Specification of Learning Objects as Web Services

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ABSTRACT
Nowadays learning objects are considered educational resources that can be employed to support learning. Combining these digital pieces of knowledge to design and develop online course is still a challenge. Some issues come from the heterogeneity of platforms, standards and instructional design it becomes difficult the maintenance, the access and the interoperability of learning objects. This work proposes to specify learning objects in terms of web services in order to mitigate these issues. The current proposal is intended to help in the maintenance and interoperability of learning objects from different sources, repositories and learning management systems. A case study presents a performance of current approach.

General Terms
E-learning, experiences and educational applications of new technologies, learning object repositories, learning objects and learning designs.

Keywords
Learning objects, repositories, web services, WSDL, metadata.

1. INTRODUCTION
A Learning Object (LO) is defined as a self-standing, reusable, discrete piece of content broken down into smaller chunks that can be reused in any environment in order to meet an instructional objective [20]. They are conveyed in many forms such as: web pages, PDF documents, video, audio, animation, and 3D representations. LOs have been developed in order to technologically and pedagogically support virtual education. Nevertheless, these products can be used under any condition or circumstance where the training or the distribution of the knowledge is required; classroom lessons, staff training in the industry, self-learning process. The LO uses metadata to be reusable, indexing, storing and retrieving is easier from a repository. The LO Metadata IEEE standard establishes which kind of information could be stored to assure interoperability between LOs Repositories [15]. This implies some economic advantages (e.g., create once, use several times) as well as pedagogical advantages (e.g., high quality interactive multimedia easily available for courses, individualized learning).

Web service is one of recent technologies is recurrently used to solve some difficulties of development of learning objects. Web services have the quality to run on any platform and can be developed on a wide variety of programming languages [16]. In fact a web service can be described as any functionality that is accessible over the Internet using XML in the communication protocol [13]. The web service uses standard XML to specify not only the metadata under the SCORM standard [10], but is also used in the SOAP protocol [11]. But for easy access of the learning object, the unit UDDI [14] and WSDL [12] use XML language to record and describe respectively the online service

Today, the availability of LO is not enough to design a course. school teachers present some difficulties to make decisions to choose: the right standards, educative models, tools, learning management systems, LOs.

This paper proposes to take into account the advantages of service oriented approach in order to specify and develop the LO in terms of web services. To this end, next section shows a series of issues that require to be solved; the third section presents our proposal trying to mitigate the aforementioned problems. Section forth puts in practice the proposal through a case study. Finally, the conclusion discuses the scope covered by this article and its future work.

2. PROBLEM OUTLINE
There is a plethora of virtual learning environments, allowing users to access online repositories to organize academic content. To this end, LOs are stored and available in repositories. Working alone an institution could easily control its repositories without any problem. However, when trying to collaborate with other institutions, the information is not as accessible as expected for many reasons: heterogeneity of platforms, standards, structure and design of the content. Sharing is not possible even if it is desired. This work uses a LO as a technology services, a web service that it is available and it is independent of the platform using it.

Creating LOs as a web service presents several challenges including:

1. Formal specification techniques to consider LOs in terms of web services [1,7].
2. Conceptual modeling to specify several aspects for the communication and interoperability [18,19].
3. Interconnectivity of distributed repositories containing web services representing LOs. Web services technology starts to be considered as a conceptual and technological support to specify and implement the LO technology [1].
4. Context-aware User interface development supporting the adaptation of the User Interface in different context of use, where the context is defined as: user, environment, platform [21].
5. Models for evaluating the quality of web services representing LOs [7, 20].
6. Development of content in a reasonable amount of time

Most of these challenges are tackled and a solution is proposed and discussed in the next sections.

