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Opening Learning Management Systems to Personal Learning Environments

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Abstract: New ICT technologies are continuously introducing changes in the way in which society generates, shares and access information. This is changing what society expects and requires of education. eLearning is acting as a vector of this change, introducing pervasive transformations in and out of the classroom. But with Learning Management Systems (LMS) users have reached a plateau of productivity and stability. At the same time outside the walled garden of the LMS new transformative tools, services and ways of learning are already in use, within the PLE and PLN paradigms. The stability and maturity of the LMS may become yet another resistance factor working against the introduction of innovations. New tools and trends cannot be ignored, and this is the reason why learning platforms should become open and flexible environments. In the course of this article the reasons for this change and how it may be addressed will be discussed, together with a proposal for architecture based on Moodle.

Keywords: Personal Learning Environment, Learning Management System, Moodle 2.0, eLearning, SOA, widgets.
Categories: L.2.0, L.2.1, L.2.2, L.2.3, L.3.0, L.3.6

1 Introduction

Learning processes are continuously being affected by many circumstances such as social trends, technological changes and so on [Ertl, et al., 10, García, 05]. One of the main representative changes has been produced by the application of ICT, which has been used in several areas in order to improve different activities, processes and policies.

ICT has begun to be taken into account in learning environments since the first half of the twentieth century, when Dr.Vannevar Bush began to explore the problem of knowledge exchange by using technologies [Bush, 45]. Later it has been implemented in several areas such as the use of the phone in distance education, computer-assisted learning, the personal Computer, multimedia cd-rom and internet application and so on. However ICT technology application has not had the transformational impact that can be observed in other application fields such as culture, society and economy [Mott and Wiley, 09, Trucano, 05].

The main reasons for this lack of success can be due to: 1) Institutional resistance to change regarding the introduction of certain technologies in formal environments (Web 2.0 tools, Social Networks, eCommerce strategies and so on) [Mott and Wiley, 09, Piscitelli, et al., 10]. 2) The insistence on the technology application when it is not required or seen as a solution. This application follows the hammer theory, outlined by Chadwick in 1998. He thinks that if you give a hammer to a five year old child, she assumed that it can be applied to many objects but they cannot [Chadwick, 01]. 3) The digital literacy necessity. The fact that lot of teachers and students are digital immigrants and the younger generations of pupils are digital natives [Bennett, et al., 08, Prensky, 01a, Prensky, 01b] implies a confrontation and a gap that makes it difficult that they can take advantage of new technologies. 4) The lack of connection between the formal, non-formal and informal environments makes it difficult to improve learning processes and the centralization of the activity in only one context.5) In addition to these factors a lot of technological applications and tools are defined without taking into account the final user, which means that its adoption and application can be difficult.

Despite all these factors there exist some popular tools such as the LMS, but also suffer from problems, such as the lack of openness, resistance to change, failure to take into account the user, lack of integration with informal context and so on. In fact, users are beginning to use them only in institutional contexts because they prefer other tools and technologies to learning activities [Mott and Wiley, 09]. Thus they should be adapted or they risk to be rejected. LMS must become what may be considered Personal Learning Environments (PLE) or must be opened to integrate the activity that is performed in those new environments.

This paper is going to present a web-service based framework that tries to allow both the openness of the learning platform and the integration of the outside performed activity.

This article will come up with a number of sections to answer the raised questions. Firstly a research framework will be defined, including a description of the problem and the state of the art of the possible solutions. Later there will be an architectural proposal and the description, followed by an example, of one of the prototypes made.

2 Research Framework

In this section the initial context and the problem to be resolved, are described. First, PLE as a key approach to opening learning platforms is going to be discussed. Then, how to implement an open environment by using Service Oriented Architectures

(SOA), is described and finally the way in which they have been integrated in a learning platform will be posed.

2.1 The problem and the context

eLearningis one of most popular trends of learning today. It is widely accepted and used in many different contexts. But, as commented above, it has relied on technology without obtaining, in many cases, the expected benefit, which has occurred in other areas. One initiative that has achieved high penetration has been the use of learning platforms (Learning Management System, LMS). For example 100% of Spanish Universities use an LMS [Prendes, 09] and 79,5% of large companies use these systems during their eLearning activities [Wexler, et al., 08]. The use of an LMS provides students and teachers with a set of tools for improving learning processes and managing them. However, despite this high level of adoption they have not resulted in the educational improvements which might have been expected. Three principal reasons have been offered for this: 1) The tools provided are not used properly and often are used as mere spaces to publish courses [Cuban, 01, Milligan, 06, Sakai-Pilot, 09], 2) LMSs restrict opportunities for collaboration in student learning and for the promotion of social constructivism which is not limited to a period of time (i.e. academic year) [Brown and Adler, 08, Wesch, 09], 3) They are focused on the course and the institution rather than the student and their needs [Downes, 06].

