LEARNING OBJECT METADATA IN A WEB-BASED LEARNING ENVIRONMENT

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ABSTRACT

The plethora and variance of learning resources embedded in modern web-based learning environments require a mechanism to enable their structured administration. This goal can be achieved by defining metadata on them and constructing a system that manages the metadata in the context of the learning environment. Both activities have to meet certain standards.

1. INTRODUCTION

A milestone in the history of educational technology was the introduction of computer networks and hypermedia systems, especially with the break-through of the Internet and the World Wide Web. One of the outcomes of the application of such technologies is the web-based learning environment (WBLE) which proved to be more than just 'a new fashion'. The WBLE has been established as the basic infrastructure for supporting the technology-based instructional process in an easy-to-use, pedagogically correct and cost-efficient manner. A WBLE contains a vast amount of homogenous and heterogeneous learning resources of great diversity. Such resources, in conformance with the object-oriented paradigm, are called **learning objects** and are defined as all entities, digital or non-digital, that can be used, re-used or referenced during technology-supported learning [IEEE 2000].

The ability of administering learning objects, in terms of updating, identifying, utilizing, sharing and re-using them, remains a great challenge, as their number continues to grow at a fast rate. The only viable solution proposed to this problem, is to define a set of **metadata** on them, that is, a set of attributes required to fully and adequately describe them [IEEE 2000]

There are certainly no standards ready to be used in this field, although a significant amount of work is taking place in the direction of standardizing metadata element sets and implementing them in real-world applications. This paper examines the undergoing research work on the field of learning objects metadata, together with the implementation of a system for managing learning object metadata in a prototype web-based learning environment. Among the issues presented are the need for standardization in technology-related instructional development with emphasis to learning objects metadata, a brief literature review of the work on metadata management, and the functional characteristics of our system along with several evaluation remarks and some

open research issues.

2. THE NEED FOR STANDARDS

Today, most faculty members have started engaging in online instruction, already creating learning resources and publishing them online. The lack of standard approaches to creating, describing and delivering such online learning resources hinders the exploitation of the potential of these technologies for both effective and efficient teaching and learning. Additionally, the ability to share, re-use and integrate units of learning material as well as educational tools and services is the core requirement of the courseware development industry. The success of the Web clearly demonstrates that standards offering even just a basic level of interoperability trigger an impressive level of development.

There are several, highly active, standardization initiatives today that are concerned with the definition of specifications for learning resources metadata. These metadata should be linked or mapped to existing taxonomy and curricula structures and should be embodied in learning environments to ensure their efficient management. The demand for standardization concerning learning resources metadata, arises from the following critical issues:

- **Discovery of learning resources:** Finding educationally appropriate materials is a "classic time-consuming, hit-or-miss activity for teachers" [Soloway 1998]. Metadata hold great promise for solving this problem with regard to Web-based materials as they support discovery of learning resources by defining the terms for describing a resource. Moreover, metadata define the information needed to retrieve a resource, as well as information needed to run a resource, or to determine if a resource is appropriate for the intended platform.
- **Reusability of content and methods:** High quality multimedia learning materials are expensive to produce. The possibility to exchange and reuse learning objects over the Internet can, therefore, support the development and take-up of common learning components and systems. It will bring economies of scale needed to build affordable educational products.
- **Interoperability:** Metadata standards promote interoperability between different learning management systems, saving time and energy, needed by learning resources producers and teachers to properly describe those resources. There are several types of interoperability, i.e., common data formats, common interchange formats, common metadata field sets.
- **Multilinguality:** Education is based on the mother language of the student. This should not prevent cross-border cooperation, especially if a multicultural environment is to be fostered. It is, therefore, of paramount importance to harmonize the approach to multilingual learning contents and services.

