Service-Oriented E-Learning System

Moon Ting Su[1], Chee Shyang Wong[2], Chuak Fen Soo[3], Choon Tsun Ooi[4], Shun Ling Sow[5]
[1,2,3,4,5]*Faculty of Computer Science and Information Technology University of Malaya, 50603 Kuala Lumpur, MALAYSIA*
smting@um.edu.my, snail_coco@yahoo.com, fen_c2@yahoo.com, ctooi2000@hotmail.com, blue_mic521@yahoo.com

Abstract

Instead of building an e-Learning system from scratch, it can be assembled by choosing the required functionalities from a set of web services related to e-Learning. Web services eliminate many interoperability issues between components written and running on different hardware and software platforms. This study aims to construct a set of e-Learning web services. With these web services, new e-Learning system(s) can be constructed by choosing the services which are required. The developed web services include Assessment, Course Management, Grading, Marking, Metadata, Registration and Reporting web services. These web services are highly in demand as the functionalities for each of the web services are very useful and important in e-Learning systems. In Marking web service, rubrics can be defined to assist in assessment evaluation. In Metadata web service, Learning Object Metadata (LOM) is applied to capture the description of the learning objects.

Keywords: Web service, e-Learning, Learning Object Metadata (LOM), rubrics.

1. Introduction

Web services for e-Learning are basically implemented for the purpose of enhancing interoperability in integrating systems to support all critical functions in one package [1]. This goal is aided by the loose-coupling between the requesting program and the service provider. Besides that, the use of XML (Extensible Markup Language), SOAP (Simple Object Access Protocol), UDDI (Universal Description, Discovery and Integration), and WSDL (Web Services Description Language) [2, 3] allow interoperability in e-Learning systems.

Assessment, Grading, Marking, Course Management, Metadata, Registration and Reporting web services are developed in this study. Assessment web service supports the delivery of assessment. Lecturers are able to upload, create, edit and delete quiz or assignments. For students, they are able to take online quiz uploaded by their lecturer. Grading web service and Marking web service work together to support automation in assessment markings and assignment of grades based on the marks given by lecturers. For subjective assessments, the marking scheme is based on the rubrics defined by the lecturers. Feedback and comments can also be submitted together with the grades. Course Management web service provides the functionalities that allow lecturers to manage the learning resources for the courses taught by them. Metadata web service allows users to create, alter and delete metadata associated with a particular learning object. The user provides the information which is related to the elements of the Learning Object Metadata (LOM) standard. Registration web service supports the registration of new users. The administrator of an e-Learning system can create new users, edit existing users' profile and delete user profile using this service. The Reporting web service generates analysis reports regarding student's performance in each quiz.

2. Literature Review

Web service is a stand-alone software component. It is interoperable, independent of operating system, usable on different web service engines regardless of the programming language used to construct it, and can interact with each other [3]. The common standards for web services are SOAP (Simple Object Access Protocol), Web Services Description Language (WSDL), and Universal Description Discovery and Integration (UDDI) [4].

For e-Learning system, this study refers to the e-learning framework (ELF) as the core concept. ELF is a service-oriented factoring of the core services required to support e-Learning applications, portals and other user agents [5]. It is an initiative by United Kingdom's Joint Information Services Committee (JISC) and Australia's Department of Education, Science and Training (DEST) to build a common approach to service-oriented architecture for e-learning. ELF consists of four service layers [5]: User Agents, Application Services, Common Services and Infrastructure. User Agents layer interacts with users directly, such as portals, learning delivery systems and

so on. Application Services layer provides the functionalities that are requested by the user agents. This layer exposes its functionalities for reuse by any number of user agents or other application services. In this study, the following services are implemented in the Application Services layer: Assessment, Grading, Marking, Course Management, Metadata, Registration and Reporting.

Common Services layer provides lower-level functionalities which are not education-specific, but upon which application services layer and user agents layer depend. The common services implemented in this study are Authorization, Authentication, Search, and Annotation.

The metadata standard used in this study is Learning Object Metadata (LOM). LOM is developed by IEEE Working Group P1484.12 [6]. LOM helps to create well-structured descriptions of learning resources which facilitate the discovery, location, evaluation and acquisition of learning resources [7]. LOM shares the description of the learning resources between resource discovery systems based on high quality resource descriptions. In addition, LOM tailors the resources descriptions to suit the specialized needs of the community and this may include choosing suitable controlled vocabularies for classification and reducing the number of the metadata elements. There are several features in LOM, which allow for linguistic diversity of both learning resources and the metadata instances that describe them; the separation of semantic model and its bindings; consistent description ensured by the recommended vocabularies of some metadata elements and accommodating extension mechanism for localization [6].

