Service-Oriented Authoring System to Achieve Interoperability among E-Learning Environment

Neil Y. Yen, Jason C. Hung[1], Hui-Huang Hsu, Timothy K. Shih[2], Louis R. Chao
Tamkang Univeristy/ Department of Computer Science and Information Engineering, Taiwan
[1]Overseas Chinese University/ Department of Information Management, Taiwan
[2]Asia University/ Department of Computer Science and Information Engineering, Taiwan
Email: neil219@gmail.com

***Abstract*—E-learning environment involves lots of relevant systems, such as the LMS (Learning Management System), the LCMS (Learning Content Management System), the Courseware Authoring System, and so on. Among them, the courseware authoring could be considered as the fundamental process while realizing an e-learning environment. As the result, to provide a friendly user interface in an authoring system has become the most essential part in the e-learning environment. On the other hand, how to simplify the authoring process for those users who aren't the experts in this domain should be solved as well to make e-learning more popular. In this paper, we mainly focus on how to develop a service-oriented online authoring system based on SCORM standard. The functionalities in our authoring system can be also taken as separate services. These services can be reused in other external systems. In addition, we proposed a transformation mechanism to achieve the interoperability between various e-learning standards. Furthermore, we utilize the IMS LIP specification to maintain the authoring history of individual author, and use these profiles for authors to achieve the personalization authoring process.**

***Index Terms*—service-oriented, e-learning standards, authoring system, interoperability, Common Cartridge**

I. E-Learning Background

The development process of e-learning has been persisted for several years. According to the all-pervading personal computer and rapid development of internet and communication technologies, the relationship between instructors and learners is not restricted by the traditional class learning style. Besides, the learning resource types are not restricted in hardcopy books or texts; they could be replaced by various multimedia resources like audios, videos, figures and so on. It makes learners don't have to attend school with heavy textbooks daily. Instead, learners could link to the LMS (Learning Management System) on a specific website through internet, and then do the learning activities arranged by the instructors in advanced just with simple mouse clicking or dragging.

LMS is the most well-known part of the whole e-learning environment as we mentioned in previous paragraph, and it's also the only part that learners would get in touch with the e-learning environment. In order to assist those who learn from LMS in getting useful learning activities, the learning materials should be generated in a well-organized way. According to this purpose, how the instructors make use of the learning resources at end-user side or on the web to create or recompose the learning materials and arrange the content become very important. In other words, how to construct a well-organized authoring system becomes an essential for e-learning system developers. To create learning content, developers have to utilize a common standard to confirm the courses that made to achieve the reusability and sharability.

There are lots of well-known e-learning standards were proposed to serve this goal, such as the LOM (Learning Object Model) [2] and SCORM (Sharable Content Object Reference Model) [1]. For the learning competency assessment, most research groups adopt the IMS QTI (Question and Test Interoperability) [6]. Furthermore, IMS integrates the specification in generating learning content (SCORM) and assessment (QTI) to propose a new e-learning standard named Common Cartridge [4]. Formatted standards really provide an optimal solution to the e-learning community; the system developers also make use of standards mentioned above to construct the e-learning systems.

Though authors can benefit from these standards in e-learning environment, there are still some vital issues or challenges. As a result of the using of e-learning standards, instructors lay more and more emphasis on the way of learning content generation and distribution. Most of the learning content is generated by one standard that we mentioned above. To take SCORM for example, the learning content could easily distribute and share throughout the Internet in SCORM format, but how to achieve the interoperability among SCORM and other standards are not be addressed. This is due to the transformation complexities among those acknowledged standards, and would result in an isolated environment for learning.

In the previous authoring aspect, instructors have to install the program to his/her personal computer, and then collect the useful learning resources to help themselves to create the learning content. Accordingly, instructors have to prepare the resources that could be used in advance

[1]Corresponding Author: Jason C. Hung, email: jhung@ocit.edu.tw

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under such workflow. This is not an easy way for them to do this in different places. It costs lots of time to request and retrieve the resources. Besides, if the system has errors needed to be fixed, or new functionalities needed to be updated, the developer has to provide the service pack to deal with it. Fortunately, the raise of the Web 2.0 technologies provides a practical solution to solve this problem.