3. CONTRIBUTION

3.1 Learning Objects as Web Services

We defined a LO (see left colored boxes in figure 1) with four elements: theoretical knowledge, evaluation, practical knowledge and related topics [7]. The first element is the theoretical knowledge of any to cover a learning goal. The second component put in practice theoretical aspects from the knowledge unit, any learning goal using interactive resources, for instance, simulation, to learn by doing, designing problems and solutions. The third component, evaluation offers a series of tests to auto-evaluate their acquired theoretical and practical knowledge. The last component provides information on line about other related LOs.

With this model of LO, the student could study a theme putting in practice the theoretical knowledge and answering several problems with evaluation. In addition the student could know more about a theme accessing the related topics of a LO.

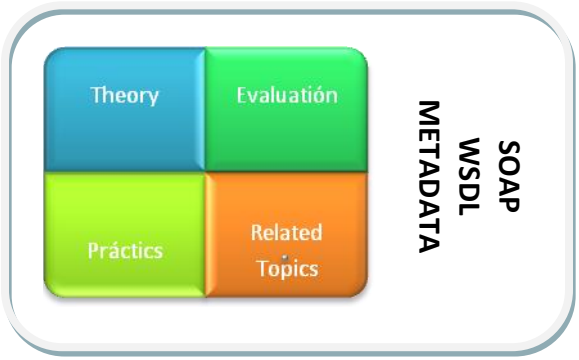

Fig 1: Learning object as a web service.

We specify a LO in terms of a web service, an entity available on internet allowing access to educative content. This is possible since a web service could be defined as an application published on internet which call be identified by a URL[9]. Web services have the quality to run on any platform and can be developed on a wide variety of programming languages, in addition to all the standard protocols based on XML [13].

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A Web service framework consists of at least the following protocols: SOAP, WSDL and UDDI [16]. SOAP is a lightweight protocol bases on XML for exchange of information in a decentralized, distributed environment. WSDL is also XML based. The purpose of WSDL is to describe web services in a standard way. After a web service is published, a UDDI registry servers as a public repository for web services information. Web services can be used as a component, thereby achieving orchestrations and aggregation services for the creation of software components with different levels of granularity.

The use of web services for e-learning facilitates the reuse of functionality of existing technology. As a web service can represent anything, deployed as component, it is possible to contain educative content and manage them in repositories. This educative content could be structured with the four elements that described our LO. Several advantages presents the web service technology, it facilitates the maintenance encapsulating the traditional LO such as: content, assessments, practices and related subjects.

3.2 Online Course

A course in a virtual learning environment requires a set of LOs each of them will be in terms of a web service. There is a vast quantity of virtual learning environments or learning management system, a simple comparison is discussed in [21]. Requirements for an interactive system for e-learning, includes, not limited to, the following aspects:

1. Facilities to interact during and after a lecture;
2. An open architecture which should include the possibility to allow extensions.
3. The system must be scalable (i.e. the system should be able to manage a single course or a whole organization).

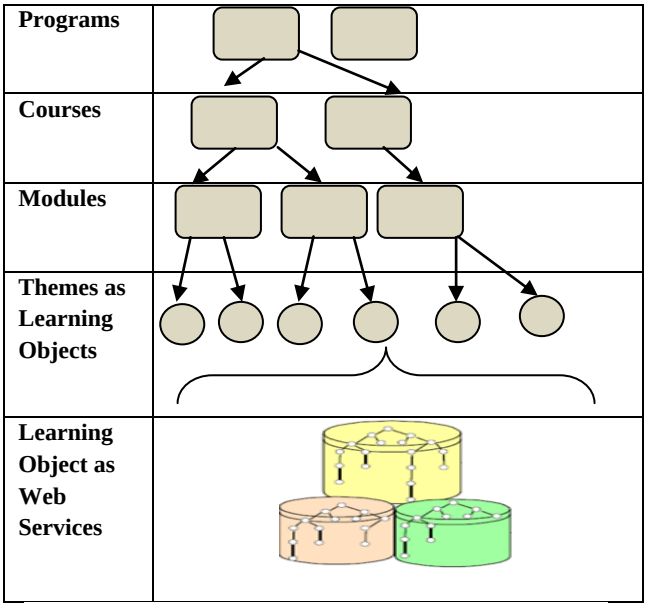

Fig 2: Elements of courses composed by learning objects in terms of web services.

