From Education to e-Learning : A Union Catalog Service of Learning Resources

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Abstract

Computer-Supported Collaborative Learning (CSCL) is a new learning method that is receiving an increasing amount of attention in Taiwan. With the rapid growth in learning resources available over the Internet, it has become more difficult for teachers to find useful resources. Although several local service providers (25 counties) in Taiwan are trying to organize their existing resources, each provider only serves the teachers in the local county. In this paper, we propose and implement a union catalog of learning resources, called the “Education to e-Learning” (EtoE) platform, to cover the 25 counties in Taiwan. Generally speaking, EtoE is an OAI-PMH service provider that gathers together all the resources spread over the Internet. It also provides resource browsing with learning skills, full-text/metadata search, personal resource management etc. We anticipate that EtoE will become an important medium between teachers and the local service providers of the 25 counties in Taiwan. With the EtoE platform, teachers will be able to utilize the resources of other counties, as well as their own. Furthermore, we hope it will encourage teachers to share and reuse learning resources through EtoE. The two main techniques used in the EtoE platform are: the IEEE LOM metadata standard, which is customized and localized to describe the learning resources; and OAI-PMH, which is used for metadata harvesting.

Keywords: EtoE, Computer-Supported Collaborative Learning, e-Learning, LOM, OAI-PMH

1. Introduction

In recent years, a great deal of effort has been invested in learning resource sharing and management systems [1][4] in Taiwan. A large number of websites, such as EduCity (http://www.educities.edu.tw/), Smart Creative Teachers (http://sctnet.edu.tw/), MOE EduContent (http://content2.edu.tw/), and the official educational websites of the 25 counties in Taiwan, have been developed to assist teachers and students in collaborative learning. These helpful and reusable resources are distributed over the Internet. However, as each e-Learning website may have its own site map (hierarchical structure), teaching materials, teaching plans, etc., teachers and students may be easily confused and find it difficult to locate suitable learning resources on their own.

The Ministry of Education in Taiwan is planning to implement a 1st - 9th Grades Curriculum Alignment Program [5] to federate all the providers of teaching programs and materials, and to provide a union platform for sharing and exchanging learning resources. The goal is to coordinate, all the learning resources currently available. To this end, we are developing a union catalog, called the Education to e-Learning (EtoE) platform, for the 1st - 9th Grades Curriculum Alignment Program. Based on the IEEE Learning Object Metadata (LOM) Schema [6] and OAI-Protocol for Metadata Harvesting (OAI-PMH) [1][7], it provides a federated portal for browsing syllabuses and schedules, searching for appropriate teaching materials, and retrieving learning resources. An overview of the architecture of the EtoE platform is illustrated in Figure 1.

As each website owns its teaching resources and directories, the metadata formats [3] must be well defined to enable exchange and integration. We
therefore held a community forum to determine and customize the IEEE LOM standard to improve the educational environment in Taiwan. More specifically, the metadata of teaching resources and directories must be exported in OAI-PMH. The OAI-PMH harvester of the EtoE platform coordinates with the OAI-PMH mediator of each website and harvests the metadata of learning resources into the union catalog. The metadata processing and indexing module deals with operations, such as metadata mapping, and metadata multi-field search. Moreover, the directory and catalog management provide the classification of learning resources. This makes it easier for teachers and students to browse and locate the resources in the EtoE platform. Furthermore, the personal knowledge and resource management are also provided. Eventually EtoE will provide browsing and searching interfaces for teachers and students.

![Figure 1: An overview of the EtoE project](image)

2. **Scenarios**

   In this section, we describe some scenarios to illustrate the goals of the EtoE project. We address the main tasks that need to be accomplished, try to organize the resources needed for the project, and describe the educational environment in which the platform will be used.

   User requirements, especially those of teachers, are our primary concern. We held several conferences with teachers to obtain their suggestions and advice. The topics included the platform interface, the effects of e-Learning, the impact of Computer-Supported Collaborative Learning (CSCL) [2], and resource sharing experiences. The interaction between the users (teachers) and the designers was important to the successful development of the EtoE platform. In our discussions, it became clear that software developers should listen to the users more, instead of writing more code. To design a useful platform for teachers to use is the primary goal of this project.

   **2.1. Users’ scenarios**

   We now consider several scenarios in an e-Learning situation.

