Indian Journal of Science and Technology, *Vol 8(S8), 219–225, April 2015*

ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Analysis of Requirements for Implementation of a Freely Usable Educational Information System Architecture

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Abstract

This study is based on college students' need to freely access and use content without the hindrance of dealing with copyright issues. Responses to a questionnaire on the desirable features of an educational information system to be used freely were collected from 1,604 undergraduate students and analyzed. As a result of the analysis it was found, first, that RESTful services should be considered from the perspective of Web services. Second, so far as information desired by students was concerned, job-related information and undergraduate major-related video contents were found to be highly important. It was then suggested that the availability of 'convenient interfaces' and 'copyright-secured data' be discussed as priorities when configuring a freely usable system. Let alone the systematic aspects, this study carries significance in that it analyzed the positions of users as well and thereby identified the types of information desired by them.

Keywords: Educational Information, RESTful, System Architecture, Usability

1. Introduction

In the era of Web 2.0 characterized by participation and openness, various attempts are being made to openly share education resources and systems. OER, a term first used by a UNESCO forum in 2006, refers to the educational movement that was started with the intention of developing universal educational resources available for the whole of humanity[1]. The origin of the OER movement can be said to have started in 2001 when the Massachusetts Institute of Technology (MIT) launched their Open Courseware (OCW) project which allows users to access part of the contents of their university courses for free. Having started with MIT's OCW, many institutions of higher education around the world began to launch similar projects, so it is no exaggeration to say that OER is an important trend in domestic and global higher education, leading the paradigm shift of information sharing[2,3].

OER delivers the benefits of being available free of charge and freely usable, including learning objects, audio lectures, video lectures, images, sounds, curriculum, courseware, schooling contents, evaluation tools, textbooks, etc[4]. In particular, OER takes center stage in that it expands learning opportunities, improves the quality of education, reduces content development costs, promotes educational institutions, expedites learning resources development and facilitates their reuse, and enables realization of altruism[1]. Importantly, it also saves content development costs by offering educational resources available to anyone and delivers positive functions for promotional initiatives of educational institutions[5]. The main interests of OER were the use of education resources in universities and contents related to teaching-learning. In other words, a great deal of effort has been made to make it possible to use many classroom materials used in universities regardless of copyrights. All these efforts were for those who teach, but

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not so much for the materials sought after by students in their quest to learn. Accordingly, this study takes interest in the copyrights and sharing of various kinds of educational information used by students for learning as well as the classroom materials used in classes[6]. That is, an operating system for the open and free use of educational information is needed. Based on that, educational materials can be freely utilized in the field without the burden of copyrights. It is clear from the start that an appropriate standard guideline is required for implementing an educational information system and, if such system has already been implemented, interoperability with any legacy educational information, etc., needs to be considered as well. In other words, to utilize OER effectively, universities should invest time first in developing educational courses or materials and training of how to search and use OER, infrastructure management and maintenance, copyright policy, OER storage and access control, etc[7]. To sum up:

First, a system to collect educational information is needed. As there currently is no agent existing for collecting all the various widespread information it is necessary to develop the administrative resources and a collection network to do so.

Second, a standard for storing the collected educational information is needed. If an information collection system is already in place, a unified storage standard for each collection agent is required for managing the collected information with standardized and unified storage tools.

Third, a standard for distributing collected educational information is required. Interoperability is essential for facilitating distribution of information between the OER information systems to be used by students and the distribution standard to be complied with in distribution is required then. In other words, standards for OER meta information is required, including a distribution standard in addition to a storage standard. Implementing an information system without compliance with standards makes it difficult to secure interoperability and scalability among different educational information systems. Accordingly, this study is intended to identify the elements to be considered when implementing an open and free system architecture for the use of education information so that undergraduate students can freely access and use educational information to improve the quality of their learning. Therefore, Web services relevant to the delivery of educational information are analyzed in the Literature Review section whereas the types of information desired by students are analyzed in the Result section.