With Web 2.0 concept and technologies, this trend impregnates the whole World Wide Web with vitality. It makes the system development architecture to transfer from stand-alone application to web-based service-oriented application. Many IT (Information Technology) companies and research organizations provide web service based on this architecture like Yahoo, AOL (America OnLine), Microsoft, Google … and etc. As a result, the internet architecture and personal information of the users becomes more and more important.

There are lots of specifications for keeping track of the personal information and learning records about the users. Two of the most famous specifications are the PAPI (Personal and Private Information) [3] proposed by IEEE and the LIP (Learner Information Package) [5] proposed by IMS. Both of them use the XML (eXtension Markup Language) to record the user profile information, preference, learning history, and etc. The main objective is the same about these two specifications, and furthermore, the latter one could enable us to create the customized information for the authors.

In this paper, we u the SCORM standard and Web 2.0 technologies to construct a service-oriented courseware authoring system and integrate the IMS LIP specification to provide personalized authoring environment and simplify the authoring process especially in learning content metadata editing. Besides, we also focus on providing a transformation mechanism to improve the interoperability among the acknowledged e-learning standards.

The remainder organizations of this paper are as follows. Section 2 introduces some related research issues, including the acknowledged e-learning standards and relevant technologies utilized in our work. We would like to introduce our proposed transformation mechanism, personalization progress and illustrate the system architecture in Section 3. We demonstrate the implementation result of the system in Section 4. The conclusion of this paper and the future work that we aim to do will be shown in last section.

II. Related Works

As stated above, in order to achieve a seamless integration among various learning resources and specifications in the Internet environment, common framework or standard should be followed to serve this purpose. Another important point of building up an integrated web-based authoring environment is the utilization of advanced internet technologies. We would like to discuss some acknowledged e-learning standards which support the web-based system architecture and the e-learning environment nowadays.

To analyze the requirements of our proposed system infrastructure, we survey on relative research topics and the e-learning standards to improve our system usability. Researchers proposed a single sign-on authentication mechanism to identify the role of the users, and made the learners could share or get the relevant learning materials between LMS and learning repositories [7]. Researchers also proposed to group the learners and analyze the different needs of the students, and then described how an e-learning system to provide personalized interface to students [8]. Authors who introduced the AEH system and the INSPIRE system to investigate the authoring process of educationally meaningful content for personalized learning [10]. Moreover, the authoring system developed to support different types of users, such as educators and learners, in authoring personalized content.

2.1 Acknowledged E-Learning Standard

The one organization of IEEE named LTSC (Learning Technology Standard Committee) proposed five-level architecture to describe the useful information for available learning resources. They also introduced the IEEE LOM to provide a unified description of learning resources. Metadata can be considered as a sort of information about information. By using the IEEE LOM, the learning resources can be retrieved and acquired easily among the e-learning environment. The IEEE LOM serves as the principal standard internationally to specify learning objects and could be comprised of 9 categories as follows: General, Life Cycle, Meta-Metadata, Technical, Education, Rights, Relation, Annotation and Classification, to annotate learning contents in a comprehensive perspective. Besides, each category has its own classification to describe the learning resources in detail.

In addition to the IEEE LOM, ADL proposed the SCORM standard to support the learning content shared in e-learning environment. SCORM is comprised of three main parts, including the CAM (Content Aggregation Model, the RTE (Run-Time Environment) and the SN (Sequencing and Navigation). CAM defines the format of learning content, including the Content Model, the Metadata, and the Content Packaging. RTE contains the protocols of running learning content to establish a standard protocol for these contents to communicate with its underlying LMS. The SCORM CAM and the RTE specification enable courseware to be exchanged among different machines. The SN specification is responsible for controlling the order of courseware delivering. We put emphasis on the SCORM CAM specification in this paper to discuss the interoperability among various e-learning specifications.

The TW LOM (Taiwan Learning Object Metadata) [12] aims at providing a customized learning specification for the e-learning society in Taiwan. The TW LOM is also based on the IEEE LOM, with additional concerns to fit the particular requirement of educational needs in Taiwan. There are a few these kinds of standards to fit the customized needs for educational environment in different countries.

2.2 Single-Sign-On Mechanism and IMS LIP

SSO (Single Sign-On) is a mechanism for authentication, and it is widely used in the IT industry. The SSO provides a well solution for enterprises to manage the inner system such as mail system, human resource management system, work flow management system and IT service management system. In order to reduce the processing time for retrieving the data among the systems, the SSO mechanism (shown in Figure 1) could help the decision-makers to make optimal solutions and to get responses immediately. The same mechanism could be applied to the actors in e-learning environment.