   **2.1.1. Browsing the content**

   In order to locate teaching materials via the EtoE platform, the teacher must first access the specified educational or e-Learning web sites. He may log on to his personal account and then browse the materials of a site. The full details of each learning resource can be displayed and browsed on our EtoE platform. Although, he can browse all the learning resources on local websites all over Taiwan, it would be just like browsing a single site. It is obvious that a friendly interface for content browsing is a key requirement of a successful and collaborative learning system. This main usage requirement is considered within the EtoE project.

   **2.1.2. Classifying the resources**

   Learning resources can be classified in a number of ways, such as by content, by subject, or by course. In our educational environment, the most common classification is by the discipline. A teacher usually majors in teaching his discipline. For example, a teacher wishes to collect teaching materials about Chinese for a lecture he will deliver on the subject. As he would like to focus on learning resources about Chinese, it would be easier to retrieve the specified resources if our EtoE platform has a well defined classification for that discipline.

   It is noteworthy that a new concept of teaching has emerged in recent years. In the traditional education system, students have always been taught a method or way to solve a problem. Now, however, the Ministry of Education is promoting a new teaching methodology whereby teachers are asked to teach skills, instead of just knowledge, to students. It is emphasized that learning a useful skill and how to use it is more practical for students. So, as a teacher prepares to teach a specified skill to his students, he may want to find and focus on the learning resources about some skills. Teachers will be able to retrieve the specified resources more easily if our EtoE platform has classified the learning resources according to the specified skills.

   **2.1.3. Metadata and full-text search**

   As learning resources are stored in many educational web sites and spread over the Internet, it is hard to find
suitable resources for specific topics. Although a teacher can retrieve a specified learning resource by clicking a hyper link or typing the URL/URI exactly, it is still not efficient enough for common use. Web search technology is now highly developed and used frequently. Sites like Yahoo (http://www.yahoo.com/), Google (http://www.google.com/), and Openfind (http://www.openfind.com.tw/) all provide a web search interface for users to search for specified resources on the Internet. It is easy to find some resources by inputting keywords. The same situation can be applied to the learning resources in a collaborative learning environment. A teacher may wish to find learning resources related to some particular keywords. For example, a teacher in Tainan would like to search learning resources about pomelo, a famous local fruit, so he would type the keyword “pomelo” or “Ma-dou”, the place where pomelos are grown, into the query box of the search engine. In addition, the teacher can also search a specified field, such as the title, description, or author, related to such keywords. Then, the related learning resource about the famous fruit of Tainan can be found and retrieved. Hence, a reliable and simple search interface that includes both metadata multi-field and full-text search is necessary for our EtoE platform.

2.1.4. Retrieving relevant resources

In general, a complete learning resource is usually divided into several parts. For example, there are several kinds of learning resources in our education system, e.g., instructional design, instructional activity, instructional material, learning sheets, and materials. Furthermore, an instructional design may include several instructional activities, while an instructional activity may include several instructional materials, learning sheets and materials. So, if a teacher is interested in an instructional activity on the EtoE platform, he may be also interested in the relevant instructional materials, learning sheets, and materials that belong to it. These learning resources make up an instructional activity that can be used in a lecture. The package structure of a learning resource is illustrated in Figure 2. Resources related to the same subject, or have the same skills, or the same author can also be considered as relevant to this learning resource. It is necessary to carry out an interface to find relevant learning resource for the teacher in our EtoE platform.

![Figure 2: Package structure of a learning resource](image)

2.2. Users’ requirements

The preceding scenarios show that several tasks must be performed to support our EtoE platform. These can be summed up as follows:

1. Collect learning resources from all the e-Learning sites in Taiwan.
2. Browse all learning resources with a friendly and easy-to-use interface.
3. Retrieve the learning resource and its relevant materials by an intuitive approach.
4. Organize and classify the learning resources according to discipline, skill and type.
5. Search for suitable and matched learning resources by inputting keywords about the specified query field.
6. Manage and create favorite resources, then share and reuse them.