2. Literature Review

Many educational institutions including universities have recently taken positive views of the effectiveness and practicality of e-learning as an innovative supplementary to the traditional education delivery system. Interests taken by the government in K-MOOC is also supportive of such views (JaMee et al., 2014). Implementing a system for OER use can expand knowledge-sharing initiatives of undergraduate students and is expected to produce a variety of benefits including not only improved quality of education but also reduced costs, improved learning resources development and expansion of learning opportunities, etc. This study reviewed Web services standards required for implementing a system delivering educational information needed by undergraduate students. First on the list was SOAP. Basic elements of Web service include SOAP (Simple Object Access Protocol) because it allows Web services to communicate on the Internet, and UDDI (Universal Description, Discovery and Integration) because it allows users to publish and advertise Web services in online directories or search Web services from outside[8]. Such basic elements also include WSDL (Web Service Description Language) in which Web services are defined and described. All data within Web services are rendered in XML (eXtensible MarkUp Language) and such data and operations handling it are defined in WSDL. Web services are published in UDDI which is a ubiquitous service repository and opened to be searchable by anyone[9]. When open Web services are used, the service requester calls services from the service provider via SOAP and retrieves the results. SOAP is a protocol through which XML-based messages are exchanged on computer networks using HTTP, HTTPS, SMTP, etc. SOAP provides a platform on which Web services deliver basic messages[10]. Generally speaking, SOAP uses the RPC (Remote Procedure Call) pattern to allow a network node (client) to send a request to another node (server) that returns a response immediately. SOAP enables access to distributed objects without dependence on a specific distribution technology or platform, and it is transferred on HTTP. SOAP messaging adopts the concept of transport and interaction neutrality from XML-RPC and WDDX. As shown in Figure 1, the structure of SOAP is rendered as a single XML document consisting of a SOAP envelope, header and body[11]. SOAP is XML-based and designed to have a pattern that includes a header and body.

The header is optional and includes repetitive meta information, security data or transaction data whereas the body includes key information (Figure 1). Second on the list was REST architecture. REST (REpresentational State Transfer) refers to a software architecture for efficient Web service in a large-scale network system. It was conceptualized when it was proposed by Roy Fielding, one of the groundbreakers of the Web, in 2000. REST constitutes a summary of ways for defining resources and designating their addresses. Domain-oriented data provides a simple interface for HTTP without an additional transfer layer such as SOAP or cookie-based section tracking[12]. Systems following REST principles are often referred to as RESTful.

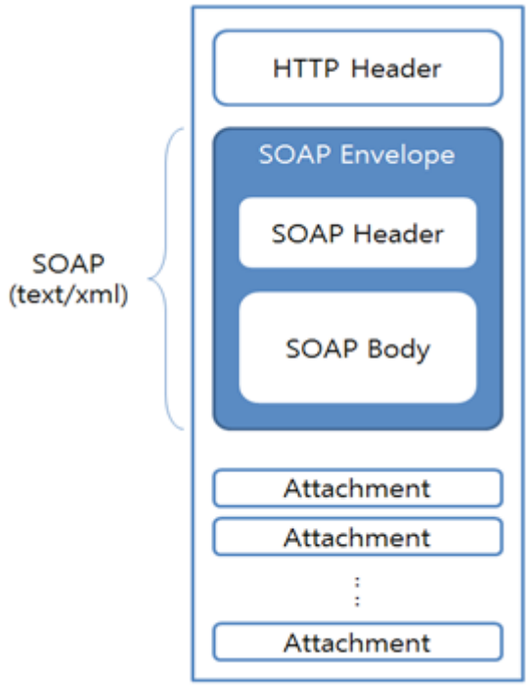

Figure 1. SOAP structure.

REST is a Web service design standard conforming to ROA (Resource Oriented Architecture). REST is an architecture that renders all resources on the Web with URI, connects them structurally and organically, and thereby uses consistent methods and resources in stateless-oriented ways. Therefore, RESTful Web service is characterized as a resource-centric representation, transfer and access approach. In other words, RESTful Web services can be accessed just with HTTP protocol, irrespective of Web server and client type, as long as resource URIs are known.

