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AUTHOR	Holzinger, Andreas; Kleinberger, Thomas; Muller, Paul
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ABSTRACT

One of the "hottest" topics in recent information systems and computer science is metadata. Learning Object Metadata (LOM) appears to be a very powerful mechanism for representing metadata, because of the great variety of LOM Objects. This is on of the reasons why the LOM standard is repeatedly cited in projects in the field of eLearning Systems. This multimedia learning related technology could enhance conventional learning systems. Some applications have many possibilities to interpret and use the information of the LOM base schema. One of the disadvantages of the very complex metadata structure is the fact that it is difficult or confusing to determine the relevant elements for a satisfying result. Therefore, a learning system based on the LOM standard is expected to provide an intuitive user interface that supports the user in getting good results. This article describes why metadata is needed, discusses the development from Dublin Core, Gateway to Educational Materials (GEM), and Warwick-Framework to the IEEE LOM, and presents four examples of successfully implemented systems. (Contains a list of 11 Internet resources and 19 references.) (Author/AEF)

Multimedia Learning Systems based on IEEE Learning Object Metadata (LOM)

Dr. Andreas HOLZINGER, PhD, MSc, MPh, BEng, DipEd
Institute of Medical Informatics, Statistics and Documentation (IMI)
Graz University, Austria
andreas.holzinger@kfunigraz.ac.at
http://www-ang.kfunigraz.ac.at/~holzinge

Thomas Kleinberger, MCS
Content Management Systems Division
tecmath AG
Kaiserslautern, Germany
kleinberger@cms.tecmath.com

Prof. Dr. Paul Müller, PhD
Department of Computer Science
University of Kaiserslautern, Germany
pmueller@rhrk.uni-kl.de

Abstract: One of the hottest topics in recent information systems and computer science is metadata. Learning Object Metadata (LOM) seems to be a very powerful mechanism to represent metadata, because of the great variety of LOM Objects. This is one of the reason why the LOM Standard is cited in a lot of projects in the field of eLearning Systems. We came to the conclusion that this multi media learning (MML) related technology could enhance conventional learning systems. Some applications have many possibilities to interpret and use the information of the Learning Object Metadata base schema. One of the disadvantages of the very complex metadata-structure is the fact, that it is going to be difficult or confusing to determine the relevant elements for a satisfying result. Therefore a Learning System based on the LOM standard is expected to provide an intuitive user interface that supports the user in getting good results. This article describes why metadata is needed, discusses the development from Dublin Core, Gateway to Educational Materials (GEM) and Warwick-Framework to the IEEE LOM and presents four examples of successful implemented systems.

1. Introduction

1.1. What is metadata?

Metadata is commonly described as being "Data about data", which provides a means by which the multimedia's semantics can be described in a structured fashion for use by various applications. More technically Metadata is standardized information to describe digital information resources (cf. Dorner, 2000). Metadata created only for use by a single application goes against Searchability, Extensibility, Reusability and Scalability. Required is a standard that everyone conforms to for the exchange and use of media. But even this may not be enough, especially for interoperability issues e.g. spoken language independency.

1.2. Why is educational metadata needed?

Traditional search techniques are user-directed, manual and often time-consuming tasks. The reason for creating metadata, from the perspective of the provider of learning material, is to improve the possibilities of document retrieval (especially the search precision) as well as to support control and management of collections. But there is still another problem remaining: Digital documents with their abundance of different formats and control measures might not always be usable directly by everyone. The format might be unreadable, the content can be encrypted, even prohibited or only permitted after payment. The document might be large, difficult or time consuming to access etc. Especially if multimedia documents are used in education like audio and video, metadata is extremely helpful in managing the multimedia learning content. A solution for all those cases could be metadata which supports the users decision process. Such metadata, necessary to describe educational material homogenous, could be e.g. language, title, catalogue numbers, date, format etc, and in the case of audio and video a time-based documentation of the audio/video image content on a layered basis depending on the documentation focus.