The first task requires a unified and applicable metadata standard, together with a proper strategy to encourage every e-Learning web site to join the collaborative project. The next three tasks deal with the interaction between teachers and the EtoE platform. The second and fourth tasks deal with the browsing interface, and the vocabulary of metadata standard, respectively. The fifth task can be accomplished by analyzing the metadata of the learning resource. Furthermore the full-text index and multi-dimension index approaches are also required. The final task will provide teachers with a collaborative environment, like a workshop, to manage the learning resource.
3. Standard

In our project, each e-Learning web site or system may have its own data format and presentation directory. However, interoperability is one of the main issues in creating a networked platform for collaborative learning. How to collect learning resources from each e-Learning website in Taiwan was the first problem we encountered. Therefore, the EtoE platform is based on a unified learning resource metadata standard and a proper resource sharing mechanism. We discuss these two aspects below.

3.1. Metadata standard

In general, metadata is defined as information about information. To benefit from the metadata of learning resources, a common metadata format should be designed. This has been one of the main objectives of e-Learning research. We briefly introduce several outstanding metadata standards, and choose the one that best fits our EtoE project.

3.1.1. Dublin Core

The Dublin Core Metadata Initiative (DC) [8] was launched in Dublin, Ohio, U.S.A in March 1995 to facilitate the discovery of online resources on the Internet. The DC Element Set describes the metadata of online resources, and consists of 15 elements: Title, Creator, Subject, Description, Publisher, Contributor, Date, Type, Format, Identifier, Source, Language, Relation, Coverage, and Rights. DC promotes the interoperability of resources in every domain.

3.1.2. SCORM

The Advanced Distribute Learning (ADL) project was set up by the U.S. Defense Department in 1997. Its primary goal was to ensure that a learner could retrieve high quality training lessons and learning resources anywhere. To achieve this, ADL integrated existing standards to establish Sharable Content Object Reference Model (SCORM) [9]. In January 2000, SCORM 1.0 was released by ADL. This was followed in January 2001 by SCORM, which integrated the Simple Sequencing Specification developed by the IMS Global Learning Consortium. SCORM describes a Content Aggregation Model (CAM) and Run-Time Environment (RTE) for learning resources to support adaptive presentation of content based on criteria such as learner objectives, preferences and performance.

3.1.3. LOM

Learning Object Metadata (LOM) Schema was developed by the IEEE Working Group P1484.12. The work of IMS and the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) were the main influence on LOM. The LOM Schema fully describes the special properties of learning resources, as well as being general enough to adapt to various resources and has been highly praised by both the academic community and commercial enterprises. The schema contains the attributes required to fully and adequately describe a learning resource. As shown in Figure 3, there are 9 general categories in the LOM Schema, namely: General, Lifecycle, Meta-metadata, Technical, Educational, Right, Relation, Annotation, and Classification.

It is still a little difficult to apply these international metadata standards in every country. The major problems are the definition of each file name and the suitability of localization. The solution is to establish a learning resource metadata with appropriate modifications and localization based on international metadata standards. For example, there is CanCore [10] for Canada (based on IEEE LOM), GEM [11] for United States (based on Dublin Core), EdNA [12] for England and Australia (based on Dublin Core), CELTS [13] for China (based on IEEE LOM), and SingCore [14] for Singapore (based on IEEE LOM). In fact, we started to develop an exchangeable metadata format for learning resources early in 2002. To meet the metadata standard for learning resources in the e-Learning environment, we hope to present the learning resources that are distributed on many e-Learning web sites in Taiwan in an integrated and general metadata format. We also wish to help the CC (computer centre) of the Ministry of Education and National Science and Technology Program for e-
Learning to establish the related national standards. Therefore, with the assistance of the Metadata Architecture and Application Team (MAAT) of Academia Sinica, we held several conferences with teachers and content managers of e-Learning web sites in last two years. We also consulted with the three main e-Learning web sites (EduCity, Smart Creative Teachers, and MOE EduContent) about the metadata format and the database field. With Chinese localization and with reference to LOM V1.0, SCORM V1.3, Dublin Core, IMS V1.2.1, and CanCore V1.1 “Taiwan K12 LOM Core V0.1” was released in March 2003. After several conferences and modifications, the fixed version, V0.5, was released in August 2003. Finally, MAAT sought advice from the official e-Learning resource repositories of 10 counties in Taiwan and put their requirements into the metadata standard. The final formal version “Taiwan K12 LOM Core V1.0” was released on March 2004.

3.2. Harvesting protocol

During the design of the sharing and exchange mechanism for collecting metadata we compared several existing mechanisms for metadata sharing. In the following sections, we introduce and compare two of these mechanisms, namely: the RDF Site Summary (RSS) and the OAI-Protocol for Metadata Harvesting (OAI-PMH).