LOM comprises a hierarchy of elements and there are totally nine elements in the first level, where each of the elements is comprised of sub-elements [7]. Table 1 shows the categories of the LOM schema and Figure 1 illustrates LOM.

Table 1. **Categories of the LOM schema [6]**

Element	Description
General	General information about learning resource as a whole
Life Cycle	The history, current state and the contribution
Meta-Metadata	Information about the metadata instance itself
Technical	The technical requirements and characteristics
Educational	The educational and pedagogic characteristics
Rights	Intellectual property rights and conditions of use
Relation	The relationship between learning resources
Annotation	Comments on the resources and their creator
Classification	The resource in relation to a classification system

Besides LOM, there is another metadata standard, Sharable Content Object Reference Model (SCORM). SCORM provides a reference model so that anyone can develop models of learning content and delivery. It provides the framework and detailed implementation reference that enables content, technology, and systems which are using SCORM to interact with each other through the application of the specifications and standards from the various groups. Thus, SCORM ensures interoperability, reusability and manageability [8].

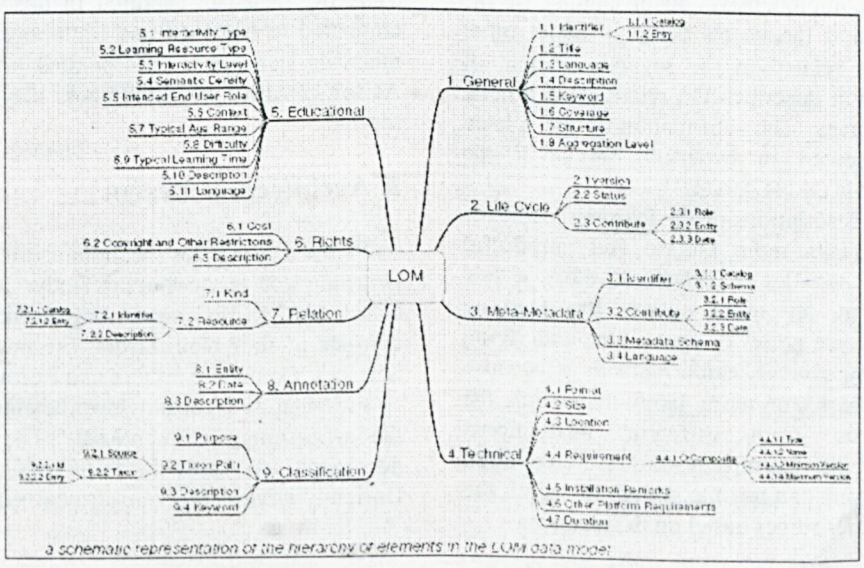

Figure 1. **Hierarchy of elements in LOM data model** [7]

The LOM metadata standard is chosen for this study because LOM is a well-known standard to describe educational web-based resources. Besides, LOM provides the common but important elements as a

guideline to capture the description of the learning resources. Apart from that, LOM is focused on educational domain and is adopted by international e-learning standards [12].

Several existing systems had been reviewed in this study. Kaleidosckop[9] from Learning Content Management System (LCMS) is deployed on open source technologies. Kaleidosckop provides processes which are similar with the work processes carried out manually by the staffs of learning organization. Besides, Kaleidosckop provides the ability to convert legacy material into SCORM material and supports customization. The operating system and database in Kaleidosckop are independent hence the system is flexible and incurs lower setup-cost. However, Kaleidosckop cannot be accessed by other software system or application over the Internet or any network. A user who is interested to have his own e-Learning system can subscribe to the portal provided by Kaleidosckop. However the modules or functions for the e-Learning system are fixed. In other words, it contains all the available modules or functions provided by Kaleidosckop and the user is not able to eliminate those undesirable modules or functions from the system. Besides, Kaleidosckop does not support automatic marking and grading for assessment.

In terms of system that supports LOM metadata standard, one of the related works is Learning Resource Metadata Management System (LRMMS) [6]. LRMMS enables the users to publicize, manage, search, browse and annotate learning objects. LRMMS provides various searching methods to enable user to retrieve resources from different points of view and perform searching in more specific and efficient way. When a user looks for a learning resource, LRMMS also shows the information on other related learning resources to give the user a comprehensive understanding of the resource and expand the user's curiosity about other resources. This is related to the seventh element of LOM scheme which describes the relationship among the learning resources. The information of the related resources is presented in hyperlink format if the metadata is available on the server.

