

# How to Define and Apply Mobile Personal Learning Environments

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**Abstract.** The application of ICT to learning, the 2.0 trends and the widespread of technologies such as the mobile devices make necessary to provide new solutions to satisfy learner necessities. Such solutions should take into account the students as the center of the learning process. They should be able to decide what tools they use to learn and the institution, independently of the context where learning activities are carried out, must consider what students do in such personal learning activities. In addition those environments should be accessible through mobile devices. During this paper a service-based approach to define mobile personal learning environments that allow communication with the institutional learning platforms, is described. Such approach is implemented and evaluated in order to show that such kind of mobile learning platform is possible, increase students' motivation and help them to learn.

## 1 Introduction

The context in which teaching and learning processes are carried out has changed because different factors. In the recent years the application of the Information and Communications Technologies (ICT) and the emergence of the 2.0 trends have different effects on those contexts.

ICT application implies the definition of a huge number of educational software systems and the use of different tools to learn, such as the Internet, mobile devices, TVs, games and so on. This leads to different learning modalities such as eLearning, mLearning, gLearning and so on. Especially eLearning it is widely accepted and used in many different contexts and also the systems that give this kind of learning support, the LMS (Learning Management System)[1, 2]. 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 [3-5], 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)[6, 7], 3) They are focused on the course and the institution rather than the student and their needs [8].

In order to address these problems, learning institutions need to change their strategies. They must provide environments more adapted to the student and open to include the new set of Web 2.0 tools that are under the student's control. The rationale for the shift of this 'locus of control' is that personalization can improve learning by empowering the student to manage their learning at their own pace [9] with their own technology within the context of the activities of their daily lives which are also managed by the same technologies. Consequently, the PLE (Personal Learning Environment) seeks to unburden the learner of the need to learn new systems when they engage in formal learning. PLEs facilitate the user learning process by allowing them to use those tools they want to use and not joining them to an specific institutional context or learning period [10].

On the other hand one of the most popular technologies used in the current society are mobile devices. In fact there is an 86,7% of this technology penetration and more than 5981 millions of mobile devices connections, which means that most of first world population use one or more mobile devices [11]. This technology has also influence in learning in which its application is known as mLearning.

Taking into account such high uptake and the necessity to consider personal environments, the next step is to represent PLE in a mobile device. The PLE should be open to other context but also needs to consider the connection with LMS because they have been highly successful in stimulating online engagement by teachers and learners and also they are widespread and big amounts of money have been invested on them [12]. So the representation of a set of educational tools in the PLE under student control is not enough, such space should be able to interoperate with the LMS.

The aim of this paper is to show how to represent and apply such kind of PLE in a mobile device. That is, how it is possible to represent the PLE in different devices and at the same time how that Mobile PLE version is connected to the LMS. In order to do so a service-based approach and different ways to represent information are described.

The paper is structured as follows: in second section, some possibilities to represent a PLE in other contexts such as mobile devices are presented. The third section will describe the architectural approach. The forth includes an implementation of such approach and how it is applied during a proof of concept and finally some conclusions are provided.

## **2 PLE Representation other Context**

The present technological landscape makes it necessary not only to consider web environments, but also new realities such as mobile devices or interactive TVs. That is, the LMS and/or PLE should not only be considered from a traditional perspective, but they must be open to other contexts. There are several possibilities to achieve this desired portability.

Some trends consider that it is not necessary any kind of adaptation of neither information nor functionality because the new contexts must provide the tools and frameworks which allow the personalization of student learning. For example, mobile devices or tablets [13-15] could be understood as a PLE. This idea is correct but the integration of the tools the students use to learn is not so clear because they are not in

the same space, which can disorient the learner.

