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The Development of Metadata Standards for Teaching Domain in Taiwan

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Abstract: Maximizing flexibility, scalability, and compatibility is the aim for the localization of metadata standard. Metadata (data about data) provides a common nomenclature to describe learning resources in a common way. Metadata standard provides an unambiguous way for describing the same attribute of learning resources. However, there exist indeed cultural differences among different countries and areas. Metadata standards should preserve enough flexibility to deal with cultural differences. In this paper, two application profiles of metadata standards, Teaching Material Markup Language (TMMML) and Metadata Lifecycle Model, adapted from IEEE LOM, SCORM, and Dublin Core are introduced. Moreover, key factors to successful development of localization for metadata standards are discussed.

Key-Words: Metadata, Standard, SCORM, Dublin Core, Cultural Differences

1 Introduction
Metadata (data about data) provides a common nomenclature to describe learning resources in a common way. Metadata can be collected in catalogs, as well as directly packaged with the learning resource it describes. Learning resources described with metadata can be systematically searched for and retrieved for use and reuse.

For example, Sharable Content Object Reference Model (SCORM) [1] defines a standard set of metadata element definitions that can be used to describe learning resources. Metadata are machine-understandable which means computers can search and retrieve learning object according to specific needs. Moreover, intelligent system such as agent-based system can utilize the information acquired from metadata to identify, recognize and analyze learning resources [2][3].

The unification of metadata standard provides unambiguous and common way for describing the same attribute of learning resources. However, there exist indeed cultural differences among different nations and areas. Metadata standards should preserve enough flexibility to deal with cultural differences.

In this paper, two metadata standards, Teaching Material Markup Language (TMMML) [4] and Metadata Architecture and Application Team Metadata (MAAT), adapted from SCORM and Dublin Core are introduced to overcome this problem.

2 Metadata Standards
In this section, two well-known metadata standards, SCORM and Dublin Core, and their evolution are discussed.

2.1 SCORM Metadata
Metadata for learning resources has been under development within a number of national and international organizations over the past few years. Advanced Distributed Learning (ADL) initiative references IEEE LTSC [5] Standard for Information Technology -- Education and Training Systems -- Learning Objects and Metadata (LOM) Working Group, the IMS [6] Global Learning Consortium, Inc. and the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [7] as the bodies that are defining metadata specifically for learning resources. These groups, which have been working collaboratively, have developed a core set of specifications.

The SCORM references the IEEE LTSC LOM Standard. The LOM was developed as a result of a joint effort between the IMS Global Learning Consortium, Inc. and the ARIADNE to define a standard set of metadata element definitions that can
be used to describe learning resources. SCORM has adopted the same set of metadata elements described in the IEEE LTSC LOM Standard. SCORM will also reference a binding specification at such time that the binding specification becomes available. The binding specification will provide an XML representation for the IEEE LTSC LOM Standard.

SCORM applies the IMS metadata element definitions to three content model components: Asset, SCO and Content Aggregation. These three components define the metadata portion of the SCORM Content Aggregation Model.

This mapping of standardized definitions from IEEE to the SCORM Content Aggregation Model provides the missing link between general specifications and specific content models. The following sections define the application of IEEE definitions to the metadata portion of the SCORM Content Aggregation Model.

2.2 Dublin Core
Ongoing efforts of Dublin Core Metadata Initiative (DCMI) participants include the collaborative development and continual refinement of metadata conventions based on research and feedback between DCMI Working Groups.

The Dublin Core standard includes two levels: Simple and Qualified. Simple Dublin Core comprises fifteen elements; Qualified Dublin Core includes three additional elements (Audience, Provenance and RightsHolder), as well as a group of element refinements (also called qualifiers) that refine the semantics of the elements in ways that may be useful in resource discovery.