The consistent descriptions of the learning resources in the LRMMS make more precise and purposeful queries possible. Besides, LRMMS develops a few search methods to let users search the learning resources from diverse points of view. One underlying reason of providing several search methods is because learners and teachers are more likely to search the learning resources from different instructional perspective. Once the learning resources are captured in LRMMS, the users can use the system to search the particular learning resources based on the metadata.

LRMMS also enables the users to add annotations to the learning resource after they review the learning resource. There is no control over the evaluation of these learning resources. The users are free to annotate their comments on the learning resource. The authors of the learning resources can access these annotations which serve as useful feedback to improve their learning resources. For learners, annotations of comments by another learner are valuable in helping them to decide whether the learning resource fits their needs.

Multibook is a web-based adaptive hypermedia learning system for multimedia and communication technology which is developed by the Technical University of Darmstadt and the University of Hagen [10]. The aims of Multibook are to cater for different users, by storing a huge number of compiled lessons. Multibook uses four dimensions for the user profile. First of all, Multibook fills the profile with the users' demands and preferences. The Multibook system also keeps track of the history of the information that had been found and learned by the users as well as the additional materials requested while the users work with Multibook system. Multibook's knowledge base consists of two separated concept spaces which are Concept Space and Media Brick Space. Concept Space contains a networked model of learning topics and uses knowledge management approaches. Media Brick Space is used to store the media bricks, which are atomic information units of various multimedia formats and are interconnected via rhetoric relations. Media bricks also uses IEEE's LOM scheme. They are described by the author and are treated as learning objects.

For this study, LOM has been extended to include grade and marks of the learning resources of students. Thus the metadata captured in this study is more as compared to LRMMS and Multibook. Besides, LOM metadata standard is incorporated into a web service. As for LRMMS and Multibook, they did not use web service.

3. Architecture Design

Figure 2 illustrates the architecture design for the e-Learning web services in this study. It is fundamentally based on the JISC e-Learning framework (ELF) and consists of four main layers: Presentation, e-Learning Services, Common Services and Resource.

Presentation layer provides the entry point to access the e-Learning web services. The second layer is developed to provide e-Learning functionalities. Currently it consists of Assessment, Grading, Marking,

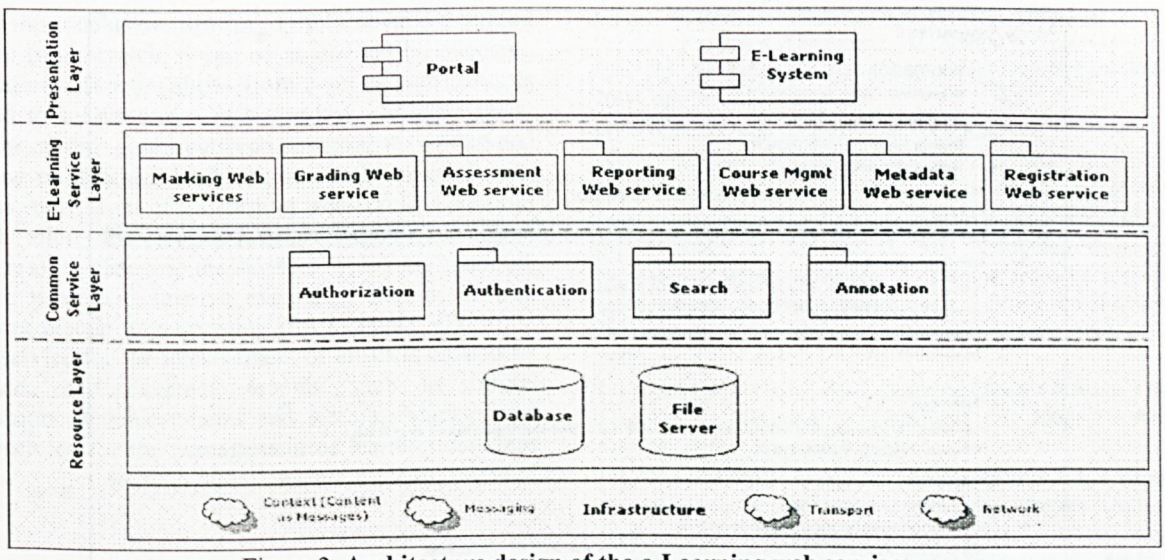

Figure 2. **Architecture design of the e-Learning web services**

Course Management, Metadata, Registration and Reporting web services (refer to section 6).

The next layer is the Common Services layer which provides web services to support the e-Learning Services layer. These services are not dependent on any particular pedagogic function and therefore can be used by applications in other domains. These common services include Authorization service, Authentication service, Search service and the Annotation service. Authorization web service establishes the rights and the permissions of the user and supports the management of access to resources. Authentication web service establishes the identity of the user. The search web service supports the finding of learning resources. The Annotation web service supports the creation, management and use of metadata.

