E-Learning Standards: The Dawn Has Broken

Abdulmotaleb El Saddik
School of Information Technology and Engineering
University of Ottawa, Canada
elsaddik@site.uottawa.ca

Abstract

In today's Internet economy, achieving integration and interoperability in digital systems in general and learning systems in particular is increasingly important. Such integration is possible with open standards, which allow an e-learning system to exchange information with other system. Here a new breed of application frameworks and approaches seek to enable true interoperability of separate systems. This paper examines standardizing trends and enabling frameworks and applications-based on these standards for making true interoperability a reality.

1. Introduction

Rapid advancement in computer, communication, and presentation technology produces new forms of media and communications, which can be used to increase the quality of educational documents visualizing complex technical problems. To help students learn difficult concepts, interactive learning software needs specific capabilities for simulation, visualization, and real-time data collection, as well as tools for analyzing, modeling, and annotating data. Such interactive, dynamic representations are meanwhile the core content of educational learning modules. These representations have to be combined flexibly with many kinds of contexts: diverse classroom presentations, tutorials, experimentation notebooks, and standardized assessments. In order to achieve that goal, the standardization of so-called *Learning Objects* has become an important issue [1].

History shows that revolutionary changes do not take off without widespread adoption of common standards. For railroads, the standard gauge of the tracks; for music the CDs and stereos we play in them; and for the Internet, the common standards of TCP/IP, HTTP, and HTML. Common standards for learning architecture containing learning objects described with metadata are mandatory for similar success of the knowledge economy. Fortunately, the work to create such standards for learning objects and related standards has been going on around the world for the past few years. This includes the creation of accredited standards from Educom's Instructional Management System (IMS) [3], the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [4], the IEEE Learning Technology Standards Committee (LTSC) [2] for Learning Object Metadata, Computer Managed Instruction, Course Sequencing, Learner Profiles and much more.

2. Learning Object Metadata: What the standards are standardizing?

Learning object is defined as any entity, digital or non-digital, which can be used, reused or referenced during technology-supported learning [2]. Examples of learning objects include multimedia content, instructional content, instructional software, and software tools, referenced during technology supported learning. In a broader sense, learning objects could even include learning objectives, persons, organizations, or events. A learning object is not necessarily a digital object; however, since we are dealing with e-Learning, the remainder of this work will focus on learning objects that are stored in a digital format.

Application of Metadata

Metadata are "data about data", they are descriptive information about resources for the purpose of finding, managing, and using these more effectively. It can be seen as a system of labels whose purpose is to describe a resource or object's characteristics and its objectives.

Metadata are a way to describe information resources and contain data about their form and content. A resource is anything you make available to others. It may be a book in the library, a document, a video or music clip, a multimedia content, an instructional content, an instructional software and software tools no matter if it is physically available on the Internet or not.

Metadata are important because they form the single web that knits an information system together, tying system components and system software to the data so the data can be processed, stored, searched, retrieved, and distributed.

It should be noted that metadata are not only for educational purposes relevant. There exist a lot of engineering and other fields where metadata plays a major role. The origin of metadata may be found in the library world. Every book in a library is described by means of author, title, publisher, publication date, and abstract. In this case, the library cards contain the metadata on the books. If we are looking for a specific book, the library

cards have the information needed. One could say that metadata structures the information we need on a resource.
Metadata for learning content, has been under development within a number of international organizations over the past few years [6], [3], and [4]. The purpose of metadata is to provide a common means to describe things (electronically) so that "learning objects" (however they are defined) can be self defined, searched, and found. Metadata is also actively being developed in all aspects of Web-based content and commerce. Today, the Internet abounds with resources. Looking for a specific topic or resource, probably hundreds or thousands of resources will be found. Most of them do not meet the requirements at all. A search most commonly ends up with an enormous list of hits where the main part is not applicable. The advantages of using metadata in general are:

- to summarize the meaning of the data, i.e., what is the data about
- to allow users to search for data
- to allow users to determine if the data is what they want
- to prevent some users such as children from accessing data
- to retrieve and use a copy of the data, i.e., where do I go to get the data
- to instruct how to interpret the data like format, encoding, encryption

To providers or publishers metadata is interesting because it eases the discovery and access to their resources to reuse it (req. #1). Making a resource available to others is one thing. But what is the point if the resource cannot be discovered? Ensuring that users can locate the resources should have a high priority.
For the person searching for material metadata is quite helpful. It optimises the search situation by narrowing down the search result list to real applicable resources. The resources that are located will always be presented with minimum information such as creator, subject, type, format, and identifier. The metadata provider must enter this kind of information. If the resource meets the searcher requirements, the location of the resource will inform him as to where to obtain it.
We need the metadata to decide whether we would like to apply a certain resource; whether there are certain conditions involved with the usage; and whether there are certain technical requirements. Metadata can be stored separately from the resource, but it can also be stored together with the resource. Metadata on the Intemet, for instance has to be machine-readable and machine-understandable. Metadata stored separately from the resource can be located in a database. Metadata stored together with the resource can be placed, e.g., in the top of a document. There are several activities in progress to develop a tagging scheme for learning objects, including the Dublin Core (DC), the Instructional Management System (IMS) project, the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE), and the IEEE Learning Technology Standards Committee (LTSC) Learning Object Metadata Working Group 12 (LOM). More initiatives exist, but it is not within the scope of this work to present all initiatives, nor is it useful to involve them all. Some of the metadata standard initiative will be discussed next.