It should also be noted that online learning does not end with the LMS. On the contrary, there are many online tools to supplement and improve it, including sources of information (such as communication tools) and the exchange of experience. Consequently "new" applications must be taken into account, such as search applications, news applications, location-enabled applications, content repositories, forums, blogs, calendars, online games, virtual worlds and so on. That is to say, the new initiatives arising from Web 2.0 [O'Reilly, 07].

Given this situation it will be necessary to develop the LMS by integrating it with contexts that include new technological trends and are focused on the student. These contexts constitute the systems referred to as Personalized Learning Environments (PLE) [Wilson, et al., 07].

This paper defines a framework that supports integration between those environments which are centred on students (PLE) and those related to the institution (LMS). In order to do this it is necessary: 1) to provide tools that enable the user to personalize their learning by including informal activities and also those that takes place in the institutional environments; and 2) take into account in the LMS of all the learning activity that the learner performs outside it.

2.2 Personal Learning Environments and integration initiatives

Every day it becomes more essential to adapt learning to trends related to Web 2.0. Education must be supplemented by new applications, tools and paradigms, leading to what has been called eLearning 2.0 [Ajjan and Hartshorne, 08]. This trend in learning requires tools that facilitate: 1) changes in the interaction between socializing the learning [Downes, 06]; 2) the specific features of new learning actors, i.e. natives and digitals immigrants [Bennett, et al., 08, Prensky, 01a]; 3) support for educational

trends related to the Bologna process such as lifelong learning or informal learning, student mobility and so on [Chen, 03]; 4) student-centred learning [Attwell, 07].

The Personal Learning Environment (PLE) has been proposed as a way of meeting these requirements. It is a relatively recent concept which emerged around 2001 [Brown, 10] although it did not become widespread until November 2004 when the term appeared as one of the sessions of the JISC / CETIS Conference of that year.

From that date on there have been many contributions from different authors regarding the definition of a PLE. This is not an easy matter and while there is some established common ground debate continues. Among the possible definitions, there is a differentiation between those who stress the importance of the technological concept and those who stress the pedagogical benefits. In this paper only two of most widely used definitions will be included.

From a technological point of view Wilson's widely accepted statement that "The PLE is not a piece of software. It is an environment where people, tools, communities and resources interact in a flexible way" is adopted [Wilson, et al., 07]. This author promotes an open environment for learning with services and resources from multiple contexts, open and bidirectional (i.e. not only consuming services but also providing them), customized to the user, using lightweight standards and interfaces, collaborative and open content-oriented and which can be seen from the perspective of both the individual and the community.

From a pedagogical point of view several authors could be taken into account. One of the most widely cited is Attwell, who believes that a PLE should not be seen as a software application: "Personalized Learning Environment is not an application but a new approach to the use of new technologies in learning. There are still many unresolved elements. But in the end the discussion about the use of PLE is not technical but philosophical, ethical and educational. The PLEs provide students their own space to develop and share their ideas, through learning environments that connect resources and contexts so far apart" [Attwell, 07].

Within both perspectives there are various classifications of PLEs, for example depending on the way in which they are implemented [Sclater, 08], or in terms of the control of the learner over the activities available in the PLE [Al-Zoube, 09].

In most of these definitions the responsibility for learning is assigned to the student [Lepper, 85]. However, some limits may be necessary in the means used by the student to define its learning, usually derived from an institution's concerns about the formality of the teaching/learning process. Hence it is necessary that the PLE be constructed by integrating online tools and an LMS [Gogoulou, et al., 07]. Defining a system that enables both aspects will be the main aim of the present discussion.

However, integration between a PLE and an LMS is not an easy task because, among other things: 1) LMSs do not normally include interoperability standards [Sclater, 08].2) The integration of training activities in the PLE is not satisfactory because they are designed for representation, classification and tracking in other platforms [Palmér, et al., 09].3) Problems of traceability of user activity in the PLE and, therefore, also in the formal environment [Põldoja and Laanpere, 09]. 4) Single-sign-on implementation problems [Severance, et al., 08]. 5) Information security problems [Casquero, et al., 10].