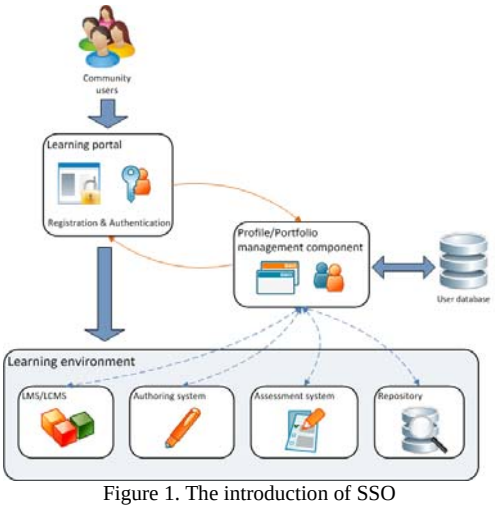

Figure 1. The introduction of SSO

The main purpose of IMS LIP is to record and manage learning-related history, goals, and accomplishments, to engage a learner in a learning experience and to discovery learning opportunities for learners. By using XML format file to record the profile can ensure the interoperability and convenience among different platforms. The profile is comprised of some essential elements about the learners and authors. The main purpose of IMS LIP is to meet the following requirements: Distributed information, Scalability, Privacy and Data Protection, Flexibility.

IMS LIP not only sets up the file format, but also defines the fields to place data and the corresponding data type. The information model contains both data and its metadata to describe the profile content. The data model of LIP specification contains eleven core elements as shown in Figure 2 and each element could be separated into three parts, Referential, Temporal, and Privacy.

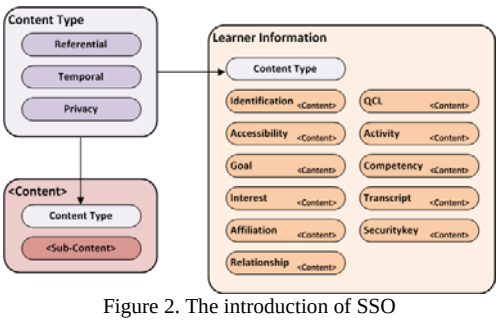

Figure 2. The introduction of SSO

With conformity to the IMS LIP, the learner profile could be also extended to record the instructors' profile. The term of "instructor" here means the producer of learning content, or the author. In this paper, we also find out a way to use the IMS LIP storage and access mechanism to create the author profile and achieve the customization and simplify editing flow in authoring phrase of our proposed authoring system on the web.

2.3 Advanced Web 2.0 Technologies

The main reason that we utilize web 2.0 architecture in this paper aims at providing an efficient online authoring tool for supporting various e-learning standards. As to the development of e-learning applications, most authoring tools are standalone applications installed in the local hosts. However, under this architecture, instructors have to design their own learning resources for the pedagogical purposes. Some of the learning resources can be acquired from the Internet, and re-uploaded to the backend learning management system after the authoring phase. This would result in an inefficient process while preparing the learning contents for learners. In addition, instructors have to spend time on retrieving, downloading and uploading the learning resources to complete the courseware authoring process, and the total costs would be improved.

III. Proposed Framework

In this section, we will focus on the authoring system based on Web 2.0 technologies to realize a rich-client authoring environment. In order to make all the functionalities in our proposed system more flexible, we use the web service technology to develop each function as a separate service module. In this way, authors could just import and set up the functionalities needed when creating the e-learning content. In other hand, authors are able to retrieve the usable learning contents from back-end servers or just on the web by utilizing the Web 2.0 technologies to save the cost of downloading learning contents in the same manner.

We sometimes take the authors as instructors in specific domain like mathematics, English … etc. Once the author creates an e-learning course and deliver it to the LMS, she/he might create e-learning courses in the same manner when login the system next time. She/he would have to do the same procedure when creating courses and refill the metadata description of the courses. Due to this reason, the use of IMS LIP standard could help the system to record and retrieve the whole authoring history. The integration with the Web 2.0 technologies also provides a total solution to serve the goal. With the rich interactions and well-organized author profile supported in Web 2.0 and IMS LIP standard, we are able to use this author profile to reach the personalized authoring environment.