3. Metadata Standard Initiative

Dublin Core

The Dublin Core initiative was an early effort to standardize what the core tags for general information objects should be, and has been remarkably successful with regard to the fact that most standardization efforts of learning content start with Dublin Core. The Dublin Core is now separately investigating the special case of educational objects, somewhat independently of other ongoing work.
The Dublin Core set is not designed for multimedia objects or learning aspects. However, Dublin Core uses widely accepted semantics, which means that the element names are commonly understood. It is a very user-friendly metadata model as it is short and simple, and most important, it is flexible and extendable. The Dublin Core set consists of 15 elements. These elements are: Title, Creator, Subject, Description, Publisher, Contributor, Date, Type, Format, Identifier, Source, Language, Relation, Coverage, and Rights. The new Dublin Core sub-elements are: Date (metadata last modified), Date (resource last modified), Price, Requirements (software and hardware), and Size (physical size in bytes). The main characteristics of the Dublin Core that distinguish it as for description of electronic resources are:

- *Simplicity*: the Dublin Core is intended to be usable by experienced and non-experienced cataloguers. Most of the elements have a commonly understood semantics of roughly the complexity of a library catalogue card.
- *Semantic interoperability*: promoting a commonly understood set of descriptors that helps to unify other data content standards increases the possibility of semantic interoperability across disciplines.
- *International consensus*: recognition of the international scope of resource discovery on the Web is critical to the development of effective discovery infrastructure. The Dublin Core benefits from active participation and promotion in countries in North America, Europe, Australia, and Asia.
- *Flexibility*: although initially motivated by the need for author-generated resource description, the Dublin Core includes sufficient flexibility and extensibility to encode the structure and more elaborate semantics inherent in richer description standards.

Dublin Core is still having some model details refined, but compared to Instructional Management System and IEEE LOM Working Group, Dublin Core is further along in the development process than the others.

ARIADNE

The Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [4] is a resource and technology development project of the 4th Framework Program of the European Union. ARIADNE's primary goal is to foster the share and reuse of electronic pedagogical material, both by universities and corporations. It is not the intention to describe the human actors involved in the process of education and training. Neither is it the intention to define the representation format for the metadata sets. ARIADNE has two goals for the metadata work:

The indexing work carried out by humans should be as easy as possible.

Looking for relevant pedagogical material should be as easy and efficient as possible.

ARIADNE also requires that the metadata system works in a multilingual and multicultural environment. However, their solution to this problem is to make the system neutral to both the language of the original document and the language of the metadata. Their reason for this approach is that mechanisms ensuring multilingual interoperability are difficult to design and implement. ARIADNE is co-operating with IMS and IEEE-LOM in order to come out with standardized learning metadata. Both of these initiatives will be discussed next.

IMS

Instructional Management System (IMS) project [3] is supported by the Educom National Learning Infrastructure Initiative. The initial development occurred as a collaborative effort among educators, information science professionals, and technologists interested in creating a standard system for accessing on-line resources plus making it easier to learn via the Internet. IMS defines metadata as "descriptive information about learning resources for the purposes of finding, managing, and using these learning resources more effectively".

The IMS Project is developing and promoting open specifications for facilitating on-line activities such as locating and using educational content, tracking learner progress, reporting learning performance, and exchanging student records between administrative systems. With these specifications, IMS-Project wants to increase the range of distributed learning opportunities and to promote the creativity and productivity of both teachers and learners in this new environment. The goal of the IMS project is the wide spread adoption of specifications that will allow distributed learning environments and content from multiple authors to work together. The IMS technical specification provides general guidelines and requirements developers must write in order to create interoperable content and management systems.

The IMS has now begun the standardization process together with ARIADNE. The two projects have worked closely on a common metadata proposal for the Learning Object Metadata Working Group of IEEE described in the next section.

IEEE-LOM

The mission of IEEE Learning Technology Standards Committee (LTSC) [2] working groups 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. LTSC has been chartered by the IEEE Computer Society Standards Activity Board. Many of the standards developed by LTSC will be advanced as international standards by ISO/IEC JTC1/SC36 Information Technology for Learning, Education, and Training.