We are going to use loosely these requirements as base of comparison between Learning Management Systems. The platform of choice for most of the learning environments is the web browser helping in the scalability and open architecture issues. Also, common elements are: tools for creating course material, assessment as well as collaborative tools (forums, emails and chats).

These tools achieve the goal imposed by the first requirement because with them we could deliver interaction during and after

the lecture, i.e. synchronous and asynchronous learning modes. The adhesion to standards such as SCORM is part of all environments but alternative or modified versions are often available [10]. We consider that a course could be composed of several modules (or sections), these could be composed by one o several themes, and every theme could be represented at least by one LO (see figure 2). Notice, the LOs are accessible as web services in the platforms and they are registered in the repositories. In general a course on line is accessible using a virtual learning environment, a teacher could defined first the numbers of modules, themes and LOs and second the teacher define also the learning process where the students could performance his/her task.

3.3 Architectural Model

Nowadays a large number of universities are producing their courses in terms of LOs and saving these objects in their own repositories, these repositories in general support several with different criteria with the information in the metadata. Thanks to the collaboration between universities are possible develop online courses with web services coming from different repositories.

Current proposal seeks to the teacher can develop a course in a transparent way searching and selecting LOs of different domains from repositories of different educative institutions.

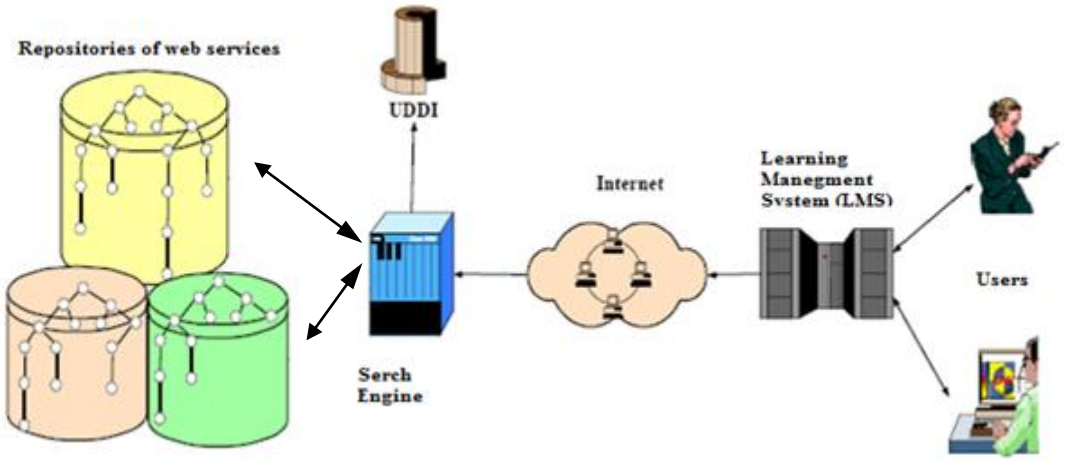

Fig 3: Accessing learning objects in terms of web services.

It is necessary an architecture model where the student could attend online courses in a transparent manner, without having to deal with interoperability problems between different platforms, reuse, portability, search and storage of LOs required other institutions. The creation of heterogeneous LOs requires the compatibility between LMS platforms, OS platforms and content of LO, but the compatibility isn't even a guaranty with portable devices such as mobile devices, handhelds, laptops etc.. Concerning the LO in terms of a web service presents several advantages such as reusability, interoperability and localizations in the web thanks to UDDI. The UDDI allows register the published web services (see figure 3). Web services are representing LOs that can be effectively putting in order and could be easily identified in the repositories using semantic web techniques.