Wilson and others proposed three possible scenarios of integration [Wilson, et al., 08]:

1. LMS and PLE existence in parallel, as formal and informal environments respectively. There are several initiatives on this area, but they will not be taken into account because they are outside the scope of the integration problem posited here.
2. The second scenario refers to the opening up of the LMS through the inclusion of Web services and interoperability initiatives. In this scenario may be included: iGoogle based initiatives[Casquero, et al., 08], social networks connected with LMSs [Torres, et al., 08], LMSs that offer support for implementations of interoperability specifications [IMS, 11], PLEs with specific communication protocols [Harmelen, 06] or integration based on service-oriented architectures - SOA [Peret, et al., 10]. The main difficulties with these initiatives are: the institutional barriers to the opening up of formal environments and the fact that they initiatives are focused on information exportation rather than interaction exchange. That is to say, communication is oriented in only one direction, from the LMS towards the external tools.
3. The third scenario is based on the integration of external tools into the LMS. In these initiatives the user cannot decide which tools she is going to use and they will be determined by institutional decisions. Some initiatives in this scenario are: LMSs defined for the integration of external tools [Booth and Clark, 09], Google Wave Gadgets integrated into Moodle [Wilson, et al., 09], PLE introducing tools based on log analysis [Verpoorten, et al., 09], initiatives based on tools integration driven by learning design activities[de-la-Fuente-Valentín, et al., 08], integration architectures [Alario-Hoyos and Wilson, 10]and so on. These initiatives have several problems such as: integration problems between tools, context integration difficulties, stiffness for customization by the student and so on. Those that best overcome these problems are the ones that define a learning platform starting from scratch or from a previous institutional development.

Taking all these solutions into account, each with its problems and approach to resolving them, it can be concluded that the integration between the LMS and the PLE is still far from being achieved. The use of web services and interoperability specifications facilitates the opening up of LMSs, but with the exception of certain initiatives [Alier, et al., 10a, Conde, et al., 11] there are no systems that support the user personalization, including tools from the LMS, and where user interaction was recorded in the institutional environment. This is the goal of the work reported here.

To achieve this one of most important aspects is to establish a means of bidirectional communication for the exchange of interaction and not only information between the LMS and the PLE. Now, how this can be achieved through the use of service-oriented architectures, is going to be considered.

2.3 Service Oriented Architectures in Educational Web Environments

For some time there has been a trend towards modularization of computing systems, due to the advantages that it offers, such as independence of development, increase in security, scalability and so on. In parallel work has been carried out towards the production of software services which are independent of the underlying implementation. The result of merging both ideas is SOA. Among the elements that

favoured the development of SOA are the developments of different types of applications, computer networks, client-server architectures, etc. [Ramaratnam, 07]. In its most basic form, SOA is a set of services that communicate with one another [Payne and Barrody, 06].

In educational contexts, the application of SOA will be useful in order to adapt the current LMS to emerging technologies, frameworks and specifications and, in this way, to transform these legacy systems into service-based eLearning platforms [Dagger, et al., 07]. In fact, many platforms already incorporate service-oriented architectures such as Moodle [Conde, et al., 11], Blackboard [Godwin-Jones, 09, Severance, et al., 08], Sakai [Dagger, et al., 07] and so on.

It is clear, therefore, that the application of these architectures enables communication with learning platforms. Accordingly, there are a number of initiatives which apply SOA to learning platforms with different purposes.

One of these purposes is the partial adaptation of LMS services in order to support mobility [Kurz, et al., 08]. That is to say, some specific services of the Learning platform are made accessible by using web services. These services are represented in other contexts such as Mobile devices. Initiatives of this sort generate a web service layer to interact with a very specific part of a platform, and it can be problematic that this layer is integrated in the platform and evolves with new LMS releases.

There are other experiences like LUISA project (Learning content management system Using Innovative, Semantic web Service Architecture) [LUISA, 09]which uses semantic web services to recover information from a learning platform. The Web services are the way communication exchanges along the processes. Although this work is extremely valuable, the architecture has not been included in any platform and it must be adapted to each LMS release.

Other purposes include the use of the information present in the LMS in an external application[Pätzold, et al., 08]. External tools can be implemented in technology which is distinct from that used in the learning platform. For example a back office tool or a system for visual information analysis could be connected to the platform [Conde, et al., 10].