Thanks to its simple access approach, most Web 2.0 APIs in OpenAPI format are offered as RESTful Web services by Google, Yahoo, Twitter, Daum, Naver, etc. RESTful Web service was also the driver that kick-started service mashup utilizing widgets. For example, Google discontinued its longstanding SOAP-based search API service on December 5, 2006 to offer instead its REST-based Ajax Search API as an alternative. In addition, it is a prevailing trend that even existing SOAP-based Web services are offered in parallel as RESTful Web services at the same time. Unlike SOAP, the REST specification is not a W3C standard by itself, yet, as the unit technologies used by REST use the existing Web standards as they are, REST can be said to be an effective Web standard technology[8]. Growing as an alternative solution to the issues of SOAP, REST is utilized in more areas than SOAP now. One can understand easily how different REST is by looking at the way it is designed to call. REST calls consist of "server address+service name+resource". If a conventional information call uses the format of http://somewhere.com/employee/getEmployee?id=123450, a REST information call is http://somewhere.com/employee/123450 (HTTP GET). REST is ROA-based and associated with the following four attributes which will help users better understand its characteristics: accessibility, connectedness, statelessness, and homogeneous interface. Third on the list was a comparison between REST and SOAP. This study compared REST and SOAP for planning an educational information system service that would enable undergraduate students to share data and suggested which of the two would be more efficient[8,10,13]. SOAP-based Web services were initially required for supporting interoperability of application services in an enterprise business environment whereas RESTful Web services were rolled out by Internet service providers to provide readily available data to application developers. SOA-based Web services are implemented in accordance with WS-* Web service standards of W3C and WS-* standards transfer message, using SOAP (Figure). However, SOAP, which is a Web service-forwarding protocol, is a HTTP application protocol consisting of a SOAP header and body that must be encoded/decoded during message transmission/reception. In other words, SOAP needs to wrap original XML data with an unnecessary envelope and then unwrap it again. Therefore, Internet services that transferred messages in

Therefore, Internet services that transferred messages in default HTTP had to address the challenges posed by processing overhead and the implementation difficulty of SOAP protocol for its desired functionality. RESTful Web service emerged as an implementation technology to address such weaknesses of SOAP[14–16]. RESTful Web service means REST-based Web service and is a Web application technology to access remote information simply with basic HTTP functions17 (Figure 2, 3).

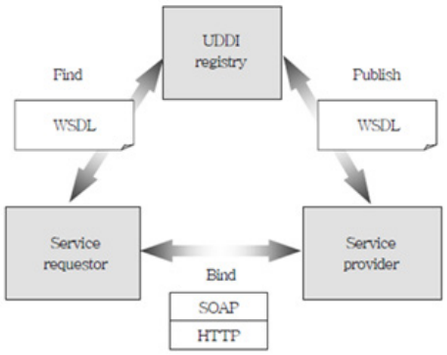

Figure 1. SOAP Web service based on SOA.

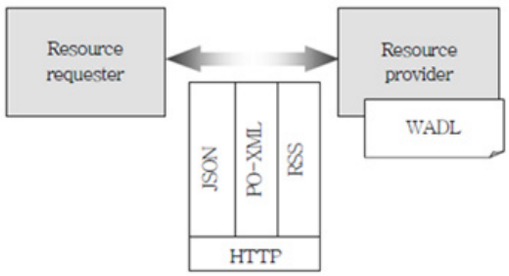

Figure 3. RESTful Web service based on ROA.

To sum up, SOAP-based Web service is a technology intended to open up service capabilities using WSDL as a medium whereas RESTful Web service is intended to open up resources with URI[12,18,19]. For example, to 'Get details of Record 123 in educational information DB,' a SOAP-based Web service will call getInfoDetails (lll_idx=123) whereas RESTful Web service will call GET/Info/123. In other words, ID 123 in the educational information DB is a resource and related information can be retrieved by the GET method. These characteristics and ease of development has caused REST to be preferred over SOAP recently[16].