After the authoring phrase, the learning materials should be generated based on the specific e-learning standards. In order to achieve the interoperability between different e-learning standards, we also proposed a transformation mechanism added on the authoring

system to serve this purpose. In this paper, we focus on the following e-learning standards: LOM, SCORM, TWLOM, and Common Cartridge.

3.1 System Architecture

Unlike conventional courseware authoring systems, we provide an easy-to-use web-based GUI (Graphic User Interface) on Web 2.0 technologies in the internet environment. For this reason, a three-tier system architecture was proposed to facilitate the authoring process as shown in Figure 3.

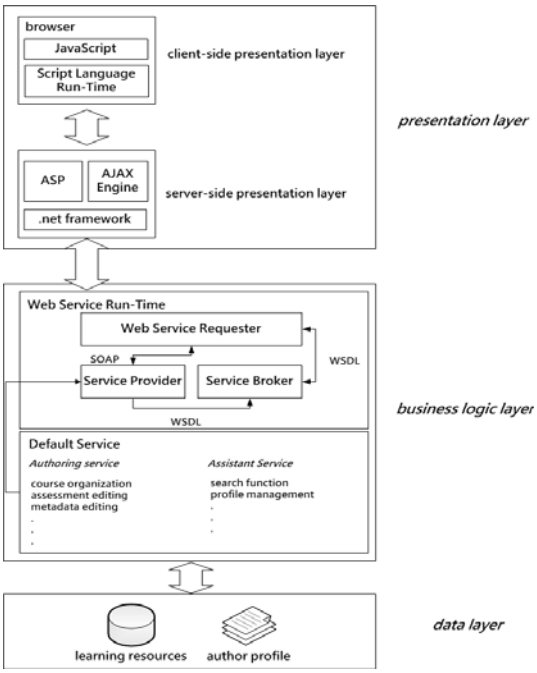

Figure 3. Three-tier architecture of the web-based authoring system

The first one is the presentation layer. Presentation layer focuses on the user interface and provide a rich-client operate environment to authors. Authors are able to set or manage the function modules for achieving the personalization in the authoring environment. And all the editing procedure would proceed in this layer as well. The second one is the business logic layer. It serves the whole plug-in functionality modules, and that is, to add the service in system runtime phase. Finally, the data layer is responsible for the date storage of learning resources and the author profile for personalization record based on IMS LIP.

In this architecture, the learning contents could be easily stored in back-end learning resources database or downloaded to the local computer. All of the learning resources like courses, web pages, MS PowerPoint files and other multimedia files would be assigned with a unique identifier. The author profile would find the relationship between the unique identifier and current author, and then record it to his/her personal author profile.

All of the existing e-learning service could be added on our system to support the authors in authoring phrase by WSDL (Web Service Description Language). When the courses have been created and the functionalities have been set up, the system would update the author profile and store the change.

3.2 Transformation Mechanism

Because of the content model and metadata description format are not the same in e-learning standards. We proposed an advanced mechanism based on CNRI's (Corporation for National Research Initiatives) Handler System for supporting the learning content that created or executed on authoring tool.

Handler system can be considered as an index method for general purposes which provide efficient, extendable, and secure Name Service. The Handler System in our work aims at providing a resolution service in the back-end learning content repository. Figure 4 shows the registration process and the returned parameters.

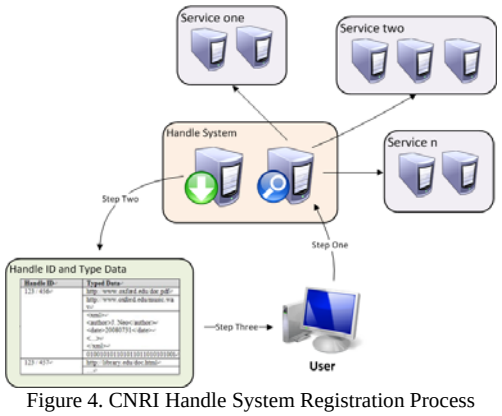

Figure 4. CNRI Handle System Registration Process

An example in figure above could be illustrated as below:

<HandleID>=<NamingAuthority>"/" <LocalName> (1)

A Handler comprised of two main parts, Handle Naming Authority and Handle Local Name. If a handler is formed as 123/456, the Naming Authority would be 123, and the Local Name of the handler would be 456. The Local Name in the belonging Naming Authority is unique and represents a specific URL for allocating the learning resources. We utilize the "HandleID" returned by CNRI server to be the basis of identification of the learning resources and metadata description while re-aggregating them into the new learning content structure. We adopt the following algorithm to proceed the transformation process.