The integration of new tools in LMS using web services should also be considered. That is to say the LMS can use web services to access new tools. The idea is to provide a transparent integration between the platform and tools for the user and to provide feedback to the platform about the use of the tools. For example users request for an external service from one of their courses in the learning platform. The LMS must connect to the external tool and provide proper information to the user [Fontenla, et al., 09].

There are also several PLE initiatives that are based on SOA approaches or use web services, such as: MUPPLE [Wild, et al., 09], PLEF [Chatti, et al., 09], MeMeTeKa [Casquero, et al., 10], Peret, Leroy y Leprêtre [Peret, et al., 10] work and so on.

These SOA initiatives help the possibility of a real bidirectional communication approach between PLE and LMS. The present proposal uses Moodle Service Layer which is going to be explained on the following section.

2.4 Moodle Service Layer

This section presents the web services layer of Moodle as an example of communication with a platform and the basis for the architectural approach adopted here.

There are different reasons for using of Moodle in this context. In addition to the fact that Moodle is one of the most popular LMS all over the world it can be noted that Moodle: 1) is open source; 2) is developed and supported by an international community with more than 1000000 members (June 2011, http://moodle.org/stats); 3) has been installed in more than 53000 servers in which there are more than 43 million students and 4) translated to more than 75 languages [Alier, et al., 10b, Cole and Foster, 07].

Moreover Moodle is continuously evolving, and now includes an SOA. Last but not least, the groups who have developed the present work (GESSI, from the Polytechnic University of Catalonia, http://www.essi.upc.edu/~gessi/ and GRIAL, from the University of Salamanca, http://grial.usal.es) have been working together towards the integration of an SOA in this LMS [Alier, et al., 10a] and so have a lot of experience working with this platform.

The adaptation of Moodle to include an SOA is not an easy task and it is the result of two years' work. This development begins with the definition of a web services layer to access the core of Moodle and it has evolved into the current architecture. The layer is intended to be useful for all developers who wish to define applications for Moodle without requiring them to touch the LMS code. That layer accesses into Moodle core by using an external Application Programming Interface (API). That API, implemented to support the web services layer, provides the basis for the development of a Service Oriented Architecture consisting of: 1) a scalable layer of connectors that separate the communication protocol applications from the web services and permit the addition of new protocols that may appear in future; 2) an integration layer that serves as an access point for the basic functionalities of Moodle, such as authentication; 3) a web service layer that at present interacts with the Moodle kernel and its inner functionalities. These layers are shown in [Fig. 2] and will be mentioned in the following section. Some of the main services developed for Moodle are shown in [Fig. 1], described using SOAml. This shows the contracts established as web services between a provider application, Moodle in this case, and any possible consumer. The figure shows Web services for managing groups, users, resources, forums and so on.

This architecture is responsible for providing information, but it remains to be considered how to visualize this information and how to integrate it in a learning environment as a learning portable component, in this case, as a widget.

Widgets are small and portable elements that can be run in any HTML context [W3C, 08], providing "live" functionality , content or functionality from some other website. This enables information from different 2.0 applications to be shown, as well as information present in an LMS. As far as the application of this work is concerned, it was necessary to implement a system capable of generating widgets to represent information from Moodle. The present approach uses Apache Wookie (incubating), an initiative derived from the TENCompetence European Union project which provides open source engines for the generation of widgets. Wookie is based on the W3C Widgets specification, but can also include widgets that use extended APIs such

as Google Wave Gadgets and OpenSocial. The reasons for using Wookie are that it is compliant with W3C specifications, and there are prior applications in a PLE [Wilson, et al., 08]. Wookie widgets are thus able to represent functionalities from the LMS and from external tools, allowing the user to define their own environment.

In this way the use of widgets can be understood as a way of opening up an LMS. There are other ways of performing this task, but none of them provide this kind of portability. For example, information can be recovered by using web services or consulting directly to the database. Then, this information could be used in different tools. However this would be conditioned by the technology used (in case of direct access to database) and would limit the use of that information to specific applications.