Other initiatives define tools for learning using such devices and considering the specific capabilities of mobile devices (GPS, camera, accelerometer, etc.). A good example would be the *CONTSENS Project* [16] used in several learning experiences in London; a Mobile Personal Environment (MPE) helping students to communicate between them and with experts by using the mobiles [17]; experiences to learn languages by using the mobile and taking into account the context of the user [18]. The problem of these solutions is that they have great dependence with the hardware and software of the mobile devices.

On the other hand, there are many projects that exploit mobile devices as PLE by adding learning functionalities and institutional tools to them. Two representative examples could be *MOLLY project* (<http://mollyproject.org/>), a free open initiative integrated with the LMS Sakai, which allows students to contact with experts, to access to academic podcasts and libraries and to obtain information related with a institution; and *CampusM*, a mobile application that provides different tools to each student adapted to her necessities (internal messages, blogs, portfolio, maps, calendars, alerts, etc.) and which allows integration with LMSs like Moodle or Blackboard [19]. The main drawback of this kind of solutions is that they are too specifically defined for an institution although this can be solve through the use specifications and standards.

Other possibility is to use mobile communication features, such as the use of RSS clients or SMS. Two examples of this use of mobile devices' features are *OnlineConnect Project*, which sends custom information to each student's mobile phone [20] or *REACH* (Researching Emerging Administration Channels), which sends alerts from the LMS to mobile devices by using that technologies [21]. The problem of these solutions is that they are quite limited by the use of technologies such as RSS and SMS.

There are also some interesting initiatives to define PLEs such as *Elgg* (<http://www.elgg.com>), that has released mobile versions in order to make possible an easy way to build PLE and access to them through mobile devices [22]. With this system it is possible to access from mobile to virtual communities defined with Elgg but this tool is not always enough to define a PLE because it should be enriched with other learning tools and has no communication ways with the LMSs.

Moreover, it is also possible to use the widgets employed to define a PLE in other contexts. In this sense, there are several initiatives such as *Aplix Web Runtime* (<http://www.iasolution.net/products/aplix-web-runtime/>), the *Widget runtime: WAC-1.0 Compliant Golden for Android* (<http://dev.opera.com/articles/view/labs-widget-runtime-wac-1-0-compliant-golden-for-android/>) and the consortiums between different companies to define common interfaces for mobile applications [23].

Also related with widgets, other projects such as *Webinos* (<http://webinos.org/>) should be considered. *Webinos* defines an open platform to share applications between different contexts. This means that an application can be used in a TV, a mobile device, in a car navigation system etc. Particularly, they define interfaces to allow information exchange and component integration (components that are an extended version of the W3C widgets) [24].

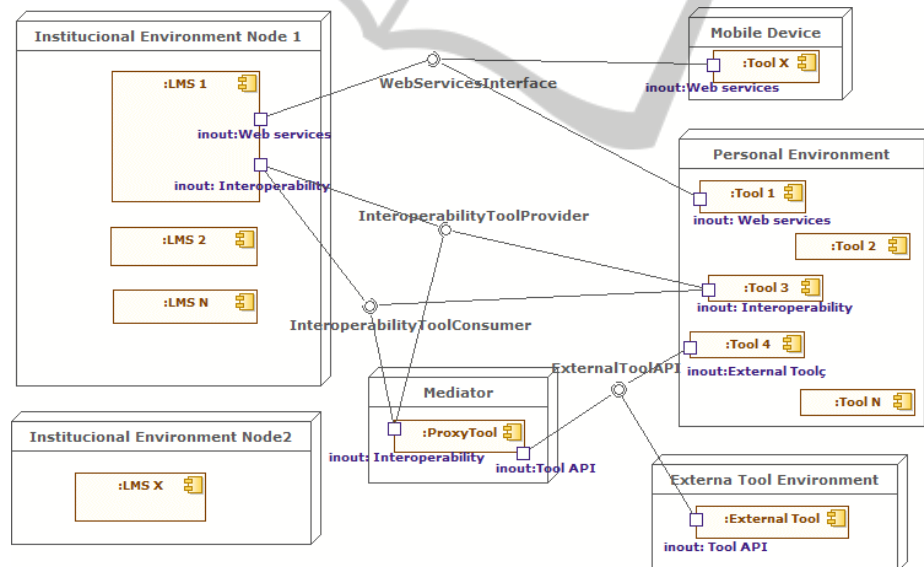
Last, but not least, it is possible to use tools LMS native tools from the mobile device, in a way that these tools can be combined with the device own tools. These are very common solutions implemented by most LMS [25-31].