StandardTransformation( )
{
1: load the metadata of request course package MD={C_a_i.b_j.c_k} where i={1, 2, …, 9}, j={1, 2, …, n}, and k={1, 2, …, m}
for each elements i
  assign HandleID $\eta_q = \alpha / \beta$ to each element
  where α = (StandardID + Value) and
    β = (Category + ResourceType)
2: select the destination standard
  StandardID= {1, 2, …, t}
3: create the corresponding template of StandardID
4: compare the η_q, and η_q in β

if β_q exists in η_q, fill( );
else check if β_q is the necessary element in η_q,
if yes return (β_q, step4)
else skip (β_q)
5: package ( )
}

The specific course package will be extracted to separate resources and each of them will be marked with a specific HID. The original metadata description would be written to the temporary memory based on LOM to re-build the metadata description and content aggregation of the other e-learning standards. The storage format of our proposed architecture is based on the Xpath. Figure 5 shows the actual instance for the mapping mechanism.

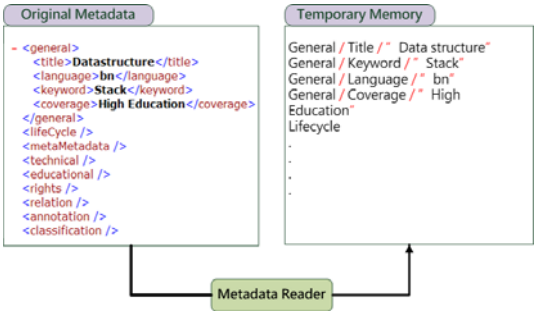

Figure 5. Temporary storing memory for metadata description

After loading and writing the metadata description into the temporary memory, our proposed mechanism would then load the format of e-learning standard that would like to transform to. In Figure 6, the program loads the metadata format of TW LOM specification first and then the metadata writer would fill out the corresponding field with the appropriate value.

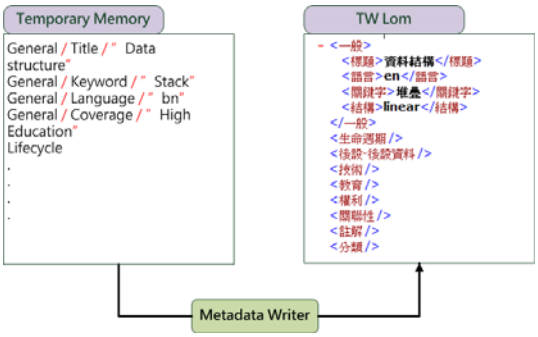

Figure 6. The re-writing process of TW LOM

3.3 Personal Profile Management

To edit metadata is not easy for the authors who aren't the expert in related domain. Thus, we make use of the data in author profile to simplify the procedure of authoring phrase and automatically generate the essential information for SCORM format metadata. The author preference would cause the personalization layout of the functionalities of system. The access procedure of the author profile in our system is shown in Figure 7.

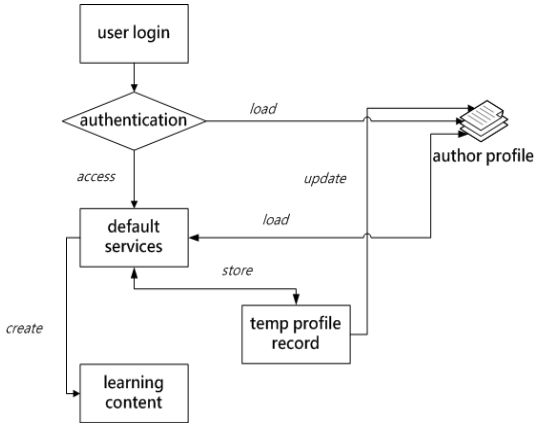

Figure 7. The access procedure of author profile

As logging in to the authoring system, the authentication mechanism would firstly identify the author in the back-end database. After that, the system would load the relative author profile for specific user, bind the essential information (shown in Figure 8), and then set up the customized interface for that user.

