Developing Learning Objects Systems through implementation of Learning Object Metadata Standard

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Summary

Learning Objects are digital resources used to support learning. They are modular in nature, and can include everything in digital format: text, Web, tutorials, multimedia, video, sounds, pictures, animations etc. Developing and hosting Learning Objects Repository as a Learning Objects Systems is daunting because of the size and complexity of the operation. To customize and enhance modules in these systems successfully, Learning Objects must have and keep several attributes: portability, accessibility, durability and interoperability. To achieve these goals, each object must be tagged with metadata of information about it object. IEEE recently approved the Learning Object Metadata (LOM) standard. LOM standard defines a structure for interoperable descriptions of Learning Objects.

Keywords: Learning Objects, Learning Object Metadata, Learning Object Repository, Learning Content Management, Reusability, Education, e-learning

1. INTRODUCTION

The Internet is changing the way people work, communicate, interact, undertake business transactions, find information, and the way they teach and learn. With the growing number of organizations moving their training and education programs into the web environment, there is an increasing demand on high-quality, reusable components – Learning Objects (LO). The demand comes from the realization that the development of high-quality Learning Objects is resource intensive and time consuming. There is a wealth of content available in public and private organizations but either it is not accessible to external users or it is difficult to find. For this reason there is a need to build Learning Object Systems based on Learning Object Repositories (LOR) aim at

establishing infrastructure for collections of high quality Learning Objects. Another issue being addressed at the same time is the development of standards for describimg Learning Objects to enable and keep several attributes: portability, accessibility, durability and interoperability. To achieve these goals, each object must be tagged with metadata of information about it object. IEEE recently approved the Learning Object Metadata (LOM) standard. LOM standard defines a structure for interoperable descriptions of Learning Objects.

In this paper basic idea of Learning Objects, Learning Objects System and structure of Learning Objects Metadata are described. In the next section we provide a description of the Learning Objects concept. The third section presents the Learning Object Systems and Learning Objects Repository. The description and structure of the Learning Object Metadata (LOM) standard are given in the section 4. Section 5 concludes the paper.

2. LEARNING OBJECTS

As practice is evolving, a number of different definitions for Learning Objects have emerged.

Definition given by IEEE LTSC (Learning Technology Standards Committee) is:

- Learning Object is defined as any entity, digital or non-digital, that can be used for learning, education or training.

Albert Ip, Alison Young and Iain Morrison define Learning Object as:

- A computer mediated or delivered module or unit, that stands by itself, that provides a meaningful learning experience in a planed learning context.

Most alternative interpretation is given by Stephen Downes:

- Learning object must be, at least, a digital resource. It must contain pedagogical intent. And finally, that what makes something a Learning Object is not what it is, but rather, how it is used.

We use David Wiley's definition.

- Learning Object presents any digital resource that can be reused to support learning.

According to this definition Learning Objects are digital resources, modular in nature, that are used to support learning. They can vary in size, scope and level of granularity. Because the focus of Learning Objects research and development has been on maximizing reusability, Learning Objects are generally understood as digital resources. (Most non-digital resources, known as "rival resources", cannot be used by more people at a time). Digital resources available on a computer network or on Internet can be used simultaneously by many people ("non-rival resources"). Example: book from the library can be checked only by one person, another person cannot use it; but, file available on a website can be used by many people at one moment. Being digital resources, Learning objects can include, but are not limited to simulations, animations, text, Websites, tutorials, quizzes, multimedia, video clips, sounds, pictures, illustrations, diagrams, graphs, maps, charts and assessments.

All that digital resources are vast collection of data, bits and bytes of information. Therefore, a clear distinction should be made between data, an information object and Learning Object. Data are stored in databases and have meaning in relation with other data in the database. An information object is a digital resource that does not include instructions (example: short video clip without information about who developed it, how to use it, what is shown, why it is shown, what does it outcome, assessments etc.). Information objects are usually stored in digital libraries.

Learning Objects often are confused with information objects. True Learning Objects include learning objectives and outcomes, assessments, and other instructional components. Most Learning Object Repositories and digital libraries contain a mix of Information and Learning Objects. In fact, there is no clear distinction that separates the two.