3. RESEARCH ACTIVITIES RELATED TO METADATA

Currently, several groups have commenced work for suggesting and developing standards and specifications related to learning resources metadata. Although international standards are the primary objective, particular attention should be given to specific European needs, such as national curricula, linguistic issues and cultural diversity. The following list, although not exhaustive,

highlights the most important of these groups:

- **Dublin Core Metadata Initiative** [http://purl.org/dc] has developed the Dublin Core Element Set, that is a core set of metadata elements which can be mapped on to more specialist catalogues used for libraries, archives and museums collections. There are many library and higher education communities that use the DC Element Set and most of the research groups that follow have been strongly influenced by it.
- **CEN/ISSS** (Comité Européen de Normalisation / Information Society Standardisation System) [http://www.cenorm.be/isss/] has been requested by the European Commission to draw up a work programme, in support of the development of Europe's Learning Society. This report is the prime task of the CEN/ISSS **Learning Technology Workshop**. In addition, the Workshop has also committed considerable work on localisation issues of the IEEE metadata standard.
- **PROMETEUS** (PROmoting Multimedia access to Education and Training in EUropean Society) [http://prometeus.org] members have been divided in several working groups (SIGs) and undertaken discussions to reach a common understanding and promote knowledge in the field. These discussions provide both input and feedback to the work of CEN/ISSS Learning Technology Workshop and other related standardisation activities.
- The IEEE, has constituted the **Learning Technology Standards Committee** [http://ltsc.ieee.org], which mission is to develop technical standards, recommended practices and guides for software components, tools, technologies and design methods that facilitate the development, deployment, maintenance and interoperation of computer implementations of education and training components and systems. Currently LTSC is comprised of several working groups, each working on a specific domain.
- Educom's **Instructional Management Systems** [http://www.imsproject.org/] Project is developing a set of specifications and prototype software for facilitating the growth and viability of distributed learning on the Internet. Its goal is the widespread implementation of a set of technical standards for software that will make it easier to publish distributed learning content and for people to use the content in multiple ways and on multiple learning systems. IMS develops the technology as a consortium and submits the specifications to the formal standards process of IEEE LTSC working groups.
- The **World Wide Web Consortium (W3C)** [http://www.w3c.org] has published the eXtended Mark-up Language (XML) which is a sub-set of SGML, intended primarily to allow metadata information to be embedded within web pages, allowing much more accurate search and retrieval of these resources. The Metadata activities within W3C also comprise the development of the Resource Description Framework (RDF), which is destined to support a wide range of applications over the web and the wider Internet, including search engine data collection (web crawling) and access to digital library collections.
- The **European Schoolnet, EUN** [http://www.en.eun.org], is developing a metadata implementation for their network that may influence decisions made

by national educational networks of member states. They have decided to use some elements of Dublin core as the basis for their metadata scheme.

- The **Virtual European School** [http://www.ves.eu.org/] has developed an implementation of a metadata model with Dublin Core.
- The **ARIADNE** project [http://www.ariadne.ac.uk] has produced a proposal for a metadata schema, based upon extensions to a Dublin Core structure, some of which are mandatory, other optional. This proposal has been aligned with the IMS Project's metadata format and submitted jointly to the IEEE, by whom it has been accepted as a base definition.

4. A PROTOTYPE METADATA MANAGEMENT SYSTEM

Athena [Koutoumanos 1999] is a prototype of a web-based learning environment engineered using modern software engineering practices such as object-oriented, component-based design, distributed functionality and open standards and technologies.

To administer the plethora of learning objects that Athena contains, a learning object metadata management system was engineered to implement the IEEE Learning Object Metadata (LOM) Draft Document 3.7. The reasons for selecting this tentative standard over other possible approaches (e.g. IMS Learning Resource Metadata Specification [http://www.imsproject.org/metadata]) were that the LOM is specialized in resources of instructional content, it is widely accepted by software and academic industry, and it is likely to become an international standard through ISO.