The Resource layer represents the underlying infrastructures. It consists of the Profiles repository which stores all the registered user profiles and the file server which stores the different types of resources.

4. Extension of LOM

Learning Object Metadata (LOM) is applied in the metadata web service. In LOM, there are nine main elements which are used to describe the learning objects. The purposes of LOM are to manage, search and locate learning objects that are increasing greatly in numbers. In this study, artifacts produced by learners are also considered as learning objects since other learner can refer to them to accomplish similar tasks (such as assignment, project and tutorial). Thus, it is important to be able to capture the marks and grade awarded to a particular learning object because these will be indications of the quality of the learning object. To do that, the LOM elements are extended to store the marks and grade of artifacts produced by the students. The two extra elements are grouped under the LOM General element. With these two elements, the users are able to determine which learning objects they should refer to in order to help them to accomplish their tasks. Figure 3 shows the extension to LOM.

1. General

……

1.9 Assessment Grade

1.10 Assessment Marks

Figure 3. **Extension to LOM**

5. Rubrics

According to Heidi Goodrich, a rubric is a scoring tool that articulates gradations of quality for each criterion, from excellent to poor by listing out the criteria of work [11]. Rubrics can be developed by lecturers to aid them to evaluate subjective assessments more consistently. It lists out the criteria to be evaluated.

Figure 4 illustrates an example of a rubric for a certain subjective assessment. It lists out all the criteria, as well as the maximum marks for each of the criteria as a guideline for the lecturer to mark that particular assessment. Lecturer can assign the mark for each of the criteria. The overall mark is calculated automatically. Comments or feedback for that particular student can be given as well.

Rubrics are also useful for students as it makes lecturers' expectations clearer to students by showing them the list of criteria. Therefore, students are able to discover and learn from their mistakes on their own. Feedbacks by lecturer can also be displayed.

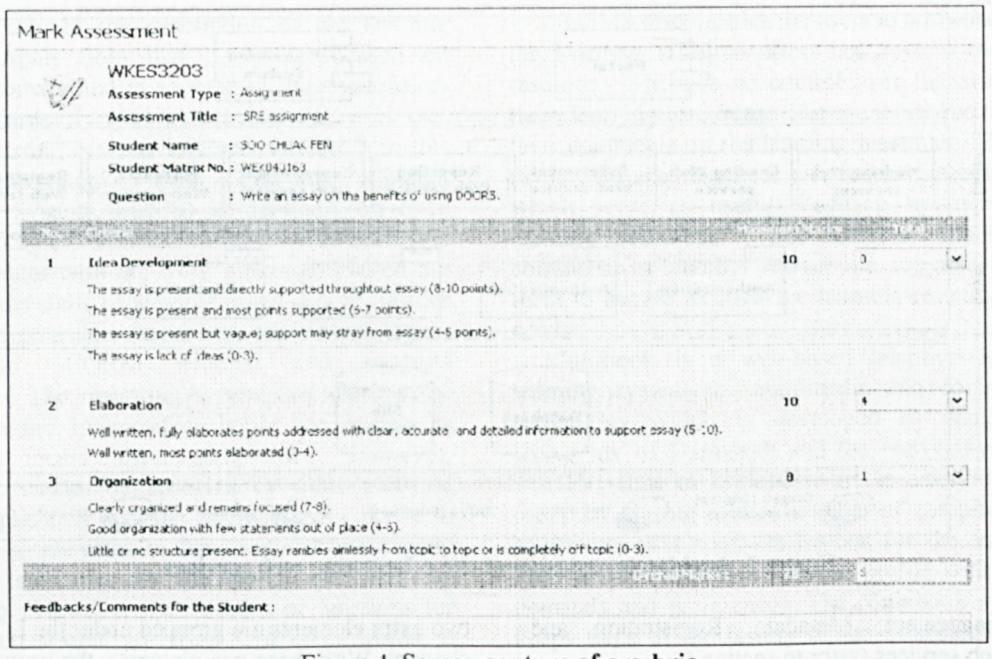

Figure 4. **Screen capture of a rubric**

Rubrics functionalities are built in Marking web service. This web service allows the lecturer to create, edit and delete rubrics for a particular subjective assessment.

6. Results

This study results in a set of web services for the e-Learning domain. The description for each of the web services is as follows:

Assessment web service - This service supports the delivery and scoring of assessment. Lecturers are able to create/edit/delete quiz or assignment questions using this service. Students on the other hand are able to take the quiz online at specific time and duration defined by the lecturers. The result of objective-type question will be displayed immediately after the students finish the quiz. Students' answer for subjective question can be retrieved from the server for marking later.