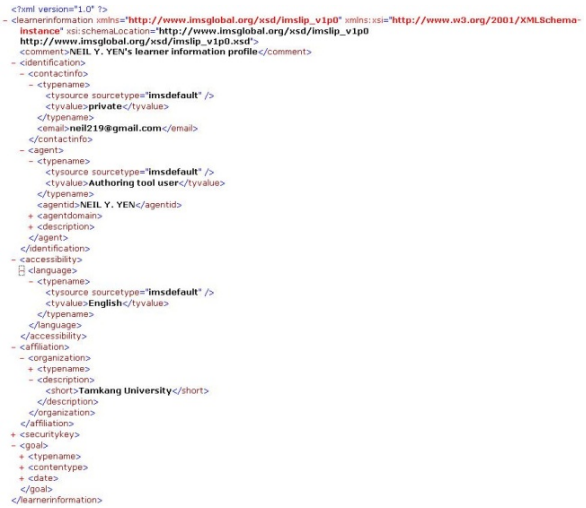

Figure 8. The essential information of author profile

When the user utilizes the default service proposed by our system, the operation process of the user would be stored in the temp author profile and update the back-end profile in asynchronous mode. After finishing all the authoring process, the learning content would be created. At the same time, system would use the information in author profile to create the essential metadata description file. All of the operating process would be recorded in temp memory and then updated into the author profile stored in the back-end database. The implementation of our proposed system is discussed in the next section.

IV. System Implementation

To make use of the authoring service in our proposed system in an easy way, the layout of user interface would be the main concern in this system.

In our proposed system, authors could easily to create an account to access the system. The main reason why authors should have an account is that our system would

generate a specific profile for every author to record the preference and authoring history. The LIP generator shown in Figure 9 would assist authors in creating personal account and profile.

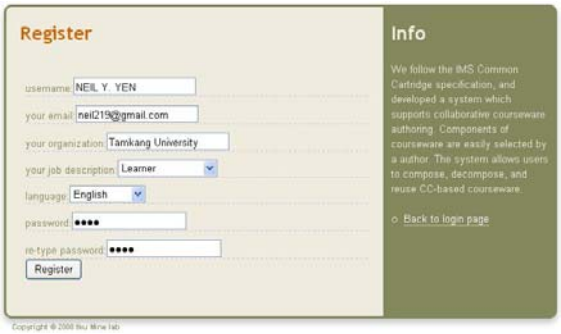

Figure 9. Interface of LIP generator

After the generation of account and profile, author logged in the system through the authentication mechanism; the system would extract the author profile in the back-end database and then load the information to arrange the layout of user interface as shown in Figure 10.

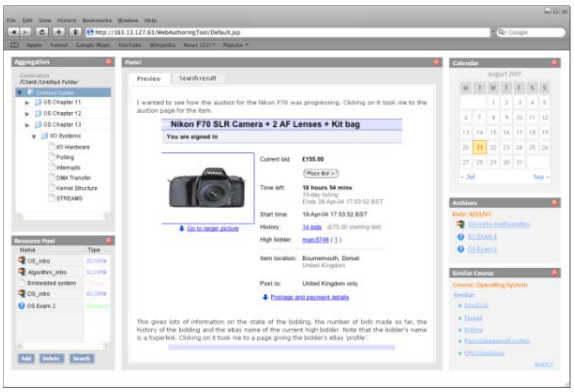

Figure 10. The user interface

Every separated part in this user interface is set up by the specific author, and is developed as a single web service. Author could select the usable functionalities to compose his/her personalized authoring tool. To take the created learning content for example, all the learning contents created by the specific author would be stored in author profile. When he/she logs in the system next time, the system would show all the authoring history to remind the author. Hence, the author won't have to spend much time in retrieving the learning contents or resources. What the author has to do is focusing on reorganizing the learning contents and learning design.

The authoring history and corresponding learning resources could be retrieved in the resource pool. Different types of learning resources would be shown in different colors and descriptions. Authors could utilize these existing resources to reduce the total cost of generating a new course. After completing the learning content, the metadata would be made by referencing the author profile stored in temp profile data structure. After metadata file is created, the system would package the whole relative learning materials into a zip file which is compatible with SCORM format.

The statement above is about the authoring process that authors would utilize to generate the learning materials. The default learning materials would be generated based on the SCORM format.