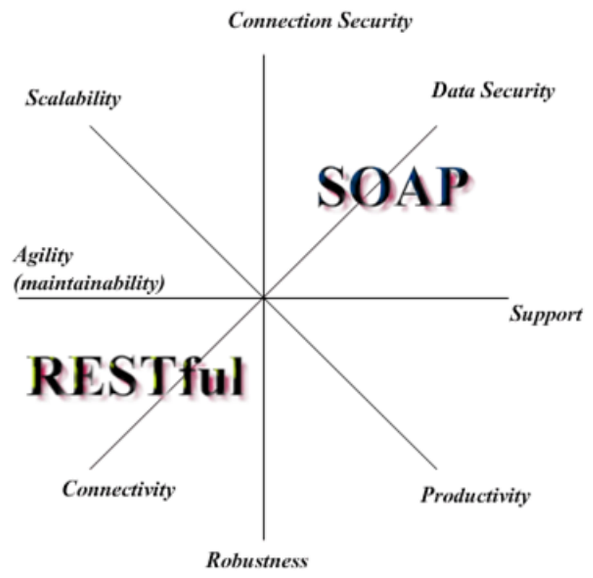

Figure 3. Comparison between SOAP & RESTful (Nicolas Zozol, 2008).

3. Research Method

3.1 Service Diagram

This study configured a portal service providing free educational information service to students as described in Figure 5.

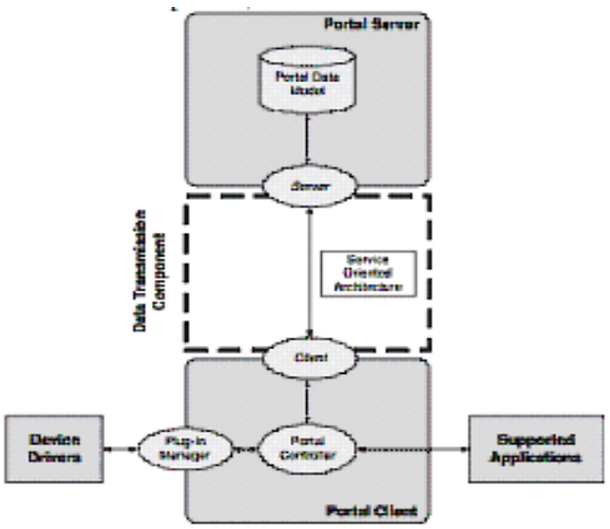

Figure 5. Portal framework architecture/data flow diagram.

As Figure 5 illustrates, the architecture was configured to enable students to be provided with service more readily.

3.2 Subject of Research

This study analyzed student's requirements in order to propose system architecture that would provide free use of educational information in a bid to enable undergraduate students to utilize various types of such information with more ease. In other words, this study intended to lead students to access and share various educational information more easily. For that purpose, this study was conducted as described below. This study employed a pre-announced Web survey (self-entry type) given to undergraduate students. Random samples were taken through participation on university websites. A total of 1,604 students participated in the survey. As freshmen might not have a clear understanding of learning contents, the survey was primarily focused on sophomores, juniors and seniors. In the end, 299 sophomores, 403 juniors and 822 seniors participated in the survey. The completed responses were analyzed by SPSS Windows. Given the characteristics of the respondents, a cross analysis and a χ^2 test (Chi-Square test) were conducted.

4. Result

Students' requirements for a system architecture that would enable them to use educational information free of charge were analyzed as described below. Table 1 shows students' willingness to use such a system if it is implemented. As a result of the analysis it was found that seniors were most willing to use such service (81.6%). The percentage of sophomores was less than those of juniors and seniors.

Table 1. Students' willingness to use service system

(In: %)

Grade	No	Yes	Statistics
Total	22.8	77.2	
Seniors	18.4	81.6	χ^2=10.813
Juniors	27.0	73.0	**
Sophomores	36.8	63.2	

n.s=non-significance, * p<.05, ** p<.01, ***p<.0.001

Table 2 shows how students will utilize the educational information service delivered to them. 'Collecting information useful for lectures' accounted for the largest percentage (45.5%). 'Preparing for employment' (41.8%) came next. In particular, demand for information useful for employment was high among the seniors and there was a significant statistical difference among the grades.