With all these initiatives, it is evident that it is absolutely possible to open the PLE to other contexts. However, the heterogeneity of communication interfaces, software and hardware, and the lack of control over the activity, is hampering the definition of real independent PLEs.

In the following section a possible solution based on web services is described.

### 3 Architectural Approach to Define a Mobile PLE

In the previous sections the necessity to represent a Mobile PLE able to interact with the LMS, has been presented. To achieve so, it is necessary the use of service oriented approaches. The authors of the present paper have defined in a previous work a service-based approach to support such kind of representation and interoperability [32]. It is based on an institutional environment represented by one or several LMSs and a PLE that includes different tools represented as widgets (that can be included in different contexts including mobile devices). Those components interact between them by using the web service layers provided by the LMSs and interfaces based on interoperability specifications. In addition, some elements are introduced to facilitate such interoperability as mediators. In order to describe the most common interaction ways between the LMS and the PLE, some interoperability scenarios have been defined [33]. Such architecture is shown in Fig 1.



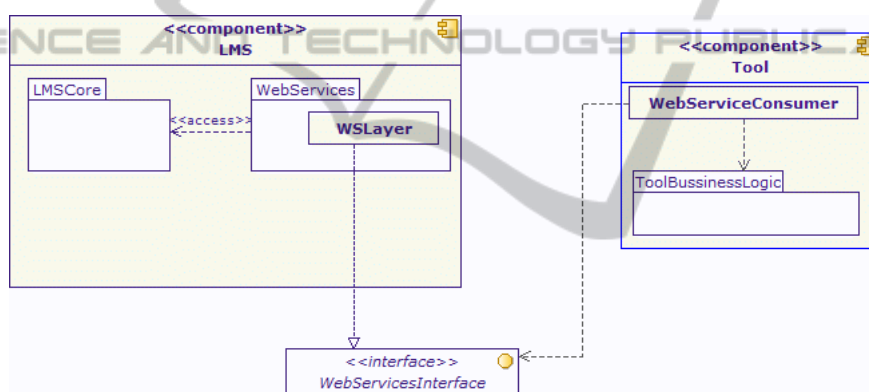
**Fig. 1.** Architecture deployment diagram. It includes two institutional nodes with different LMS, a proxy tool in a mediator node, the personal environment, an external learning tool and a Mobile device.

In this case just one of the interoperability scenarios and the some of the components should be taken into account, because the aim of this work is to describe how to represent the PLE in the mobile device. This means that from the previous

diagram just the institutional node with the LMS 1 and a web service interface that is used by the Mobile device should be considered. The functionality in the mobile device is represented in two possible ways, as a widget (a kind of mini-application), which can be displayed in a widget container (such as Aplix Web Runtime or the Widget runtime: WAC-1.0-compliant Golden for Android described above); or as a LMS mobile version that can include other tools such as could be Moodbile (<http://moodbile.org>). The widget option allows the user to combine functionalities exported from the LMS with other tools she used to learn. The LMS mobile version includes several tools and can include new ones (although this is conditioned by the solution selected from the existing ones).

In Fig 2. it is shown how the components involved in the architecture are connected. The tool, represented in the mobile device uses an interface based on web services and implemented by the LMS web service layer. This layer receives a request for an LMS service and access to the LMS core in order to return the results of the service, such information is later displayed in the mobile device. In this way it is possible to carry out an activity by using a tool of a Mobile PLE and such tool provides information to the LMS of what is happening there.