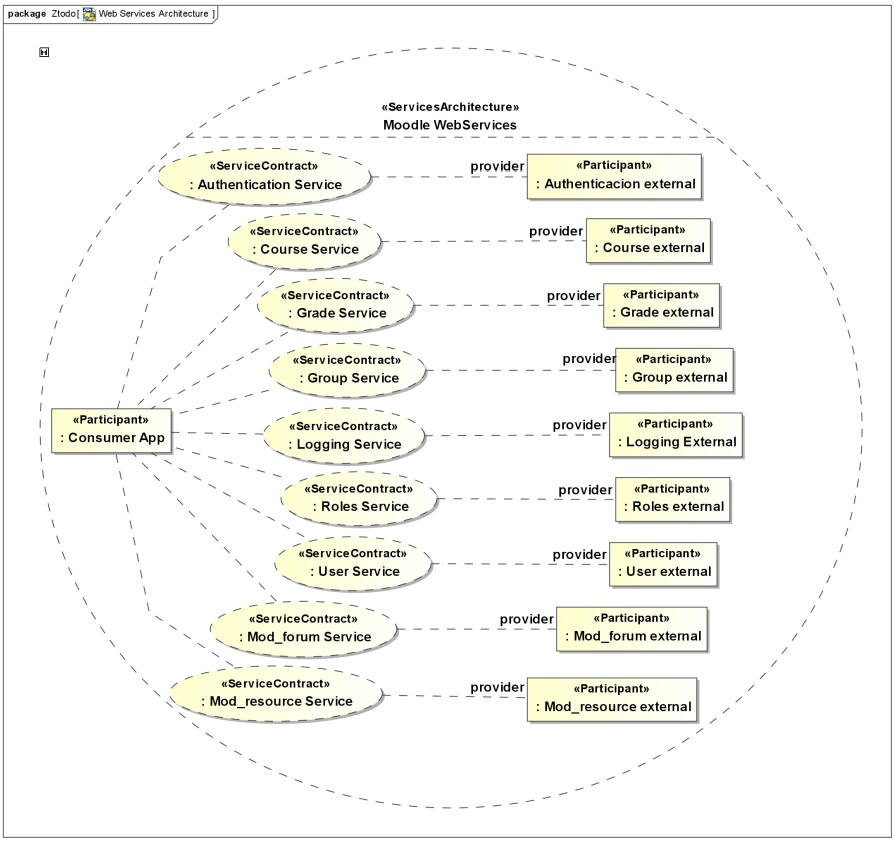

Figure 1: Moodle Service Contracts

3 Findings

3.1 Service-based framework proposal

Having established the theoretical basis, a service framework for opening up learning platforms and integrating informal and formal environments is going to be proposed. This solution is based both on the export of interaction and the integration of external features. As already discussed the present framework uses the Moodle web service layer, integrates a widget engine and exports them to different contexts. The widget generation model has been defined following the information in Moodle as the source of learning portable components to be integrated in the PLEs. Furthermore it is desirable to include information in the LMS about the activities performed in the PLE, enabling the activity carried out in the informal environment to be taken into account in the institutional context. In order to provide a practical integration approach, interoperability specifications must be taken into account, and one of the most significant of these are IMS TI, IMS LTI, SAML, Power Links, OKI [Severance, et al., 08]. One of the most relevant specifications is IMS LTI (also known as Full LTI) because it facilitates a real and full integration between tools and learning platforms. However, many LMS or tools do not support it due to its difficult implantation [Leal and Queirós, 11]. In order to overcome this, a 'light' version of the specification was released: Basic LTI (BLTI). This version, supported by the most popular LMSs [IMS, 11], supports the creation of an external tool instance inside the learning platform, launching it and providing a single-sign-on access. However, BLTI presents a problem: there is no real integration only authentication, so there is no exchange of information about the activity performed on the tool towards the LMS (i.e.: the grade of an activity, the users' activity logs and so on). IMS Global Learning Consortium is working in some extensions, such as BLTI-outcomes that provide a way to return to the LMS a grade about the activity performed in the external context, and this extension is used in the present proposal.

The present approach uses the Moodle web service layer, Apache Wookie (incubating) as a widget engine and BLTI outcomes to define communication ways between PLE and LMS.

[Fig. 2] articulates the different parts of this approach, which are:

- **The institutional context (on the left side of [Fig. 2]).** This part is represented by a LMS, in this case Moodle 2.0 which incorporates a scalable web service layer that allows the exportation of information from the LMS [Conde, et al., 10]. This layer is an API that allows access to Moodle core data. The methods present in the external layer are invoked by a set of web services, which are defined as another layer on the architecture (these services are described in [Fig. 1]). To the right of this layer a set of connectors are defined. These elements provide access to web services by using various protocols. This layer is scalable using plugins which may be necessary when the service and connector layers do not provide the appropriate information to a specific context. For example a new plug-in has been added to this architecture in order to connect widgets and Moodle with a mobile client such as Moodbile (see [subsection 3.3])