Table 3 shows the responses to the questions on the perceived importance of information service and current availability of such information on a Likert scale. As can be seen, what mattered most to the students was 'Employment-related information' (Seniors: 4.8, Juniors: 4.4, Sophomores: 4.1), including 'information useful for preparation for employment,' 'information required for preparation for class,' 'video lecture related to undergraduate major,' etc. However, it was found that 'video lecture related to undergraduate major' (Seniors: 1.7, Juniors: 1.8, Sophomores: 1.9), 'professional information related to undergraduate major,' etc. were hard to find for the students (at the time of the survey). Table 4 shows items important for when providing information services and students' satisfaction level with the websites that they are using now. It was found that items considered important in building a portal for free use of educational information included 'convenient interface' and 'secure copyrights' for the available contents. Not only architecture but also the interface deserves sufficient discussion when making educational information available to students.

5. Conclusion

This study analyzed the elements that deserve consideration when designing an OER system in addition to systematic elements when an information sharing system is to be implemented to enable undergraduate students to use educational information freely. Responses from 1,604 students were analyzed and the following results were obtained. First, for system architecture, students were found to prefer RESTful Web services that not only provided more ease of information search but also represented, transferred and allowed for access to contents with a focus on resources. RESTful Web service allows administrators to access service only with HTTP protocol, independent of Web server or client type, as long as the Resource URI of the RESTful Web service is known. Second, desired content of the Web service was also discussed in addition to the system aspects. It was found that the students found employment-related content and video content related to their majors most important in terms of the information they desired. It was also found that delivery of a 'convenient interface' and 'copyright-secure contents' also deserve significant attention when discussing the configuration of the system intended herein.

Table 2. Purpose of using the service

(In : %)

Grade	Collaboration with other students	Collecting information useful for lectures	Preparing for employment	Utilize as community	Information for school performance management	Statistics
Total	10.2	45.5	41.8	1.4	1.1	χ^2=10.813 **
Seniors	8.2	45.3	44.0	1.2	1.2	χ^2=10.813 **
Juniors	16.7	45.8	33.3	2.8	1.4	χ^2=10.813 **
Sophomores	10.3	46.2	43.6	0.0	0.0	χ^2=10.813 **

n.s=non-significance, * p<.05, ** p<.01, ***p<.0.001

Table 3. Current status and level of importance concerning aspects of the information provision service

Available Information 제공 정보	Current Status			Importance		
	Seniors	Juniors	Sophomores	Seniors	Juniors	Sophomores
Professional information related to major classes	1.9	1.8	1.8	3.8	3.4	3.5
Information related to humanities classes	2.0	2.1	2.2	3.5	3.5	4.0
Information related to employment	2.3	2.3	2.0	4.8	4.4	4.1
Information useful for employment (professional licenses, school performance evaluation questionnaire, etc.)	2.3	2.1	2.0	4.7	4.5	3.8
Information useful for preparation for class (multimedia content such as MS Powerpoint files, etc.)	2.0	1.9	2.0	3.7	4.2	4.5
Video clips related to undergraduate majors	1.7	1.8	1.9	3.9	3.9	4.5
Video clips related to humanities classes	2.3	2.4	2.4	3.7	3.7	3.6
Research information (academic journals, global trend reports, case studies, etc.)	3.5	3.5	3.3	2.8	2.8	2.5

Table 4. Items important with regard to information services

	Satisfaction with Website			Importance		
	Seniors	Juniors	Sophomores	Seniors	Juniors	Sophomores
Accessibility	4.1	3.9	4.1	3.8	4.3	4.5
Convenience of information use	3.2	3.2	2.9	4.3	4.5	4.7
Ease of information search	3.8	3.3	2.9	4.5	4.3	4.8
Convenient interface	3.3	3.5	3.2	4.6	4.7	4.6
Copyright-secured contents	2.7	2.4	3.2	4.7	4.6	4.6

Many studies proposing system architectures deal only with the technical aspects, failing to consider the types of information actually desired by users. This study, however, carries significance in that it discussed not only Web service approaches but also types of information to be made available to students. It was analyzed in advance how students were using the contents and it was found that the percentage of students utilizing 3rd party copyrighted contents was higher as the grade of the student was lower. In contrast, the percentage of students willing to share their own copyrighted contents was higher as the grade of student was higher. Copyrights have always been discussed from the perspective of teachers. However, it was found in this study that an approach to allow learners to use copyrighted contents freely should also be discussed.

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