3.2.1. RSS

The RDF Site Summary (RSS) [15] is a lightweight format that is designed to share headlines and web contents. It was developed by UserLand in 1997 and first used by Netscape to publish the external news feeds in “My Netscape Portal”. RSS is based on XML and provides an open standard for syndicating and aggregating web content. As a result, it has evolved into a popular standard for sharing content between web sites in recent years. Using the RSS format, we can create a data feed that supplies headlines, links, and article summaries from our web site.

3.2.2. OAI-PMH

The OAI-Protocol for Metadata Harvesting (OAI-PMH) provides an application-independent, interoperable framework for metadata harvesting. It defines a mechanism to gather records that contain metadata from several existing repositories, based on the existing open standards: Hypertext Transport Protocol (HTTP) and Extensible Markup Language (XML). The metadata that is harvested can be in any format that is accepted by OAI-PMH, which means that the protocol can be used in different domains, such as digital libraries, e-Learning, etc. When metadata from many repositories is gathered together in one repository through OAI-PMH, an add-on service based on the centrally harvested data can be provided.

Although RSS is a popular standard for data sharing on the Web, we chose OAI-PMH for two reasons. First, it defines more flexible and complete verbs (operations) [7] for retrieving shared resources than RSS (Table 1 shows the verbs defined in OAI-PMH). If the facility for OAI-PMH is available, we can easily adapt it, regardless of whether we have to write a complex retrieval code for the EtoE platform. The second reason is that OAI-PMH defines several primary metadata structures for organizing resources, such as the “Set” tree structure. This enables us to describe a learning resource more accurately than using RSS. Thus, OAI-PMH is used in the EtoE platform to exchange the metadata of learning resources.

### Table 1: The 6 verbs defined in OAI-PMH

<table>
<thead>
<tr>
<th>Verbs</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GetRecord</td>
<td>This operation is used to retrieve an individual metadata record from a repository.</td>
</tr>
<tr>
<td>ListRecords</td>
<td>This operation is used to harvest records from a repository.</td>
</tr>
<tr>
<td>ListIdentifiers</td>
<td>This operation is an abbreviated form of ListRecords, retrieving only headers rather than records.</td>
</tr>
<tr>
<td>ListSets</td>
<td>This operation is used to retrieve the set structure of a repository.</td>
</tr>
<tr>
<td>ListMetadataFormats</td>
<td>This operation is used to retrieve the metadata formats available from a repository.</td>
</tr>
<tr>
<td>Identify</td>
<td>This operation is used to retrieve information about a repository.</td>
</tr>
</tbody>
</table>

4. The EtoE Platform

In this section, we introduce the EtoE platform and show the e-Learning services we provide.

4.1. Architecture

The EtoE platform is a central portal, web-based system, as shown in Figure 4. In general, the EtoE platform is a union catalog of learning resources for the 1st-9th Grades Curriculum Alignment Program mentioned earlier. Each e-Learning web site has its own metadata schema and data directories, as well as its own data repository for learning resources. Through OAI-PMH Mediator, the learning resources can be exported in a unified metadata format. Using the well defined operations of OAI-PMH, the EtoE platform
can gather the metadata of learning resources from the OAI-PMH Harvester component. With the metadata gathered from each learning web site, EtoE provides added value services, such as metadata browsing and searching, personal directories, and bookmark management.

4.2. Services

The ultimate goal of the EtoE project is to provide e-Learning services and a collaborative learning-network environment for teachers. First of all, to harvest and gather learning resources distributed all over the e-Learning websites in Taiwan, a strategy must be developed so interested websites can join a federated alliance to share content based on a unified metadata. Hence a unified metadata standard, “Taiwan K12 LOM Core”, has been released by MAAT, along with a simple metadata export toolkit. When the distributed learning resources are gathered, the EtoE platform acts as a portal site for the resources. Just as resources on the Web can be found by the generic web search engine, we believe that learning resources in Taiwan can be found through the EtoE platform. Furthermore, other e-services are also provided by the EtoE platform, e.g., learning resource browsing and retrieving, relevant resources retrieving, and personal bookmarks for resources. These services are described below.