To achieve the interoperability, the metadata description is the most essential part that we should take into consider. We also proposed a metadata editor as a service of our system to assist authors to annotate the learning materials in SCORM metadata. The interface of our metadata editor is shown in Figure 11.

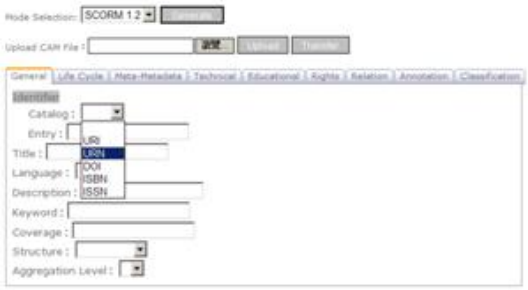

Figure 11. The metadata editor

After the modification of metadata description, the program would re-aggregate the learning resources in the original learning content, and then follow the specification of the new e-learning standard to generate the content organization. To take Figure 12 for example, the upper side is the SCORM based learning content and metadata description, and the lower side is the transformation result of our proposed mechanism based on IMS Common Cartridge.

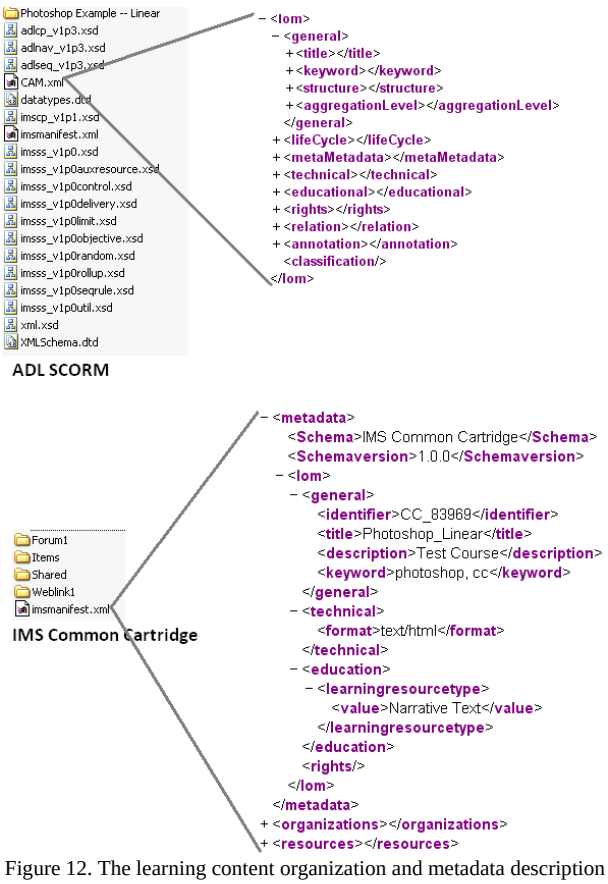

Figure 12. The learning content organization and metadata description

V. Conclusions and Future Works

With the SCORM standard, the authoring system provides the advantage of reusability, accessibility, interoperability, and durability in content authoring phase. And the use of the IMS LIP specification provides a uniform storage mechanism to store the personal information into a single XML file.

In this paper, we proposed a service-oriented authoring system based on Web 2.0 technologies. With the rich-client user experience, authors are able to set up their personalized authoring functionalities, which were supposed to be available only in standalone applications, in a web browser. Some learning resources stored in back-end computer or storage device could be manipulated during the authoring process without pre-downloading. The cost of the time in generating learning materials would be definitely reduced. The authors could pay more attention on the content of learning materials rather than on learning resources retrieving.

On the other hand, with the profile recorded in IMS LIP specification, the authoring history and process step of authors would be stored in the specific profile. And with the profile, our proposed authoring system could simplify the authoring process for the authors who are not experts in information technology domain. It would provide guidance on re-organizing the learning materials and assist authors in editing the metadata description.

Furthermore, we proposed a transformation mechanism for e-learning standards. The proposed mechanism could be considered as an add-on service in any e-learning systems. An index mechanism, named as handler, serves this purpose to affiliate the resources in the learning content. We finished the transformation mechanism among IEEE LOM, ADL SCORM, IMS Common Cartridge, and TW LOM.