Visual metaphors help to illustrate the relationship between Learning Objects and the instructional context. Formerly, LO was compare to the versatile children toy: LEGO blocks. LEGOs can be assembled into imaginative wholes by anyone. LEGOs are portable, sharable, durable, and interoperable. They are standardized. But, this is "dangerous" simplistic comparison (Wiley, 1999). He proposed the more sophisticated metaphor of the atom. Unlike LEGOs, not every atom is combinable with every other atom. Assembly requires expertise and design strategy – to make sense. He told about something like "learning crystal" in which individual Learning Objects are combined into useful structure.

What constitutes a Learning Object? What is the acceptable size and scope of the Learning Objects? Those are the questions critical to creating a usable, scalable database (repository) of objects. Instructional designers have to build small instructional components that can be used a number of times in different context. According that LO are self-contained learning components, and they are stored and accessed independently LO can be re-assembled to create new courses to form individual learning paths. To success this idea, "the size of a Learning Object are defined as a meaningful division of learning that can be accomplished in one sitting" (Mow, 2002).

3. LEARNING OBJECT SYSTEMS

A Learning Object Repository (LOR) is an electronic/digital catalogue that facilitates searches for digital Learning Objects (LO) on the Internet. There are thousands of web sites that contain thousands of digital LO. An LOR simplifies the search for LO, using a common semantic metadata, an LOR catalogues them (digital Learning Objects) by subject, author, title, grade level, language, etc. Using the LOR, a seeker of digital learning content can tailor searches to suit learners or teachers needs.

Technically, a Learning Objects Repository is a database that contains digital learning content. It should not be confused with a Learning Management System. The LOR is one component in a complex network and should be understood in that context.

The technical aspects of developing and hosting a Learning Object Repository as a Learning Objects Systems (LOS) can be expensive and daunting because of the size and complexity of the operation. Like an enterprise-wide data warehouse project, the infrastructure to support a repository is composed of clusters of powerful workstations

capable of providing fast network connectivity and high-end database management operations. For the time being, there is not an off-the-shelf, end-to-end solution available for the educational market. Most repositories run on homegrown or proprietary applications. Simplified schema of the LOS is given below. There are four main parts:

- Learning Objects Repository (LOR),
- Interface supported by Learning Objects Metadata Standard,
- Content Generation System (CGS) and
- Learning Management System (LMS).

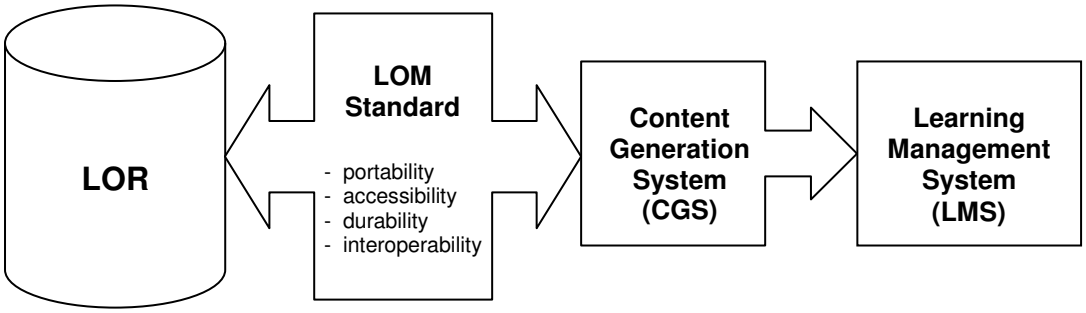

Fig.1 Simplified Schema of LOS

To customize and enhance modules in these LOS successfully, Learning Objects must have and keep several attributes: portability, accessibility, durability and interoperability. To achieve these goals, each object must be tagged with metadata of information about its object. IEEE recently approved the Learning Object Metadata (LOM) standard. LOM standard defines a structure for interoperable descriptions of Learning Objects.

4. LEARNING OBJECT METADATA STANDARD

Because many Learning Objects are non-textual (animations, pictures, video clips, audio) Locating Learning Objects within a digital library can be a daunting task without help of metadata. Metadata is information about an object, whether it is physical or digital. As the number of objects grows exponentially the lack of information or metadata about objects places a critical and fundamental constraint on ability to found, discover, manage and use objects.