IEEE-LTSC P1484.12 Learning Object Metadata Working Group (LOM) tries to specify syntax and semantics of Learning Object metadata, defined as the attributes required to adequately describe a Learning Object. The Learning Object metadata standards focuses on the set of properties needed to allow these Learning Objects to be managed, located, and evaluated. The standard accommodates the ability for locally extending the basic properties as defined through data elements and entity types, and the properties can have a status of obligatory (must be present), optional (may be absent), conditional, or not allowed. Relevant properties of Learning Objects to be described include type of object, author, owner, terms of distribution, and format. Where applicable, Learning Object Metadata may also include pedagogical properties such as; teaching or interaction style, grade level, mastery level, and prerequisites. It is possible for any given Learning Object to have more than one Learning Object Metadata set.

IEEE's specification of Learning Object's Metadata (LOM) defines the following nine categories [Gro00] for metadata of a learning object, which will be described in detail because of their importance for the presented work:

- *General*: General Metadata, such as the title, language, structure, or description of a Learning Object (LO).
- *Life Cycle:* Status, version, and role of a LO.
- *Meta MetaData:* Metadata describing the metadata used for a LO.
- *Technical:* All technical information about a LO, such as the format, the length, browser requirements, etc.
- *Educational:* Information about the educational objective of a LO, such as interactivity, difficulty, end-user type, etc. (details see below).
- *Rights:* Commercial use and ownership of a LO.
- *Relation:* Implements a concept similar to hypermedia links to be able to refer to other LOs.
- *Annotation:* Used to provide additional, eventually more detailed information about a LO.
- *Classification:* Defines different purposes of a LO, together with its location within a taxonomy of keywords.

The standard supports security, privacy, commerce, and evaluation, but only to the extent that metadata fields will be provided for specifying descriptive tokens related to these areas; the standard will not concern itself with how these features are implemented. IEEE-LOM expects these standards will conform to, integrate with, or reference existing open standards and existing work in related areas.

GEM

The Gateway to Educational Materials (GEM), supported by he U.S. Department of Education, expands educators' capability to access Internet-based lesson plans, curriculum units and other educational materials [6]. GEM's goal is to improve the organization and accessibility of the substantial, but non catalogued, collections of materials that are already available on various federal, state, universities, non-profit, and commercial Internet sites. GEM has extended the Dublin Core with metadata to support the description of lessons, curriculum units and special educational resources.

Advanced Distributed Learning (ADL)

The work done by the US Federal Government ADL initiative and their recently released Shareable Courseware Object Reference Model (SCORM) provides one of the best and most recent examples of the application and integration of these learning standards [5]. These guidelines provide a foundation for how the Department of Defense will use learning technologies to build, and operate in, the learning environment of the future. The US military (be it Navy, Air Force, Army, or Marines) can all use, exchange, manage, track, and reuse all of their learning content and data no matter its source or application. Moreover, the Federal Government can choose multiple vendors, if they comply with the IEEE LTSC standards and the SCORM specifications, for various projects and know that all of the products and services will interoperate.

Aviation Industry CBT Committee (AICC)

AICC is an organisation, which has published a set of guidelines called AGR (the AICC Guidelines and Recommendations) [7]. This standard contains a lot of different recommendations, ranging from hardware (trackballs, video players etc.) to the way in which digital video should be presented, and which operating systems should be used when performing CBT (Computer Based Training, i.e. CD-Roms). AICC has issued documents concerning the interchange of data between "CMI" systems (Computer Managed Instructional systems), however they mainly provide a detailed description of the ways in which different DOS commands and ".bat" files should be executed. AICC have stated that they will adopt the IMS Meta-Data standard.

4. Projects Applying Metadata Standards

Multibook

Multibook is a web-based adaptive hypermedia learning system for multimedia and communication technology, focused on providing end-users with specific lessons tailored to a targeted group. These lessons are created using a knowledge base of multimedia elements, especially interactive animations. In Multibbok media elements (multimedia content) are atomic information units of various multimedia formats. These units described using the IEEE's Learning Object Metadata (LOM) scheme.

K-Med

K-Med, a joint project of the Medical Department of University Gießen (Germany) and the Department of Electrical Engineering and Information Technology at Darmstadt University of Technology (Germany) funded by the Hessian Ministry for Science and Arts (HMWK). The goal of the project is the enhancement of education in Medical Schools by means of a flexible system. The flexibility of the system aims at self-studying, independently from space and time. K-Med is a system, which provides tools for storing, managing and especially locating and combining learning resources. It offers means for both describing single sources (thereby putting them into a context) and combining single resources to courses. Thus K-Med represents a knowledge base with efficient access and tools to generate arbitrary coherent courses from single information units. In K-Med Learning Objects Metadata (LOM) are used for the description of information units. Using this widespread IEEE proposal for a standardized description of "learning objects" allow not only other systems to access K-Med resources but also simplify the integration of resources developed elsewhere.