Grading web service - This service supports the assignment of grades based on the marks. Marks submitted by lecturers will be graded automatically based on the grading scheme uploaded by the administrator of the e-Learning system. Feedback can be submitted together with the grade.

Marking web service - This service provides the automated marking functionalities for multiple choices assessment. For subjective assessment, the marking scheme is defined using rubrics. Rubric is a guide for assessing a piece of student's work and aids in achieving consistency in marking.

Course Management web service - This service allows lecturers to manage the courses (uploading, editing and deleting of lecture materials). It also allows the users to manage their favorites' resources. Users can also search, view and download the learning resources. The searching is done based on the LOM metadata elements provided by the creator of the learning resources.

Metadata web service - This service is developed based on LOM metadata standard. It allows users to upload the learning objects together with its metadata. The metadata is useful in managing, searching and locating the learning object.

Registration web service - This service allows administrator of an e-Learning System to create new users, edit and delete the existing user profiles and also delete particular users.

Reporting web service - This service generates the performance report for quiz by using Crystal Report.

In this study, the main functionalities of typical e-Learning systems are built using web services. The strength of this approach is reusability and interoperability. Developing a new e-Learning system will involve assembling the required web services. The e-Learning system can be developed and run on different hardware and software platforms. However, the disadvantage of this approach is if the server that hosts the web services is off-line, the e-Learning system which depends on these web services will not be operational.

Another important feature of this study is the use of rubrics in guiding the instructor to evaluate subjective assessment. Rubrics improve consistency in the evaluation of students' work especially when there is a large number of student and multiple instructors are involved in the evaluation.

7. Conclusion

As the conclusion, instead of building an e-Learning system from scratch, it can be assembled by choosing the required functionalities from a set of web services related to e-Learning. Web services eliminate many interoperability issues between components written and running on different hardware and software platforms. In this study, a set of e-Learning web services are built which allow the user to construct new e-Learning system(s) by choosing the services which are required. Future work will involve expanding the set of web services related to e-Learning (for example, ePortfolio web service for the management of artifacts created by learners, and evidence records such as formal transcripts of achievements and Activity Management web service for the management of learning activities [5]).

References

[1] P. Brusilovsky, "Knowledge Tree: A Distributed Architecture for Adaptive E-Learning", *Proceedings of the International World Wide Web Conference (WWW 2004)*, 2004, pp. 104-113.

[2] G. Angad, R. Shri, P. Rob and C. F. Chun, "The E-Learning Lifecycle and its Services: The Web Services Approach", *Second International Conference on e Learning for Knowledge-Based Society*, 2005, pp. 4.1-4.8.

[3] G. Vossen and P. Westerkamp, "E-Learning as a Web Service (Extended Abstract)", *M. Samia, S. Conrad (eds.): Proc. 16. Workshop on "Grundlagen von Datenbanken 2004"*, 2004, pp. 113-117.

[4] Wikipedia, *http://en.wikipedia.org/wiki/*

[5] S. Wilson, K. Blinco, D. Rehak, "An E-Learning Framework: A Summary.", 2004 (Access on 10 August 2006). *http://www.jisc.ac.uk/uploaded_documents/Altilab04-ELF.pdf*

[6] Z. Shen, Y. Shi, & G. Xu, "Computer Supported Cooperative Work in Design. A learning resource metadata management system based on LOM specification", *Proceedings of the 7th International Conference, Sept. 25-27*, 2002, pp. 452 – 457.

[7] P. Barker, "What is IEEE Learning Object Metadata / IMS Learning Resource Metadata", 2005, April, *http://metadata.cetis.ac.uk/guides/*

[8] The MASIE Center. "Making Sense of Learning Specifications & Standards: A Decision Maker's Guide to their Adoption", 2002, March. *http://www.masie.com/masie/default.cfm?page=standards*

[9] Kaleidoscop, *http://www.kaleidoscop.com/*

[10] E. S. Abdulmotaleb & S. Fischer & R. Steinmetz, "Reusable Multimedia Content in Web-based learning Systems". *IEEE Multimedia*. 2001, pp. 30-38.

[11] H. Goodrich, "Understanding rubrics". *Educational Leadership*, 1997, 54(4), 14-17.

[12] L. Pansanato & R. Fortes, "Strategies for automatic LOM metadata generating in a web-based CSCL tool", *Proceeding of the 11th Brazilian Symposium on Multimedia and the Web*, July 05-07, 2005.