Advantages of using Web Services as Learning Objects

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ABSTRACT
The creation of educational content for use in e-learning, requires compliance with certain characteristics of the technology while allowing the adaptability of the material to different student profiles. Meeting these requirements makes the task of creating and designing the e-course content (theoretical material, examples, exercises, etc.) expensive. Learning Management Systems (LMS) have provided an environment for creating courses but the instructional materials and activities available to teachers (interested in achieving certain learning goals) have been limited. Thinking about Web Services as Learning Objects offers new possibilities. This helps achieving a learning experience in line with the expectations of new generations of students.

General Terms
Semantic Web Technologies and Social Semantic Web, Information Personalization.

Keywords
Web Services; Adaptability; Metadata, e-learning; instructional design

1. INTRODUCTION
In the instructional design of a course the teacher tries to reach some learning goals. To achieve these objectives, the teacher decides what materials and educational activities must be included in the course, however the effective inclusion of the materials derives from the facilities provided by the Learning Platform.

Incorporating external tools to the e-Learning Platform greatly expands the possibilities of achieving better results. In this sense, the idea of using Web Services as Learning Objects allows teachers to incorporate existing web services, in many cases already known by the students, to achieve educational goals.

In this work we analyze not only how to use a web service interface, but we also show how to add the ability to collect metadata evaluating their use in the learning context. This information is useful to define recommendations for different student profiles.

Metadata harvesting during the instance of learning allows engaging the teacher in the process of cataloging web services. In addition, students contribute to the improvement of the course.

The task of building and designing course content is expensive in time and money so it is necessary to maximize content's reuse. This work proposes to adapt an e-course as a mechanism to promote content's reuse. However, the adaptation process should not lose sight of educational objectives, the learning model that guides the pedagogical process and the particularities of the different students' profiles. The content is then represented in the form of learning objects.

The main concept in the E-Learning paradigm is the learning object. Learning objects are "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" [1]. Wiley [2] defined Learning Object as "any digital resource that can be reused to support learning".

In recent work, Dietz et al. [3] and Taraghi et al. [4] propose to use Web Services as mechanism for achieving adaptability. Using Web Services as low granularity learning objects may allow adapting an e-course to a particular student profile. An e-course that includes a Web service has the ability to adapt, through personalizing the service to the characteristics of a student profile. Language, background and preferences can be parameters to personalize a service.

Our work focuses on facilitating the use of Web Services from the point of view of Learning Objects and their application to achieve adaptability of e-courses.

The e-courses can be contained in a variety of Learning Management Systems such as Moodle, ATutor, and Blackboard. For this reason we propose using a platform independent mechanism for including Web Services.

Also in this work we propose to use LMS's instructional activities during the learning activity, with the purpose of harvesting metadata. This idea applies to both traditional learning objects as well as learning web services.

The rest of the paper is organized as follows. In Section II we present different approaches for e-courses adaptability. Section III discusses an approach for integrating Web Services into Learning Management System. In Section IV we describe how e-courses can be designed using Web Services. Finally in Section V we discuss some conclusions and future research.

2. APPROACHES FOR E-COURSES ADAPTABILITY
In this section we present different approaches for e-courses adaptability such as Ontology-driven adaptability, Personalization through learning object annotation, Peer recommendations, Scenario-oriented approach, Personal

Learning Environments, Mashups and Learning Web Services. Finally we discuss and compare the presented approaches.

2.1 Ontology-driven adaptability

Dolog et al [5][6] propose a service-based architecture in the context of an Adaptive Educational Semantic Web. The central components of the architecture are the Personal Learning Assistant (PLA) Service and The Ontology Service. The Ontology Service holds one or several ontologies and can be asked to return a whole ontology or can return a set of concepts selected via some filter criterion. The ontologies are used to represent the knowledge about learning resources, students and learning web services. The PLA integrates and uses Personalization Services and other Support Services to provide the personalized access to learning resources in an e-Learning network.

Learning personalization is based on the use of semantic web technologies to represent the learning services through DAML-S [7]. On the other hand the information resources and learning resources are represented by OWL [8].

Works related to the use of Semantic Web on issues like the semantic representation of the course design and in the development of distributed networks for lifelong learning can be found in [9].