- **Informal and personalized context (on the right side of [Fig. 2]).** This part provides tools to users in order to carry out learning activities. It also has to include activities from the LMS so the learner can mix them with the other tools which they use for learning. These activities (in purple in the [Fig. 2]) are be represented by Wookie widgets and use the connectors and web service layer to access to the LMS information and exchange interaction with it.
- **The set of tools.** External tools that are used for learning and are to be integrated into the PLE. These tools, which are mixed with the LMS activities, are also represented by widgets. Those widgets must return information about the activity that is carried out within them. To do this there are two possibilities. The first is that the teacher enters into the external tool context and evaluates it as an external assignment (in light green in [Fig. 2]). In the second the widge provides the result of the evaluation of the activity by using BLTI outcomes (In light blue in [Fig. 2]). In this way the grade is integrated in the LMS grade-book as with any other activity.

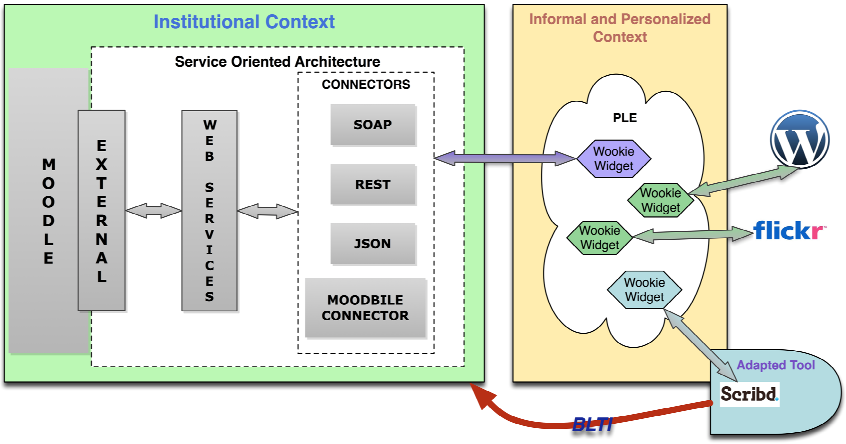

Figure 2: Service-based Framework approach. This image describes the different elements of the proposal, the institutional context, the informal and personalized one and the adapted tools that connect to the LMS by using BLTI.

3.2 Service-based framework proposal

In order to verify the validity of the framework a prototype is being developed, including a Wookie widget that exchanges interaction with Moodle.

The first step was to define the desired functionality and how many interactions would be allowed. Taking into consideration the various resources and activities provided by Moodle, and as proof of concept, the forum is used as the first widget. This is because it is one of the most used tools included into Moodle and because this tool is widely used in learning contexts.

Once the functionality had been defined, it was necessary to study how to connect the widget with the LMS in order to represent the forum information and interaction. To develop this prototype the JSON connector was used because, this is a very light and easier protocol to implement. These are the main steps required:

1. XMLHttpRequest Object. A XMLHttpRequest object is instantiated, this is used to make requests to the Web service using JSON protocol.
2. Proxy. The use of the variable "proxy" from Wookie Widget API is necessary to avoid cross-domain problems (if Moodle is in a different server to Wookie it will be necessary to add the Moodle server address to Wookie white list).
3. Connection Settings. Connection must be set to define whether data is sent using GET or POST methods (as in this prototype JSON is used, POST method must be used). Also Moodle URL must be established and whether to use synchronous or asynchronous connection (forum widget uses synchronous connections).
4. Data Delivery. Data required by JSON protocol is sent, which are: user, password, name of the method to connect with, index and data to send. All in a suitable format for the selected protocol.
5. Data reception. The JSON connector receives data and parses it. If everything is correct, the desired method is called. For example, in the case of retrieving discussions from a certain forum, the connector would invoke to the interface method called "get_discussions" with the forum id as a parameter. The corresponding method from the external layer would be called and the required information would be returned. [Fig 3] shows the methods of the Forum Web service interface.
6. Service Interface. The method invoked by using the web service will return the forum data. The forum web service can be seen in the SOAML diagram of the [Fig 3].This diagramrepresents the forum contract between a provider and consumer and the different methods that the interface includes. These methods are invoked to recover information about the different elements of the forum.
7. Data recovery. Data is retrieved and returned from Moodle. This information will be parsed as a javascript object.