The Simple Dublin Core Metadata Element Set (DCMES) consists of 15 metadata elements as shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Simple Dublin Core Metadata Element Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Title 2 Creator 3 Subject</td>
</tr>
<tr>
<td>4 Description 5 Publisher 6 Contributor</td>
</tr>
<tr>
<td>7 Date 8 Type 9 Format</td>
</tr>
<tr>
<td>10 Identifier 11 Source 12 Language</td>
</tr>
<tr>
<td>13 Relation 14 Coverage 15 Rights</td>
</tr>
</tbody>
</table>

Each Dublin Core element is optional and may be repeated. The DCMI has established standard ways to refine elements and encourage the use of encoding and vocabulary schemes. There is no prescribed order in Dublin Core for presenting or using the elements.

2.3 CanCore
Supporting the use and reuse of digital learning objects, the CanCore Metadata Initiative aims to assist project implementers and indexers in the development of high-quality systems and records. These educational or learning objects can be simple assets as individual web pages, video clips, or interactive presentations; meanwhile they can also be comprehensive aggregations as full lessons, courses or training programs.

CanCore has been working with an expanding community of implementers since November 2000. Guidelines are provided for all of the elements in the Learning Object Metadata standard, and a sub-set of these elements are identified for their special utility in resource description and discovery as shown in Fig. 1. Efforts are also spent at specifying and clarifying the interpretations of elements to increase the interoperability.

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CanCore has been developed with input and feedback from educators and technology developers, and from Canadian projects and implementations internationally. The CanCore Initiative is currently funded by the e-Learning Marketplace Strategy Group of Industry Canada’s e-Learning Directorate, and supported by TeleUniveriste and Athabasca University, CANARIE, Alberta Learning, Netera Alliance, TeleCampus.edu, and the Electronic Text Centre at the University of New Brunswick have also been provided Funding and support.

2.4 UK LOM Core
The development of the UK Learning Object Metadata Core (formerly the UK Common Metadata Framework) stems from a position paper presented to the UK Metadata for Education Group in April 2002. This paper called for the formation of a community of practitioners to identify common UK practice in the use of metadata in packaged e-learning content. A subsequent comparison was undertaken of twelve metadata schemas based on the IEEE Learning Object Metadata Standard. As a result of this comparison, a set of guidelines has been drafted to
inform UK practitioners on the implementation of a minimum common core of LOM elements and associated value spaces. The UK LOM Core is essentially an application profile of the IEEE 1484.12.1 - 2002 Standard for Learning Object Metadata that has been optimized for use within the context of UK education.

UK LOM Core aims to identify common practice and provide guidelines for metadata implementers, creators and users. The UK LOM Core has been heavily influenced by the work of CanCore, the Canadian Core Guidelines for the Implementation of Learning Object Metadata. Draft of the UK LOM Core application profile contains an information model only and is not accompanied by a binding.

### 2.5 CELTS-3

Service quality assurance is becoming a common concern among different kinds of stakeholders with the increasing use of e-learning technology in education and training. Though a lot of efforts are found among international bodies in developing specification for quality assurance of e-learning, their emphases are on Institutional Support, Course Development, Teaching/Learning, Course Structure, Student Support, Faculty Support, Evaluation, and Assessment. However, few researches are devoted to service quality and its assurance system.

The LOM draft standard is arguably the most mature one of the LTSC draft standards. As stated in the “Purpose” section of the standard, the purpose of LOM standard is to facilitate search, evaluation, acquisition, and use of learning objects by learners or instructors or automated software processes.

Adopting the hierarchy and all elements of the LOM model, CELTS-3 (Chinese E-Learning Technology Standard) is the localized version of up-to-date IEEE 1484.12.1 draft standard in China. Similar to CanCore and UK LOM Core, the foremost revision to the LOM model in CELTS-3 is the introduction of the core elements set.

LOM Model is hard to understand and practically use because the model has been designed to be hierarchical and rather complex. It took approximately half an hour for an teacher to fill in all the LOM elements in the metadata instance for a resource. Consequently, constructing a resource database with all the LOM elements to be mandatory to be used for all resources is very resource-costly and ineffective.

Analyzing all the LOM elements as well as the hierarchy, one can notice that the importance of them vary. For example, 1.2 “title”, and 2.3 “contribute” are indispensable for nearly all learning objects, while 4.7 “duration” may not make any sense to a JPEG image, and 7 “relation” is not meaningful for most raw media. Making all the LOM elements “mandatory” to all users indiscriminately is not effective and flexible.