The metadata management system in the Athena learning environment is intended to be used primarily by authors of instructional content. Authors shall create, update and locate learning objects (e.g. an image, a book chapter), so as to *re-use* them in their own material. Re-use of content guarantees added value to the work of individuals. Furthermore learners and instructors may utilize the system in order to search, acquire and evaluate those learning objects that are of interest to them. Finally the sharing and exchange of learning objects between Athena and other learning environments can be achieved. The ability of trading learning objects between different systems can lead to a wealthy pool of such objects that can be easily located, evaluated and re-used [Quinn 2000].

The metadata management system provides the mechanisms to create, view and update metadata stored in a relational database via a web-based GUI, and facilitates a search engine for learning objects, that queries the database using metadata as searching criteria. The database where metadata are stored was designed according to the specifications of LOM. In order for the system to operate on the Web, it was implemented using the Java language, in particular with the use of Java applets and servlets. Figure 1 depicts a screenshot from the metadata insertion GUI.

The system has been tested using real-world learning objects that were derived from the content already embedded in the learning environment. The implementation test bed, i.e. the LOM instances, was of varied granularity, from single images to whole courses. The feedback from this preliminary use of the system dictated that the tool for insertion, update and view was quite user-friendly and straightforward and can claim full conformance to the LOM. The query

mechanism implemented so far, only facilitated the construction of simple queries but is quite fast and powerful in the presentation of results and is easily extensible to implement full queries.

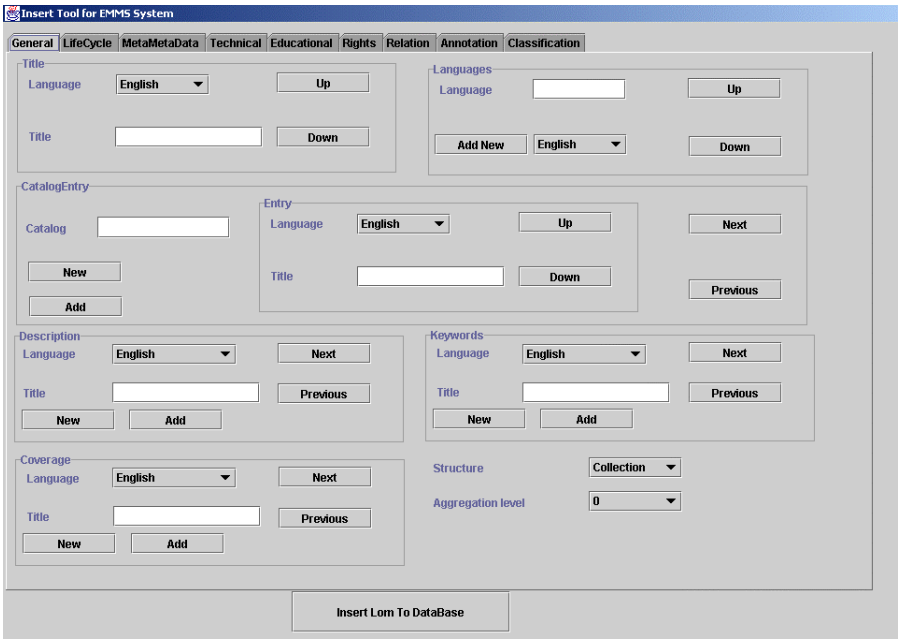

Figure 1 - The tool for the insertion of metadata

5. OPEN ISSUES

IEEE LTSC LOM is currently in version 4 and will continue to evolve through the IEEE special work group, until it becomes a final and complete standard. Except for the attempt to standardize a metadata model for learning resources there is also significant work taking place towards the standardization of an API for operating on learning object metadata databases, so as to achieve fully automated interoperability between different systems that utilize them. Finally there is ongoing work for standardizing the representation schema of the LOM using a cross-platform interoperable format such as XML documents. Examples of this are the IMS Learning Resource Metadata XML Binding Specification [http://www.imsproject.org/metadata/mdbind01.doc] and the Advanced Distributed Learning Initiative SCORM [http://www.adlnet.org/].

6. REFERENCES

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