It was then necessary to compose the basic structure of the forum widget [see Fig 4] several invocations to web services were necessary. In the forum example of the [Fig 4]: firstly it was necessary to recover information about what discussions of the forum the user could see, then the discussions, after that the posts of each discussion and so on. And also interaction was represented so when a user clicks on a discussion new information must be recover. That is to say the widgets must provide not only information but also interaction.

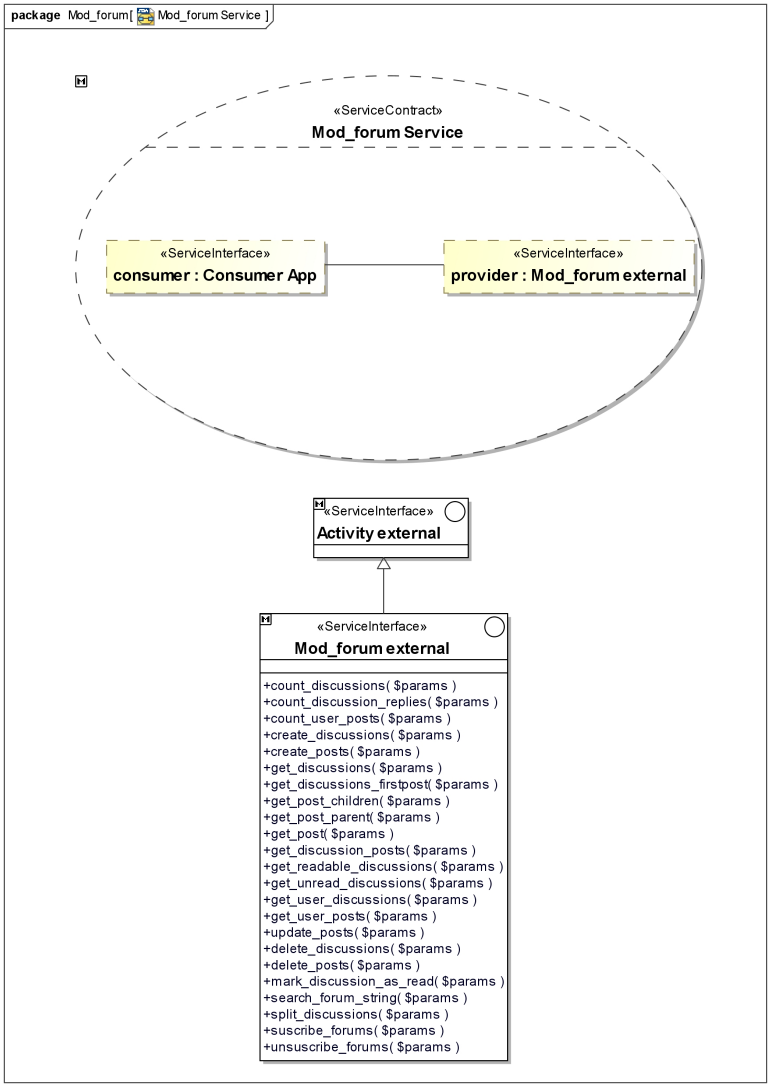

Figure 3: Forum service description. This includes the forum service contract and the interface that can be accessed through that contract.