Meanwhile, leave users to decide which elements should be chosen to describe their own resources is not a suitable solution. There will be a chaos if applications use the elements of LOM in inconsistent ways. Few portability and interoperability exist in this kind of chaos.

CELTS-3 identifies some elements in the LOM model as “mandatory”, and the rest “optional”. All elements in the core elements set are mandated to be contained in a metadata instance, while elements in the optional elements set may or may not occur in a metadata instance. Metadata applications are allowed to freely choose optional elements they are interested and all elements in the core elements set must be included to ensure consistency.

### 2.6 Comparison of CanCore, UK LOM Core, and CELTS-3

The comparison of CanCore, UK LOM Core, and CELTS-3 are described as follows and listed in Table 2.

1. **CanCore**

   There are 62 elements, chose from 77 metadata elements of IEEE LOM, in the CanCore core set. All elements are “optional” because of the belief that the removing of restrictions can actually increase the flexibility of using metadata elements. Efforts are spent at specifying and clarifying the interpretations of elements to increase the interoperability.

2. **UK LOM Core**

   One of the main features of UK LOM Core is the emphasis on meta-metadata category. All elements belong in meta-metadata category are mandatory metadata elements. The emphasis on meta-metadata enhances the reusability and interoperability of metadata. Totally 27 elements are selected into core set and should be contained in all metadata instances.

3. **CELTS-3**

   CELTS-3 is the localized version of up-to-date IEEE 1484.12.1 draft standard in China. A systematic methodology of categorizing is emphasized to enhance the indexing and management of learning resources. CELTS-3 identifies some important elements in the LOM model as “mandatory”, and the rest “optional”. Therefore the elements of LOM model are divided into two parts in CELTS-3: the core elements set and
the optional elements set. There are totally 26 elements in the core set.

Different strategies are used in various countries to maximize flexibility, scalability, and compatibility in the localization of metadata standards. The emphasis of meta-metadata enhances the interoperability. The division between mandatory (core set) and optional elements balance the trade-off between compatibility and flexibility. These issues are vital and play important roles in a smooth localization of metadata standards.

Table 2: Definition and comparison of metadata standards

<table>
<thead>
<tr>
<th>Feature</th>
<th>Core set or mandatory elements</th>
<th>Application profile</th>
<th># of mandatory element</th>
</tr>
</thead>
<tbody>
<tr>
<td>CanCore</td>
<td>Metadata elements in core set are highly recommended. All elements are optional.</td>
<td>All elements are optional. Unimportant elements are excluded from core set.</td>
<td>None (62 in the core set)</td>
</tr>
<tr>
<td>UK LOM Core</td>
<td>Metadata elements are divided into three groups: mandatory, recommended, and optional.</td>
<td>Elements for meta-metadata are mandatory. Mandatory elements should be contained in metadata instances of UK LOM Core.</td>
<td>27</td>
</tr>
<tr>
<td>CELTS-3</td>
<td>Metadata elements are divided into two groups: mandatory and optional.</td>
<td>Mandatory elements should be contained in metadata instances of CELTS-3.</td>
<td>26</td>
</tr>
</tbody>
</table>

In Taiwan, several research projects have been launched to focus on modifying metadata standards so that they can adapt to cultural differences without losing compatibility with original standards. Two of the research project outcomes are mentioned in this section. Some recommendations are also concluded for researchers attempt to adapt metadata standards.

3.1 Teaching Material Markup Language (TMML)

TMML is developed by a project named “A Study of Recommending the Standard Format for e-Learning Systems, Platform, and Content” launched in 2002. This project, sponsored by National Science Council (NSC) in Taiwan, had the mission to localize and customize the metadata standard for the educational society in Taiwan.

TMML divides metadata elements into two levels, generic metadata level and specific domain metadata level. The architecture of TMML is illustrated in Fig. 2. The first level, generic metadata level, defines metadata elements commonly used in general domain. While in the second level, specific domain metadata level, metadata elements applied to describe learning resources in specific educational domain.