In order to check the approach an implementation has been carried out and it is described in the following section.



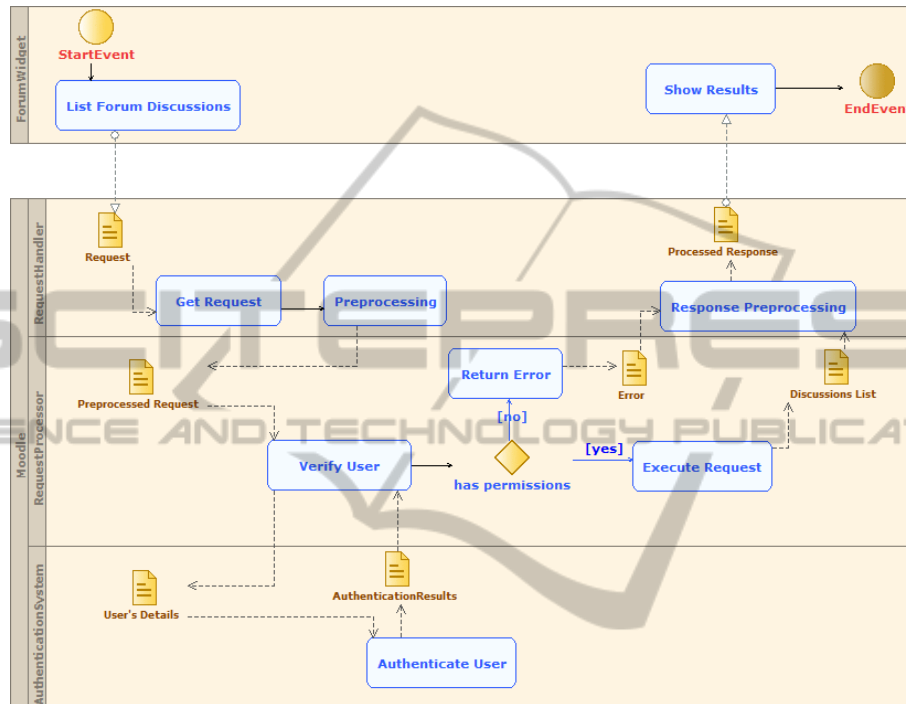
**Fig. 2.** Connection between the components included in the approach. It includes the LMS, the WebServicesInterface used by the tool and tool with a WebServiceConsumer.

## 4 Proof of Concept

The above-described architecture should be implemented to validate it. To do so a proof of concept is carried out using: 1) Moodle as the LMS in the institutional environment, this LMS is selected because of its high uptake (<http://moodle.org/stats>) and the web service layer that includes [34]; 2) a W3C Widget (<http://www.w3.org/TR/widgets/>) to represent the tool into the mobile device [35] because it is the specification to define widgets proposed by the W3C and in this way it is easier to represent this widgets in other contexts; 3) Moodbile as a Mobile LMS software to check the other possible tool representation in the device; and 4) the web services interfaces to facilitate the interaction with the LMS.

The implementation has considered a specific Moodle tool, the forum. It is implemented as a widget for one of the representation options and Moodle includes it for the other. Such functionality is based on the results returned by the Moodle Web Service Layer to different requests.

In Fig 3. it is shown the sequence of actions carried out to return the list of forum discussions through a BPMN (Business Process Management Notation) diagram [36].