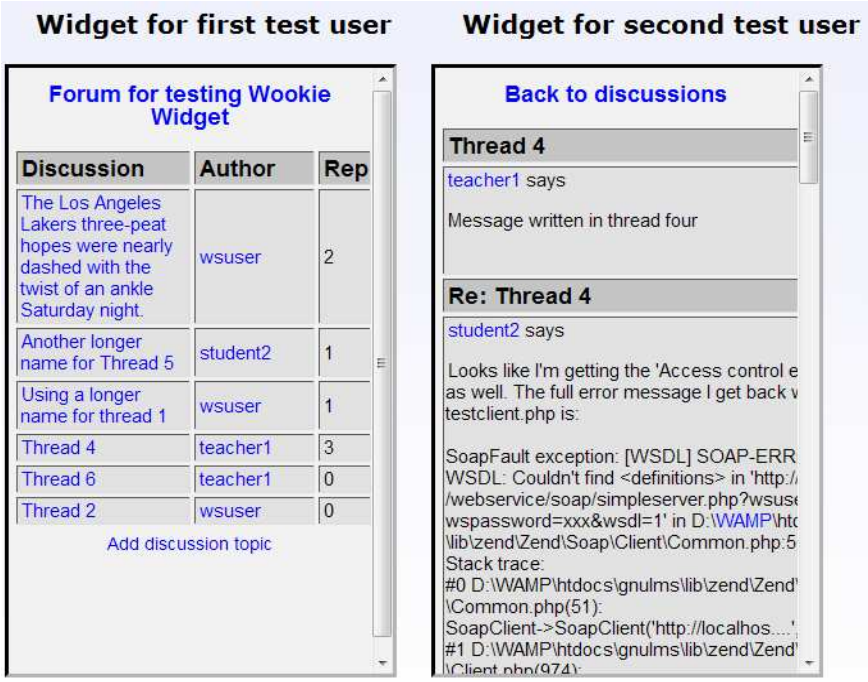

Figure 4: Moodle Wookie prototype. On the left side of the image a list of the discussions to what the user has access is shown. On the right side the messages included in one of the discussions are shown.

It should be mentioned that although this prototype is finished, the developers of this project are working on the implementation of a widget of the other two types: a widget to represent an external tool (Flickr and Wordpress are being adapted), and a widget to represent an external measurable tool that provides feedback to Moodle by using BLTI outcomes. Also other Moodle functionalities will be adapted, in order to export more functionality from the LMS.

3.3 Other application contexts

In order to define a really innovative system with great potential for learning the possibility has been explored of opening the framework to allow the use of those widgets not only in web containers, but also in mobile devices. Mobile phones are also employing 2.0 applications [Jaokar and Fish, 06], offering new alternatives in both traditional learning and in informal learning [Cobcroft, et al., 06]. There are a number of existing initiatives seeking LMS integration in mobile phones [Cheung, et al., 06, Podwyszynski and Schwab, 08, Riad, 08], but the present project does not follow that path. Rather the goal is to integrate specified portable elements in a widget container of a mobile device. The experience of the members of both groups will prove very valuable in order to achieve this task, using previous work done, such as Moodbile [Alier and Casado, 07] and CLAYMobile [Conde, et al., 08].

These two projects are being merged into a mobile client for Moodle called Moodbile (http://moodbile.org), which consists of a set of SOA components that package Moodle services with a HTML 5.0 + AJAX client. This client implements a mobile application designed to experience Moodle from a mobile browser (such as those provided by Android, iPhone and so on). Once this is achieved, the SOA defined on Moodle and Moodbile adaptation and visualization systems will be used in order to integrate in a single device the learning portable components and a set of 2.0 applications.

4 Conclusions

eLearning needs evolve, and this evolution must take the student into consideration. Usually, in online learning processes, the student is conditioned by temporal issues, LMS technical constraints or an inefficient use of learning platforms features. If students are not placed at the centre of the eLearning processes, and if emerging technological and sociological trends are forgotten, any eLearning activity will fail.

To avoid this situation it will be necessary to open the present LMS conception. LMSs should allow the integration of other tools and must be centred in the user. In this paper the different problems that LMS present have been explored. Taking them into account the need of integration has been clarified. Not only the integration the openness of LMS and integration of new tools is necessary, but also allowing the users use their own environments and tools, integrating the activity carried out by them into the institutional environment, that is to say, making it possible the communication between the informal and the formal contexts. In order to define a possible solution a web service-based framework has been posed. It has Moodle as the institutional environment, Wookie widgets container as the informal and personalized one (as a PLE) and uses web services, and interoperability specifications to communicate both environments. In order to check the potential of this framework some parts were implemented, specifically the integration between the Wookie widgets and Moodle by using the service web layer.That implementation has provided enough information to know how to integrate widgets by using the web service layer and also to observe the necessity of the implementation of secure ways to exchange information and, if possible, a single-sign-on system.

This approach is not finished and needs to consider the range of applications, integration implementations, and tools that the user uses in her learning processes. In fact, different integration ways are being explored (new specification, changes in the existing ones), feedback communication channels (ways to provide feedback to the user from the institutional environment to the personal one) andnew possible ways to measure the users' informal activity. Also new interaction ways are being studied and beginning to be implemented, such as those related to the use of mobile devices. This proposal aims to be a core for further learning initiatives and can be used in other contexts such as mobile environments.

Specifically in the future, it will be necessary to implement additional widgets, to adapt different external tools, extend BLTI integration in order to provide not only a grade but also logs with user interaction and so on. Moreover the learning portable components should be usable in other contexts such as mobile devices, also different experiments must be carried out in institutional environments to check in order to

improve the framework and observe the validity of the proposed integration approach in academic environments.

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