Gestalt

Getting Educational Systems Talking Across Leading-Edge Technologies (GESTALT) is based upon the IEEE LOM. The emphasis in GESTALT is on resource discovery, learning environment and delivery designs. This entails tight-knit integration between the learning delivery and the central management of the institution, with reliable flow-through of data on student tracking etc. The GESTALT project is then coming at this problem from a systems perspective, the goal being to achieve organization-wide integration of existing and future systems within the institution and linking the promotion of on-line learning opportunities with the CORBA-based brokerage service. The broker would service queries from potential learners across a wide range of delivering organizations and a central value-added function of the broker is that it quality assures these offerings and the institutions behind them.

Prometeus

PROmoting Multimedia Access to Education and Training in EUropean Society (PROMETEUS) is another example of applying and integrating the IEEE LTSC and learning standards. Looking to apply not only the IEEE LTSC standards, the various Special Interest Groups (SIGs) of PROMETEUS work to integrate these into Europe context and cultures. Telematics, knowledge content, and multimedia-based tools are widely considered central ingredients for evolving new ways to provide learning and training. These factors are at the core of European Union research programs and are being addressed by a number of

EU projects for research, technological development, and demonstration (RTD).

L3

The objective of the Life Long Learning (L3) project is to develop and establish an innovative technical and organizational infrastructure for computer-supported life-long learning. In L3 small, medium and large companies, university departments and research organizations cooperate to set up an infrastructure consisting of a service center and several learning centers, which provide access to courses for life-long learners. Furthermore, methods and tools to run courses open to the general public are developed, and methods and organizational structures established to operate the service and learning centers efficiently.

The central component of the educational infrastructure is a multimedia content repository, which manages online educational content. The educational multimedia content consists of learning objects (text, audio, and video), which can be structured hierarchically in courses and lessons. The actual relationship between the learning objects is defined in a course structure, which is represented in XML. Metadata for the learning objects is represented in an XML notation of the LOM with appropriate document type definitions. Media objects are references out of the LOM metadata objects to physical media objects stored also in the multimedia repository.

Splash

SPLASH is part of the Portals for On-line Objects in Education (POOL) Consortium Project, funded in part by the Canarie Inc. eLearning Program and involving a number of Canadian research institutions and companies. Splash represents a peer to peer architecture for the storage, search, and retrieval of electronic objects. Its architecture is based on the IMS Learning Resource Meta-data Specification.

5. Conclusion

Learning standards are well on their way to becoming a reality proved by some research projects and some vendors are already incorporating the specifications on which they'll be based into their products. Just to conclude the benefits of the emerging e-learning standards are:

- Standardization will allow the use of instructional material in any management system.
- Standardization will enable the modularization of content (its breakdown into smaller learning objects) so that multimedia content can be reused in various customized courses.
- Standardization can help create a commercial infrastructure for the development, sale and distribution of learning material throughout the world.

Whether it is the creation of learning management systems and applications, or content libraries, accredited standards will reduce the risk of making large investments in learning technologies because systems will be able to work together like never before. Accredited standards assure that the investment in time and intellectual capital can move from one system to the next. When companies find their content trapped inside a proprietary format (such as a registration system, a courseware design, or a course sequencing model), the story is the same in each case. It is virtually impossible to reuse, transfer, or have interoperability between these proprietary models. This won't change until we build systems on an open accredited standard.

References

[1] Abdulmotaleb El Saddik, "Interactive Multimedia Learning" ISBN: 3-540-41930-6, Springer-Verlag (2001), 200 pages.

[2] IEEE Learning Technology Standards Committee (LTSC). http://ltsc.ieee.org/wg12. 2001.

[3] Educom's instructional management systems project (IMS). http:// www.imsproject.org. 2001.

[4] Alliance of Remote Instructional Authoring and Distribution Networks for Europe, ARIADNE. project of European Union. http://ariadne.unil.ch. 2001.

[5] Advanced Distributed Learning (ADL) Initiative doing their Sharable Courseware Object Reference Model (SCORM). http://www.adlnet.org. 2001.

[6] Gateway to Educational Materials (GEM). http://www.geminfo.org. 2001.

[7] Aviation Industry CBT Committee (AICC). http://www.aicc.org. 2001.

Project web sites:

[8] Multibook: http://www.multibook.de

[9] K-Med: http://www.k-med.org

[10] Getsalt: http://www.fdgroup.com/gestalt/metadata.html

[11] Prometeus: http://prometeus.org/

[12] L3 - Live Long Learning: http://www.l-3.de/

[13] Splash: http://www.edusplash.net