The information registered in a UDDI corresponds to description about how contact a service and the functionality offered by it. It is suitable to include information describing the LOs in the WSDL document. So, it is possible to say that the search engine and the UDDI allows to find the LOs in terms of web services and the SOAP is used for a remote access. The web services are registered in the repository under various criteria (per application domain, by degree of similarity, and functionality etc...). The search engine offers a mechanism for sort and selection of services by certain criteria and performs the search with the descriptions of selected services in the repositories. It is possible to remotely access using SOAP messaging facilitating reuse. With this model, a customer can find a LO by accessing the UDDI registry and getting the information of WSDL and the search in the respective fields of SCORM of LOs [10]. The figure 4 shows the process to recovery of metadata of LOs distributed throughout the repositories. The searches at semantic level take key data contained in the metadata for the time being in the LOs, like they are name of the object, title, description, and authors. This extracted information of metadata is taking inside the web service to form a group of key information related to the LOs inside the federation. It is important to say that a a LO could be part of a task, then it will be used in a task, this information is relevant when further we explain how a LO is mapped to a UI from a task model.

4. CASE STUDY

This section describes a case study where an online course is specified according the contribution proposed here. For this end, next section presents the structure of online course and afterward some results of search for web services are presented in the graphical user interface of a learning management system.

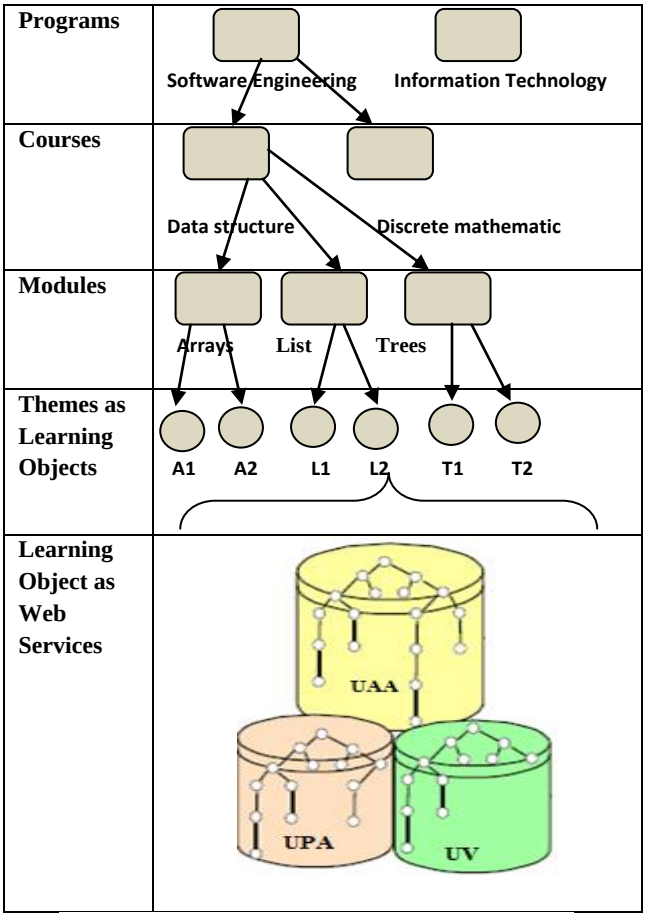

Fig 4: Elements of a course of software engineering.

4.1 Online Course

In this case study the online course of structure data is composed of several LOs in terms of web services distributed in different modules such as: *Arrays*, *Trees and Lists*. A student of this course could selects one of themes for example the *Tree type B*, then the platform search with this names a web service in the repositories, this case study take into several repositories of Mexican universities from states of Veracruz (UV), Aguascalientes (UAA) and (UPA) [8].

According the figure 4, every module of the structure data course is composed of several themes, for example the module of list is composed of linear (L1) and circular (L2) lists. Every theme is defined as a web services under the model of figure 1 where the educative content are structured with the four sections of a LO.

4.2 Acceding to Web Services Repositories

This section shows some results from search applied to web services repositories in the domain of data structure.