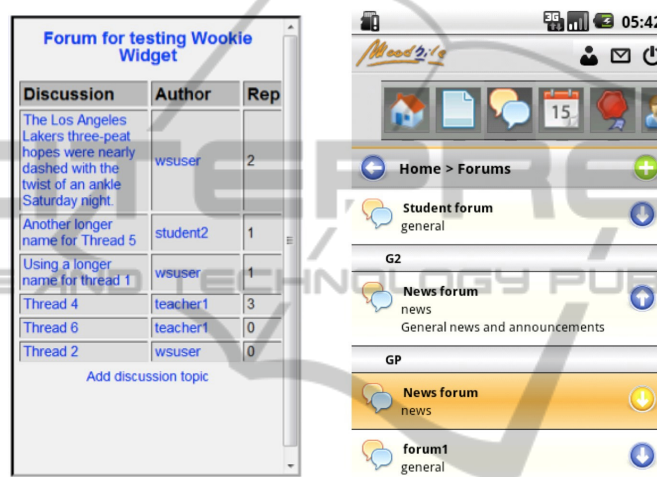


**Fig. 3.** BPMN Diagram for describe the actions exchanged between Moodle and the ForumTool to list the discussions.

There are two main participants the Tool or Widget and Moodle. A user of the tool request the list of discussions, such request is received and preprocessed by a RequestHandler (this means that the arguments are extracted from the messages something done in a different way depending on the web services implementation, i.e.: SOAP, REST, JSON-RPC). After that the content of the request is sent to the request processor where the identity of the user that try to recover the list of discussions is checked. If she does not have permissions a response is sent with an error, if she is allowed to gather the information the discussion list is returned following the web service model used in the request. Once this data is in the tool it is shown to the user. These actions are exactly the same for both representation choices but the way in which the results are shown is different.

Once the tool is represented in the Mobile PLE it can be combined with other applications the student's use to learn. During the experience a widget following the W3C recommendation is carried out and it has been represented included with the widgets of the widget runtime WAC-1.0-compliant Golden for Android. This solution

will be valid for a PLE based on a container that supports these widgets such as Apache Wookie (Incubating) and not only for a mobile device, but regarding to mobile devices it is linked to a specific mobile device system (as Android) although it can be included in other containers. Taking this into account it is also used the representation with Moodbile that provides a tool for Android Systems, but also an HTML5.0 (<http://www.w3.org/TR/html5/>) representation, which makes it independent of the device system. Both representations are shown in Fig 4. The problem of this solution is that it is joined to a specific LMS and that, is not so easy to include other tools. This will be solved by using in Moodle interoperability specifications such as BLTI (<http://www.imsglobal.org/developers/blti/>) that facilitates tools integration that later could be shown through the mobile adaptation.



**Fig. 4.** Forum representation in a W3C widget (on the left side) and in Moodbile (on the right side).

## 5 Conclusions

During this paper two main problems have been presented, one is related with the shift to the user in learning contexts, which leads to the definition of the PLE concept, the other is related with how to represent such element into a mobile device and also to facilitate the communication with the existing LMS.

In order to do so an architectural approach has been posed and a proof of concept that implements part of it is described. In such implementation two possible ways to represent the system have been developed. Such implementation has been validated in a quantitative way with students and teachers of the University of Salamanca. Specifically several pilot experiences have been carried out. During this experience a quasi-experimental methodology was used [37], with a control and a experimental group. The students involve in the latter checked the approach with tablets, android mobile phones, and a HTML 5.0 interface. Later they filled some tests and the data gathered has been analyzed by using statistic techniques. From that experience it can be concluded that, from the experimental group students' perspective, the opportunity



to represent their PLE in a mobile device that includes functionalities and/or information from the LMS and can be combined with other tools they use to learn, encourages them to participate in the subjects and helps them to learn.

In order to guarantee these results the experience should be repeated in other different contexts such as Secondary and Primary contexts and some improvements should be done in the system i.e.: new tools needs to be adapted to be included in the PLE; the activity of the users in other tools included in the PLE should be taken into account from the LMS; problems related with widget representation in mobile devices have to be solved; new ways to represent contents in such devices must be developed, etc.

As a final conclusion it can be said that the definition and application of Mobile PLE is possible, there exist several ways to do it, but any of them should consider the interaction with the LMS.

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