also the integration within the institution of learning outcomes from personal activities. In order to achieve this in a flexible, extensible and open way, web services and interoperability specifications are used. In addition some interoperability scenarios are posed. The framework has been tested in real learning contexts and the results show that interoperability is possible, and that it benefits learners, teachers and institutions.

* Corresponding author.
E-mail addresses: mconde@usal.es (M.Á. Conde), fgarcia@usal.es (F. García-Peñalvo), marc.alier@upc.edu (M. Alier), mayol@essi.upc.edu (E. Mayol), camino.fernandez@unileon.es (C. Fernández-Llamas).

0167-6423/$ – see front matter
http://dx.doi.org/10.1016/j.scico.2013.10.012

1. Introduction

The application of Information and Communication Technologies (ICT) to education, triggers changes that affect the way in which people learn and teach, raising new challenges in for learners, teachers and institutions. ICT makes available new tools to support learning activities that can help to satisfy particular needs of learners and teachers. For example various kinds of software (online) can be used tools to manage and develop learning activities [1]; trends such as web 2.0 involve a shift to the user, who is enabled to participate in the learning process in a more active role than that of content consumer [2]; communication and channels for the exchange of information are enhanced, making it easier for informal learning to become explicit [3], etc.

But this support requires that several issues be addressed: in the first place, the diversity of technologies and tools used in learning contexts forces students to use many different systems during their training and studies, and they may become confused; secondly, we should not regard learning as being limited to formal learning environments, since people learn throughout their lives in various informal contexts (lifelong learning), the problem is to know what happens beyond those formal learning environments; thirdly, teachers and instructors are usually constrained by their institution when it comes to the use of specific set of tools for learning activities; and finally, despite the emergence of new solutions designed for learning, their inclusion in institutional learning environments is rather complex due to the slow evolution of such environments.

Many of these issues are ignored in technological solutions such as Learning Management Systems (LMS). These are systems that [4]: 1) fulfil institutional learning management requirements; 2) provide teachers and academic staff with tools for the management of courses, students, resources, activities, etc.; and 3) create specific areas for students in which they may perform their academic activities, supplement their lectures and (to a greater or lesser extent) collaborate with other students and teachers. These systems are focused on the course and provide with tools, which not only support but also extend the traditional concept of classroom. However these systems raise problems because their focus is on the support of learning processes that happens in specific periods of time, such as academic courses (though it is not impossible to use them in other ways) [5]; they are monolithic and so it is a complex task to adapt them in response to new technological trends or tools (such as 2.0 tools, export of functionalities and information to non-web based contexts, etc.) [6]; and also to evolve the towards new models of learning or to other contexts [7].

Students do not only use institutional learning environments to learn, they use other services, tools, devices and learn in other contexts that are not necessarily linked to an institution or an academic course [8]. The PLE (Personal Learning Environment) approach is a response to this situation. A PLE is more than a technological environment, it is best understood as a concept, rather than a thing. As Wilson has remarked “The PLE is not a piece of software. It is an environment where people, tools, communities and resources interact in a flexible way” [9].

A PLE is not a replacement for an LMS because the two environments support different kinds of learning. On the one hand LMSs are institutional tools that facilitate management, control and assessment of learning, generally focused on the course and with a low level of support for personal needs and tools. They have are widely implemented (especially in institutional environments) [10–13], have been used during several years and are thoroughly tested, both teachers and students are accustomed to their use, and institutions have made a major investment in their implementation, improvement and adaptation [14]. On the other hand the PLE is focused on the learner and their needs. If we accept that both contexts of use are necessary then some degree of integration and interoperability is clearly necessary. In this way, the LMS can export functionalities to the PLE and the activity that is carried out in these environments can be tracked and taken into account from the institutional environment. There are several approaches that can be classified in three strategies posed by Wilson, Sharples and Griffiths [15]:

- Strategy 1. PLEs and LMSs could exist in parallel, as formal and informal environments respectively, without any interaction or integration of the activity that takes place in those contexts.
- Strategy 2. LMSs could be opened up through the inclusion of web services and interoperability initiatives. Included within this approach are *iGoogle* based initiatives [16]; social networks connected with the LMS [17]; LMS support for implementation of interoperability specifications [18]; PLEs with specific communication protocols [19]; or integration based on service-oriented architectures (SOA) [20]. The main difficulties faced by these initiatives include institutional barriers to the opening of formal environments and the fact that those initiatives are focused on information export and not on interaction exchange. That is to say, communication is unidirectional, from the LMS towards the external tools; basically this communication consists on the exchange of information about what happens on the platform, providing no interaction or information back to the LMS.
- Strategy 3. External tools could be integrated into the LMS. In these initiatives, the user might not decide which tools she is going to use and the final decision to authorize tools would exclusively in the hands of the institution. Some initiatives that can be included in this group are: LMSs designed for the integration of external tools [21]; initiatives based on tool integration driven by learning design activities [22]; PLEs based on the inclusion of tools depending on information stored in the learning environments log [23]; or integration architectures [24]. The main difficulties faced by these initiatives involve the integration between tools or contexts, rigid configurations impeding customization by students, etc. At the present time the greatest success in overcoming these problems has been achieved by initiatives that define an entirely new learning platform or build on a prior institutional development. This greatly limits the scope