2.2 Personalization through learning objects annotations

In the <e-aula> project P. Sancho et al. [10] propose an ontology-based approach to Learning Objects annotations. The annotation of Learning Objects allows selecting and combining them in runtime to generate personalized courses. The personalized courses are obtained by combining pedagogical ontology [11], conceptual domain ontology and student profile. The learning objects of <e-aula> project are annotated using a subset of LOM [1] categories.

2.3 Peer recommendations

While Web 2.0 [12] provides a wide range of opportunities for accessing information and tools that enable sharing of knowledge across the world, it also introduces the problem of "abundance". Teachers and students might have problems accessing the resources best suited to their needs and preferences. Drachsler et al [13] propose to solve this problem by applying concepts of recommendation systems used in other disciplines such as e-commerce. The idea is to apply collaborative filtering to generate recommendations based on the opinions of students with similar views on an educational resource.

2.4 Scenario-oriented approach

According Sicilia & Lytras [14] a scenario is a discrete sequence of steps in a Learning Management System or other related systems such as Learning Objects Repositories. They also define a Learning Object from the perspective of Software Engineering as a piece with a specific purpose according to a usage scenario. The "semantic conformance profile" concept is introduced in [15] to describe different types of scenarios. The user-based selection is an example of a type of scenario. Scenario-driven approach is one way to achieve adaptability to the characteristics of a student.

2.5 Personal Learning Environments

A Personal Learning Environment (PLE) is a collection of services and tools that help learners to build their Personal Knowledge Networks [16]. According to [4] the PLE concept focuses on the learners and their personal learning interests. Within a PLE the learners arranges and uses Web learning resources and Web based learning tools in a way that it supports their personal knowledge management and learning. According to Palmer et al [17] the PLE architecture can visualized as a set of Widgets. Then propose extending a learning platform using Widgets. The widgets are small embedded applications that can be included in HTML pages.

2.6 Mashups

According to Severance et al [18], current Virtual Learning Environments evolve into Personal Learning Environments through the concept of "functionality mashups". This proposal suggests the use of IMS Learning Tool Interoperability standard as a way to extend learning platforms with external applications and services.

On the Internet, the availability of web services dynamically changes affecting mashups that use it. Dorn et al [19] propose semiautomatic reconfiguration and replaceability strategies to support the change in services availability.

On the other hand, Chatti et al [20] propose using Semantic Mashups to solve problems such as interoperability, reuse, integration and automatic mediation of data through semantic annotation.

2.7 Learning Web Services

Dietze et al [3] propose achieve adaptability to different learning contexts through the use of Semantic Web Services technology. From their point of view, learning processes are described in terms of user objectives (learning goals). At run time learning goals are implemented through the selection and automatic invocation of the services that best fit user needs.

2.8 Comparing approaches

Table 1 presents a comparison of different approaches to the adaptability of e-courses taking into account the following criteria for comparison: i) the proposal is metadata-based, ii) the adaptability takes into account the students characteristics, iii) context on which the customization is done (learning context and work context) and iv) the proposal is based on e-learning standards.

Table 1. Comparing approaches

Approaches	Comparison criteria			
	The proposal is metadata-based.	The adaptability takes into account the students characteristics.	Context on which the customization is done.	The proposal is based on e-learning standards.
Ontology-driven adaptability	Yes	Yes	learning context	Yes
Learning Objects annotations	Yes	Yes	learning context	Yes
Peer recommendations	Yes	Yes	learning context	No
Scenario-oriented approach	Yes	Yes	learning context & work context	Yes
Personal Learning Environments	Yes	Yes	work context	No
Mashups	Yes	No	work context	Yes
Learning Web Services	Yes	Yes	learning context	Yes

Common to all approaches is that they rely on metadata: metadata associated with either the resources or learning activities, metadata to describe the characteristics of students or metadata used to describe concepts and teaching specific knowledge domain. LOM and Dublin Core are the metadata standards used in the e-courses adaptability approaches to describe learning objects.

The use of Web Services can be a mechanism to facilitate the adaptability of a course to a particular student profile, but there is a need to identify the context on which the service is personalized. The difference between "work context" and "learning context" can be expressed in terms of who defines it: the work context will be the student's preferences while the learning context can be given by the learning levels of the e-course. Learning levels of the cognitive domain are also known as Bloom's Taxonomy [21]. A Web Service might have metadata to describe learning levels covered. This information may be useful for teachers when deciding whether to use a Web Service or not in an e-course.