Standard for Learning Object Metadata (LOM) addresses this problem by defining structure for interoperable description of Learning Objects. IEEE Learning Technology Standards Committee defines this Standard as a multi-part standard that specifies LOM. We are looking over the Part of Standard that specifies a conceptual data schema that

defines the structure of metadata instance for Learning Object. A metadata for Learning Object describes relevant characteristics of the Learning Object to which it applies. Such characteristics are grouped in these categories: general, life-cycle, meta-metadata, educational, technical, rights, relation, annotation, and classification.

Data elements which compose a metadata instance for Learning Object are given by the conceptual data schema.

Standard for Learning Object Metadata (LOM) does not define how a learning technology system represents or uses a metadata instance for a Learning Object. The purpose of this standard is to facilitate search, evaluation, acquisition, and use of Learning Objects, for instance by learners or instructors or other automated software processes. This multi-part Standard also addresses the possibilities for sharing and exchange of Learning Objects. It is performed by enabling the development of catalogues and inventories while taking into account the diversity of cultural and lingual contexts in which the Learning Objects and their metadata are reused.

4.1. Overview of the Metadata Structure

Data elements describe a Learning Object and are grouped into categories. The LOMv1.0 **Basic Metadata Structure** are given in Base Schema that consist nine such categories:

a) The ***General*** category, groups the general information that describes the Learning Object as a whole.
b) The ***Lifecycle*** category, groups the features related to the history and current state of this Learning Object and those who have affected this Learning Object during its evolution.
c) The ***Meta-Metadata*** category, groups information about the metadata instance itself (rather than the Learning Object that the metadata instance describes).
d) The ***Technical*** category groups the technical requirements and technical characteristics of the Learning Object.
e) The ***Educational*** category groups the educational and pedagogy characteristics of the Learning Object.
f) The ***Rights*** category groups the intellectual property rights and conditions of use for Learning Object.
g) The ***Relation*** category groups features that define the relationship between the Learning Object.
h) The ***Annotation*** category provides comments on the educational use of the Learning Object and provides information on when and by whom the comments were created.
i) The ***Classification*** category describes this Learning Object in relation to a particular classification system.

These categories group **Data Elements**. The LOM data model is a hierarchy of data elements, including aggregate data elements and simple data elements (leaf nodes of the hierarchy). Aggregates in the LOMv1.0 Base Schema do not have individual values. Consequently, they have no value space or datatype. For each data element, the LOMv1.0 Base Schema defines:

- *name:* the name by which the data element is referenced;
- *explanation:* the definition of the data element;
- *size:* the number of values allowed;
- *order:* whether the order of the values is significant;

- *example*: an illustrative example.

In the LOMv1.0 Base Schema, only simple data elements (leaf nodes) have individual values defined through their associated value space and datatype. For simple data elements, the LOMv1.0 Base Schema also defines:

- *value space:* the set of allowed values for the data element – typically in the form of a vocabulary or a reference to another standard;
- *datatype:* indicates whether the values are LangString, DateTime, Duration, Vocabulary, CharacterString or Undefined.

In some instances, a data element contains a ***list of values***, rather than a single value. This list can be:

- *ordered:* the order of the values in the list is significant. For example, in a list of authors of a publication, the first author is often considered the more important one. As another example, in a hierarchical classification structure, the order is from more general to more specific.
- *unordered:* the order of the values in the list bears no meaning. For example, if the description of a simulation includes three short texts that describe the intended educational use in three different languages, then the order of these texts is not significant. They may appear in any order without loss of information.

For some data elements *Vocabularies* are defined. A vocabulary is a recommended list of appropriate values. Other values, not present in the list, may be used as well. However, metadata that rely on the recommended values will have the highest degree of semantic interoperability.

In the LOMv1.0 Base Schema (clause 6), *smallest permitted maximum values* are defined for aggregate data elements and data elements with datatype CharacterString or LangString.

5. CONCLUSION

Learning Objects support reusability. They can be created and stored in Learning Objects Repository. Using a common semantic metadata enables a simpler and easier way to search for Learning Objects. Thus the user of LOR can adapt his needs to the contents as well as to the learners and to teachers. The four attributes mentioned above (portability, accessibility, durability and interoperability) have to be obtained and sustained. To achieve these goals, each object must be tagged with metadata of information. IEEE recently approved the Final Draft Standard for Learning Object Metadata (LOM). This standard gives a progressive stage for further development of Learning Objects Systems.

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