4.2.1. Federated alliance

In a collaborative learning environment, the sharing of learning resources is a kind of interaction. Our EtoE project promotes learning resource sharing between e-Learning web sites. We adopt OAI-PMH as the metadata sharing and harvesting protocol. Our service model is shown in Figure 5.

Figure 4: Architecture of the EtoE platform

If e-Learning web sites want to join the federated alliance, we explain the unified metadata standard and the use of the metadata export toolkit and help them transform their heterogeneous databases into unified metadata files for content sharing. With unified metadata files, each e-Learning web site can construct its own OAI data provider (repository). The EtoE platform (OAI service provider in Figure 5) can gather the learning resources; and e-services, such as learning resource browsing and searching, can also be provided to teachers.

4.2.2. Learning resources browsing and retrieving

The primary interface of the EtoE platform is shown in Figure 6.

Figure 5: Service model for federated web sites

Figure 6: Primary interface of the EtoE platform

The left side contains the working panel for personal resource management, the announcement panel, and the documents and toolkits for the “Taiwan K12 LOM Core” metadata standard. The right side is the major display area for the learning resources. The top of the
right side provides a query interface for teachers to search for learning resources, while the middle of the right side shows the path of the tree which the user browses through. In the design of the EtoE platform, the first level of the resource directory is organized by discipline. The leaf level is associated with the skill of the discipline. When teachers browse the leaf directory, detailed information about the learning resources associated with this skill are displayed on the bottom right-hand side of the interface. A right-click on a learning resource will then take the user to the e-Learning website that shares the resource.

4.2.3. A search engine for learning resources
In addition to browsing learning resources, the full-text index engine of the EtoE platform builds multi-dimension indexes according the metadata. In Figure 7, the query interface for multi-field input is placed on the top of the working panel. The user can type in a keyword (by IEEE LOM 1.5 Keyword), title (by IEEE LOM 1.2 Title), authors (by IEEE LOM 2.3 Contribute) etc. Furthermore, the user can check the desired resource type (by IEEE LOM 9 Classification), or the suitable learning grade (by IEEE LOM 9 Classification). The details of search result will be shown in the bottom part of the working panel.

4.2.4. Vertical and horizontal hyper-linking with learning resources
As shown in Figure 8, when the user finds the required learning resource, the metadata will show information about the learning resource (title, description, contributed web site, etc). It also directs the user to other relevant resources. If the user right-clicks on the keyword (it shows learning resources with the same keyword), or right-clicks on skill (it shows learning resources with the same skill). We call this kind of relation a horizontal hyper-linking. Furthermore, if the learning resource is an instructional activity, the relevant instructional material, learning sheet, and material will also be shown. This kind of relation is called vertical hyper-linking and described in the IEEE LOM 7 Relation.

4.2.5. Personal resource management
The EtoE platform also provides teachers with a personal directory (workshop) to manage their learning resources, as shown in Figure 9.

When a teacher opens an account with the EtoE platform, he acquires a private directory to store learning resources. The personal options for directory management will be displayed on the top right-hand side when the teacher logs on to his account. After log on, he can build his own knowledge architecture by clustering some relevant learning resources into the same directory. Furthermore, he can click the interesting learning resources to bookmark them into his personal directory (the interface is shown in Figure 9). The bookmarked information of a learning resource will be stored by IEEE LOM 7 Relation (reference
We consider that it is a better learning resource for teachers because of the references from other teachers.

5. Conclusion

The goal of the EtoE project is to build a platform for gathering e-Learning resources in Taiwan. The project solves two issues: 1) the problem of searching for learning resources over the Internet and several independent local repositories, and 2) how to build a sharing mechanism for gathering the learning resources. To solve these problems, EtoE proposes a metadata standard, Taiwan K12 LOM Core, adapted from IEEE LOM Schema to describe learning resources; and OAI-PMH to gather the metadata-annotated learning resources from different e-Learning web sites. The EtoE project focuses on the search for learning resources and yields more precise searching results (because of LOM). It also provides interoperability for any e-Learning website that joins the EtoE platform through OAI-PMH.

In the near future, we hope that the EtoE platform will not only play an important role in learning resource exchange and searching, but will also be an e-Learning interface that teachers and students can utilize. We expect there will be interesting feedback from teachers and students about the EtoE platform, which will help us to better understand their needs. It will also help us to determine the most suitable collaborative learning environment for Taiwan. This, in turn, will promote a more successful and useful learning model for our teachers and students.

6. References