3. INTEGRATION OF WEB SERVICES INTO LEARNING MANAGEMENT SYSTEMS

In the instructional design of a course the teacher follows learning goals. The teacher decides which instructional materials and activities to incorporate into the course. The decision is constrained by the functionality provided by the learning platform in which the course is built. In our work we consider the possibility of incorporating external tools and web services mainly to learning platforms. By adding external tools the possibilities and resources that the teacher has to achieve its objectives are extended.

Learning platforms in its various denominations (LMS, CMS, VLE) must evolve quickly to contemplate educational institution's requirements. In this evolution development efforts are repeated. Discussion forums, chats, wikis are examples of tools implemented by learning platforms when there are third party tools with proven acceptance.

Tools and Web Services need some kind of metadata for cataloging, assessing, and finally recovering and reuse. In particular, tools and Web Services need instructional metadata.

In the following, we present the learning standards that were used in our work. We are using IMS LTI [22] to allow tools and web services to be integrated into learning platform. On the other hand in our work the metadata standard used is LOM [1] and LOM-ES [23] profile.

IMS Learning Tool Interoperability (LTI) is a IMS Global Learning Consortium standard. IMS LTI is a platform-independent mechanism that allows the inclusion of external tools and services into a course. The IMS LTI specification defines two styles of integration: full LTI and basic LTI. LTI has two main components: Learning Management System which is called "Tool Consumer" and an external tool or content which is called "Tool Provider". We are using IMS Basic LTI and a particular implementation for the Moodle learning platform. Our proposal builds on the fact that there is a significant amount of e-learning products open source that are compatible with IMS Basic LTI or are working for it. ATutor, Moodle, Sakai, OLAT and GeNIE are open source learning platforms that implement the consumer side of the standard. On the other hand MediaWiki and WordPress are external tools that implement the provider side of the standard.

In Fig. 1 we present an example of integration of external tools or web services without the use of standard Basic IMS LTI. In this type of integration for n external tools or services and m LMS we need n*m custom connectors. Campus Pack is a set of collaborative and social networking tools aligned with Web 2.0. Campus Pack offers custom connectors to integrate with some LMS like Moodle and Blackboard.

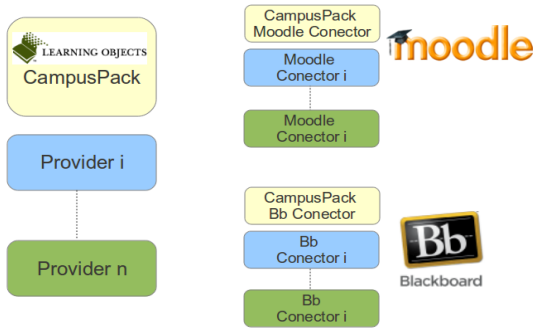

Fig 1: An example of integration without Basic IMS LTI

On the other hand in Fig. 2 we present an example of integration using the standard IMS Basic LTI and a set of Web 2.0 services. In this type of integration an external tool or web service has to implement only one connector; this connector is the provider side of the standard. Each LMS implements the consumer side of the standard and uses an instance for each tool or service that integrates. This type of integration is independent of external tools or services and the LMS. The Option 2 shows another way to cover the features provided by Campus Pack using a set of Web 2.0 services.

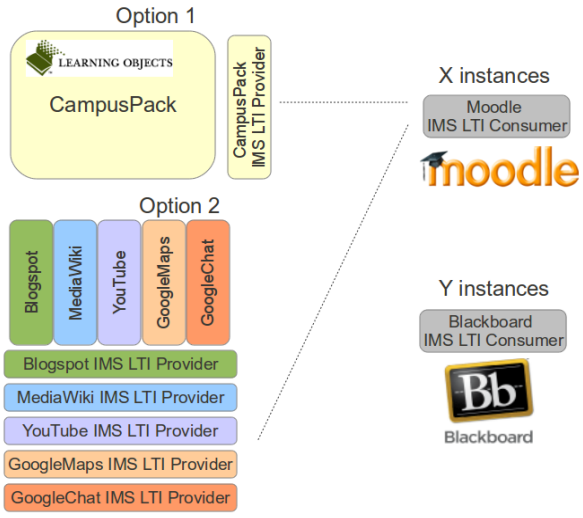

Fig 2: An example of integration with Basic IMS LTI

When we speak about Web Services integration we are referring to RESTful Web Services or RESTful Web Services composition. RESTful Web Services are also known as RESTful APIs or Web APIs. The RESTful Web Services compositions are called Mashups.