Fig. 5a **Fig. 5b**

List of web services displayed in a screen of a PC (fig 5a) and a mobile devices (fig 5b).

The items showed by the screen on a PC (fig 5a) and a mobile devices (fig 5b) are LOs in terms of web services. This list is given by a request applied to the repository of University of Aguascalientes, a teacher can select, visualize, update, download web service from the repository before to insert the web service in an online course in learning management system.

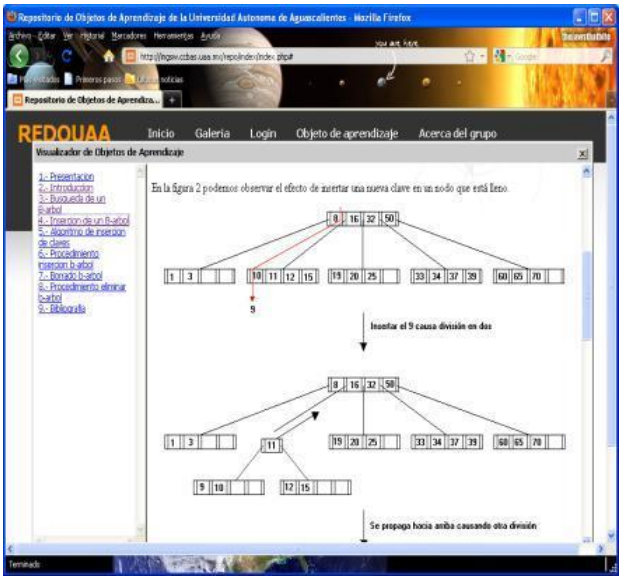

Fig 6. Information given by the three B web service.

The right section of window of figure 6 visualizes an excerpt of theoretical information given by a tree B web service. Notice the left section of this window allows to navigate in the remaining component of a LO: practical knowledge, evaluation and related topics.

5. RELATED WORK

In this section we compare current approach with another related work. We use the following criteria to identify advantages and disadvantages of our approach: use of agents, web services repositories, traditional repositories, LOs as web services and web services for managing repositories.

Table 1.Related works using web service & learning objects

Criteria/Works	[1]	[2]	[3]	[4]	[5]	Current work
Agents				*		
SOA		*			*	
repositories	*	*	*	*	*	*
Traditional Learning objects		*	*	*		
Learning objects as web services						*
Web services for managing repositories	*	*	*	*		

The last table describes different works according different criteria related to specify LO as web services. Most works proposes [1-4] the use of web service to manage educative content repositories with different LMS. For example Vossen and Westerkamp [1] show how to realize a logical organization as a collection of web services, where learners can search for suitable content offerings and, if successful, configure an appropriate delivery, learners can additionally arrange for a suitable observation of their progress and achievements, and authors can adhere to content production services that can be called upon in function of domain. In addition, the agent approach is used in [5] with the web services in order to take into account user profile and identify pertinent educative content in forms of LOs.

Unlike previous work of table 1, current work proposes the use of LO as web services. These kind of web services could be part of educative content of a online course where the students could call them in order to have the educative content of a LO. This work also proposes the interconnections of web service repositories to learning virtual environment in order to help the teacher's task to develop and design course on line.

6. CONCLUSIONS

Given the heterogeneity of platforms, standards, and applications for the production of LOs this paper proposes to specify them in terms of web services; this helps to improve its maintenance, access and reuse of these same objects. Then, the end users can access and consume the LOs from a course offered in a virtual learning environment which will be connected to multiple distributed repositories in several educational institutions.

Finally, there are several aspects as future work, we consider develop a methodology for a massive production of LOs in terms of web services. It is necessary to define mechanisms to search for this kind of web service taking into account the context such as user profile and learning styles.

7. ACKNOWLEDGMENTS

This work was supported by Conacyt (reference 21733) and the Promep project (Reference UAA-CA-48).

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