Teaching Material Markup Language (TMML)

![Fig. 2: The architecture of TMML](image_url)

All the metadata elements are divided into fourteen categories, nine categories inherited from SCORM Metadata and five expanded categories adapted from IMS Question & Test Interoperability Specification and IMS Simple Sequencing Specification. Further information about TMML and the download service for specification related documents can be found in the following website: http://e-learning.nctu.edu.tw.
3.2 Metadata Architecture and Application Team Metadata (MAAT)

The "National Digital Archives Program" (NDAP) project in Taiwan was launched on January 1st, 2002 and is sponsored by the National Science Council (NSC). The aim is to promote and coordinate content digitization and preservation at leading museums, archives, universities, research institutes, and other content holders in Taiwan.

Before the NDAP was launched, years were spent studying the impact of Information and Communication Technologies (ICT) on socio-economics. These studies lead us to believe that mankind is facing critical cultural and social change, including changes in the means of communication from printed matter to electronics, and other changes to the way of life in society. ICT has advanced to a level that affords us the opportunity to digitize our cultural treasures and heritage, so they can be preserved and utilized in the digital era. Otherwise, some of them might gradually disappear and possibly become extinct.

MAAT, one of the technical teams in NDAP, develop Metadata Lifecycle Model to standardize the process of defining metadata for specific domain such as content digitization and preservation. As shown in Fig. 3, there are four phases in the Metadata Lifecycle Model.

![Metadata Lifecycle Model](image)

Fig. 3: Metadata Lifecycle Model

In the Requirement Assessment & Content Analysis Phase, The first step of the metadata lifecycle is to interview the content experts or providers about their metadata requirements for each collection project, and to analyze the attributes of collection projects. Then relevant metadata standards are reviewed and deep metadata needs are investigated. The last step is Identification of strategies for the metadata schemes and achieving interoperability with Well-known Metadata Standards.

In the System Requirement Specification Phase, the preparation of the metadata requirement specification and evaluation of metadata systems are performed. This stage involves the evaluation of potential metadata systems. The collection project members can select an existing system developed by homogeneous or similar collection projects.

In the Metadata System Phase, the preparation of best practice guidance and development of the metadata system are performed. System developers develop metadata tools and systems based on the metadata requirement specification.

In the Service & Evaluation Phase, maintenance of metadata service and evaluation of metadata performance are performed. The last stage of the MLM seeks to review results of the whole metadata process and performance. The evaluation is conducted according to the assessment of metadata record quality, the effectiveness of adopting a metadata scheme for retrieval, the use of metadata creation tools within the collection project, and the application of the Metadata Lifecycle Model in each stage.

4 Conclusion

After analyzing the development of Metadata Standard in Taiwan, we deem that two important properties of Metadata Standard should be maintained during the development phase of metadata specification — layered structure and well-defined lifecycle.

Layered structure divides the elements into layers which preserves the most flexibility. Applications can choose proper level of detail in the metadata standard after evaluating the basic and deep needs. Fig. 4 illustrated the layer structure we recommended. The bottom layer is Generic Metadata Layer whose elements can be used to describe general resources. Metadata elements in this layer are designed for general purpose and compatible with Internet and Library Resource Metadata [8]. The middle layer is Learning Resource Metadata Layer designed for describing learning resources. The top layer is Specific Domain Metadata for learning resources in specific domain including elementary education, high school education, college education, and lifelong education.
Metadata is an emerging approach to organizing structured digital collections, in order to support precise retrieval, long-term preservation, and interoperability [9] on an extraordinary Internet scale. Although there are many metadata practices in digital libraries, few literatures have addressed the methodology of a best practice for developing metadata. In the light of metadata provision, digital library projects often face a series of issues, including: how to get started, how to acquire metadata needs, how to choose a suitable metadata standard and adopt it, how to develop metadata specification, how to evaluate a metadata system, and so forth. A set of effective methods to develop metadata is thus very important.

**References:**