REST is an architectural style for distributed systems. A characteristic of the REST architecture is that client-server communication is stateless. Each request from any client contains all of the information necessary to service the request, and any session state is held in the client.

In our work we use ProgrammableWeb [24], a directory of APIs and Mashups. In ProgrammableWeb the APIs and Mashups are described with technical metadata. We need to incorporate metadata of educational interest.

To categorize, assess, search, recover and finally reuse Web Services in a course we need metadata. We propose to use metadata of LOM Educational category because its suitability for cataloging web services from a pedagogical point of view. In our work we use the LOM-ES [23] application profile to design quizzes to collect metadata during learning instance. The idea is to include into the course special activities to record the knowledge and experience of teachers in the use of web services. Also the activities are used to collect feedback from students about the web services' usability and their instructional contribution to the course. The main advantage of collecting metadata at the learning instance is that the metadata entered by teachers and students are related to the course context. The course context offers other metadata such as student profile information and course topics; this metadata is automatically saved into the learning platform.

4. INSTRUCTIONAL DESIGN OF AN E-COURSE USING WEB SERVICES

The LMS stores student profile information such as personal data, academic formation, background and other courses taken in the same platform. Also the LMS stores information about courses such as name, content, target audience, previous knowledge required and previous knowledge recommended. This information provides metadata that can be used to personalize web services included in the course. Metadata can be extracted from LMS and sent to the service using custom key/value parameters. The custom key/value parameters are part of the IMS LTI Basic specification.

To test the concept of using web services in a traditional learning platform widely available we work with Moodle. We use basiclti4moodle [25], which is an implementation of the IMS Basic LTI available for Moodle 1.9 and Moodle 2.0.

Our sample course's main objective is to convey to students the basic concepts related to e-Government and its application to the student's home country. The course consists of 4 sections: Main Unit, Additional Unit, Law Search and Share Materials. The Main Unit and Additional Unit are learning objects downloaded from the repository of learning objects OpenLearn [26]. The Law Search and Share Materials sections are IMS Basic LTI consumer instances. The Law Search Service is a prototype implementation of IMS Basic LTI provider. It builds a search string from the parameters received by POST and starts a search using Google AJAX Search API. The Law Search Service is customized to the student's home country and the subject of the course by retrieving laws relating to them. Share Materials section includes MediaWiki external tool. It is used by students to upload and share materials.

During the course the teacher and students evaluate the Law Search Service and MediaWiki external tool using a Moodle's choice activity. Also, the teacher associate metadata of educational interest to the Law Search Services and MediaWiki. We use Moodle's choice activity or Moodle's assignments online-text activity for each data element of LOM Educational category.

In the future the outcome of the assessment can help deciding if a web service or external tool needs to be replaced by others that

meet the same educational objective but that are better accepted by the teacher and the students.

5. . CONCLUSIONS AND FUTURE RESEARCH

The use of Web Services through the application of interoperability standards extends the capabilities of the LMS and allows the reuse of third party tools with proven acceptance. The Open Source learning platforms, and also proprietary platforms such as Blackboard and Desire2Learn, are interested in the implementation of the IMS LTI and they are working for it. Even if the LMS are prepared it is necessary to increase the number of tools that implement the standard provider-side and especially that they are free to use.

If we associate metadata of educational interest to web services, we can identify them and assess their suitability for reuse in a particular e-course. One possible line of future work is to study the feasibility of using instructional activities of other Open Source LMS such as ATutor and Claroline to collect metadata.

For accessing web services of interest to the educational environment from the LMS, we consider the possibility of using learning object repositories standards such as SQI [27].

Finally we intend to continue working with the approach of personalizing web services to the characteristics of the student and the course content. We envision this path as a way to achieve e-courses adaptability to students' characteristics and to diverse pedagogical models.

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