After constructing our proposed system, the works that we should continue working on is to integrate IMS LIP with other external web services provided by related e-learning participators. And the other target we aim at is to include the other acknowledged e-learning standards to our mechanism. As a result, the interoperability of learning contents would be realized. Besides, the learning content and assessment would be considered as the two sides of a coin and have to integrate together. Eventually we would like to make use of our proposed authoring system to assist generating the assessment content and integrate it with the IMS LIP specification.

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Neil Y. Yen received his master's degree at Tamkang University in 2008. He is currently a Ph.D. student in Dept. of Computer Science and Information Engineering at Tamkang University. He is also a member of distance learning group in Multimedia Information Networking laboratory in Tamkang University. His research interests are in the scope of multimedia computing, distance learning, and web mining. His contact email is neil219@gmail.com.

Jason C. Hung is an Associate Professor of Dept. of Information Management, Overseas Chinese University, Taiwan. His research interests include Multimedia Computing and Networking, Distance Learning, E-Commerce, and Agent Technology. From 1999 to date, he was a part time faculty of the Computer Science and Information Engineering Department at Tamkang University. Dr. Hung received his BS and MS degrees in Computer Science and Information Engineering from Tamkang

University, in 1996 and 1998, respectively. He also received his Ph.D. in Computer Science and Information Engineering from Tamkang University in 2001. Dr. Hung participated in many international academic activities, including the organization of many international conferences. He is the founder and Workshop chair of International Workshop on Mobile Systems, E-commerce, and Agent Technology. He is also the Associate Editor of the International Journal of Distance Education Technologies, published by Idea Group Publishing, USA. The contact email is jhung@ocu.edu.tw

Hui-Huang Hsu is an associate professor of Computer Science and Information Engineering at Tamkang University, Taipei, Taiwan. He received his Ph.D. degree in electrical engineering from the University of Florida, USA in 1994. His current research interests are in the areas of machine learning, data mining, bioinformatics, multimedia processing, and e-learning. Dr. Hsu is a senior member of the IEEE. His contact email is h_hsu@mail.tku.edu.tw

Dr. **Timothy K. Shih** is a professor of the Department of Computer Science and Information Engineering at Asia University, Taiwan. Dr. Shih is a Fellow of the Institution of Engineering and Technology, UK. He is a member of ACM. As a senior member of IEEE, Dr. Shih joined the Educational Activities Board of the Computer Society. His current research interests include Multimedia Computing and Distance Learning. Dr. Shih has edited many books and published about 400 papers and book chapters, as well as participated in many international academic activities, including the organization of more than 50 international conferences and several special issues of international journals. He is the founder and co-editor-in-chief of the International Journal of Distance Education Technologies, published by Idea Group Publishing, USA. Dr. Shih is an associate editor of the ACM Transactions on Internet Technology and an associate editor of the IEEE Transactions on Learning Technologies. He was also an associate editor of the IEEE Transactions on Multimedia. Dr. Shih has received many research awards, including research awards from National Science Council of Taiwan, IIAS research award from Germany, HSSS award from Greece, Brandon Hall award from USA, and several best paper awards from international conferences. Dr. Shih has been invited to give more than 30 keynote speeches and plenary talks in international conferences, tutorials in IEEE ICME 2001/2006 and ACM Multimedia 2002/2007, and talks at international conferences and overseas research organizations. His contact email is timothykshih@gmail.com

Louis R. Chao is a professor of Department of Computer Science and Information Engineering at Tamkang University. He spared no efforts on researches. Expect being the founder of the Association of E-Learning, he is also a Director of Department of Computer Science, Chief of Engineering Institute, Dean of Academic Affairs, Vice-Chancellor, and Chancellor at Tamkang University. He also held lots of international conferences such as “International Conference on Computer and Education”, “International Computer Symposium”, “National Computer Symposium”, and established the International Journal of Information and Management in his serving time at university. He is not only a pioneer of “informationization”, “internationalization” in Tamkang University, but also a pioneer of computer assisted instruction and a researcher on distance learning. He has original opinions and abundant experience on how to integrate the information technologies and education. His research interests are in the scope of Distance Learning, Networking and Communication, Information Security, Multimedia, Neural Networks, Fuzzy Theory and etc. He also has deeply dabbled in enterprise organization, management, tactics application and etc. His contact email is sally@mail.tku.edu.tw