As these multimedia objects typically get larger and larger, a manual metadata documentation becomes very expensive and is not practical anymore. In these cases content management systems (CMS) can support automatic extraction of metadata with audio/video analysis processes that e.g. separate clips into scenes or extract relevant key-frames (cf. Kleinberger, Schrepfer, Holzinger, Müller 2000).

1.3. Why are standards needed?

Metadata is information about an object and as the number of objects increases, the lack of information or metadata about objects has produced a critical and fundamental constraint on our ability to discover, manage and use objects. Only standards might address this problem by defining a structure for interoperable descriptions of learning objects. According to Wantz & Miller (1998) there are four remarkable efforts concerning education via the Web:

1.4. Dublin Core

Emerging from the field of digital cataloguing the Dublin Core defines a small, core set of metadata attributes for describing features of generic Web resources [W01, W02]. This core set of metadata is given in the following XML-notation which can be a possible physical representation of the Dublin Core metadata attributes:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:dc = "http://purl.org/dc/elements/1.1/">
 <rdf:Description about="http://purl.org/dc/about/index.htm">
  <dc:title>Dublin Core Metadata Initiative - About the Organization and Process</dc:title>
  <dc:description>A description of the Dublin Core Metadata Initiative process.</dc:description>
  <dc:date>1999-04-06</dc:date>
  <dc:format>text/html</dc:format>
  <dc:language>en</dc:language>
  <dc:contributor>The Dublin Core Metadata Initiative</dc:contributor>
 </rdf:Description>
</rdf:RDF>
```

Forsberg & Dannstedt (2000) encountered problems when applying Dublin Core due to the fact that these problems are a consequence of trying to describe information resources without taking into account the context in which the learners create and consume information.

1.5. Gateway to Educational Materials (GEM)

The GEM-Project, as a project of U.S. Department of Education and the Educational Resources Information Center on Information Technology (ERIC/IT), has extended the Dublin Core with metadata to support the description of lessons, curriculum units and special educational resources [W03]. The Dublin Core Element Set (DC) became the base referent for GEM elements. The following GEM metadata example from Sutton (1998) shows the integration of scheme and type information in HTML 4.0 meta tags:

```
<META NAME="DC.subject.levelOne.1" SCHEME="GEM" CONTENT="Science">
<META NAME="DC.subject.levelTwo.1" SCHEME="GEM" CONTENT="Biological sciences">
<META NAME="DC.subject.levelTwo.1" SCHEME=/GEM" CONTENT="Life sciences">
<META NAME="DC.subject.levelTwo.1" SCHEME="GEM" CONTENT="Technology">
```

1.6. Warwick-Framework

Based on the Warwick Workshop 1996 in the UK, the so called Warwick-Framework provides an architecture for the interchange of distinct metadata packages and allows to combine good extensibility to provide elaborated schemes to certain communities with a simple interoperable Dublin Core description of form and content of the objects. Feature overkill is avoided. It provides the possibility to describe either on an item or on a collection level. The Dublin Core could be a good incentive to authors and publishers to deliver a minimum of metadata with their documents [W04], (cf. Lagoze et.al, 1996).

1.7. IEEE Learning Object Metadata (LOM)

The IEEE Learning Technology Standards Committee (LTSC, [W05]) working group IEEE P1484.12 (Learning Object Metadata Working Group, Chair: Wayne Hodgins) has developed a standard conceptual model.

The IEEE conceptual model for meta-data definitions is a hierarchy (see fig.1). At the top of this hierarchy is the so called "root" element. This root element contains many sub-elements. If a sub-element itself contains additional sub-elements it is called a "branch." Sub-elements that do not contain any sub-elements are called "leaves." This entire hierarchical model is called the "tree structure" of a document [W06].

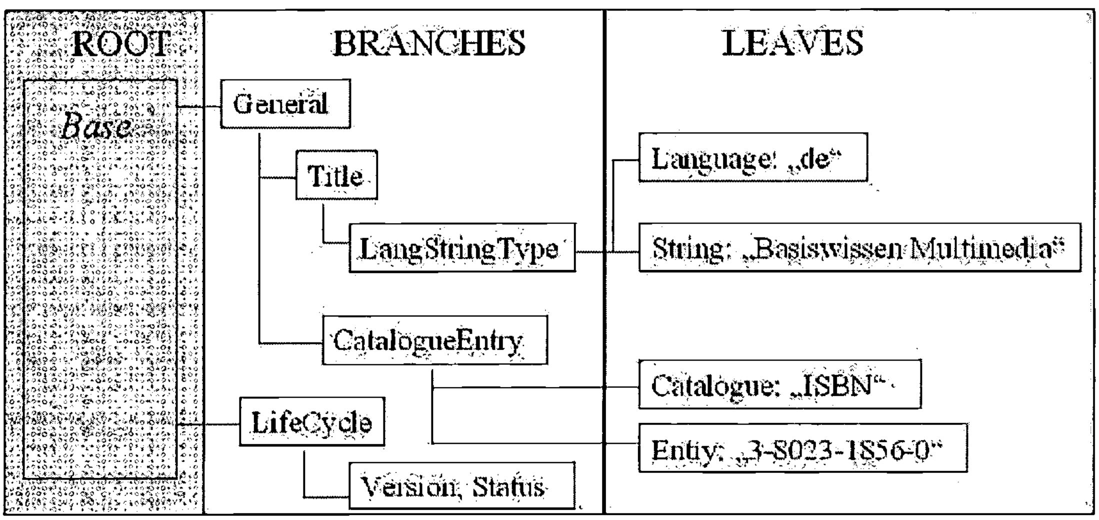

Fig.1: The IEEE LOM Hierarchy

2. LOM – Scope, purpose and working draft

2.1. Scope

This proposed standard will specify the syntax and semantics of Learning Object Metadata, defined as attributes required to fully/adequately describe a Learning Object. Learning Objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology supported learning include computer-based training (CBT), web-based training (WBT), or intelligent computer-aided instruction systems in Medicine (cf. Holzinger et.al., 2000). Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning.

The Learning Object Metadata standards will focus on the minimal set of attributes needed to allow these Learning Objects to be managed, located, and evaluated. The standards will accommodate the ability for locally extending the basic fields and entity types, and the fields can have a status of obligatory (must be present) or optional (may be absent). Relevant attributes 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 attributes 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 set of Learning Object Metadata. The proposed standard will support 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. The working group is expecting that these standards will conform to, integrate with, or reference existing open standards and existing work in related areas. For example core attributes of Learning Objects will be coordinated with or may simply defer to the efforts to standardize content objects in general [W07].

2.2. Purposes

According to the WG the main purposes of the LOM are to enable [W06]:
learners/teachers to search, evaluate, acquire, and utilize Learning Objects,
the sharing and exchange of Learning Objects across any technology supported learning system,
the development of learning objects in units that can be combined and decomposed in meaningful ways,
computer agents to automatically and dynamically compose personalized lessons for an individual learner,
education, training and learning organizations, both government, public and private, to express educational content and performance standards in a standardized format that is independent of the content itself,
a strong and growing economy for Learning Objects that supports and sustains all forms of distribution; non-profit, not-for-profit and for profit,
the documentation and recognition of the completion of existing or new learning & performance objectives associated with Learning Objects.
and least but not last to compliment the direct work on standards that are focused on enabling multiple Learning Objects to work together within a open distributed learning environment.

To provide researchers with standards that support the collection and sharing of comparable data concerning the applicability and effectiveness of Learning Objects. To define a standard that is simple yet extensible to multiple domains and jurisdictions so as to be most easily and broadly adopted and applied. To support necessary security and authentication for the distribution and use of Learning Objects.

3. Examples of LOM-based Systems

3.1. ABITS - An Agent Based Intelligent Tutoring System for Distance Learning

ABITS (An Agent Based Intelligent Tutoring System for Distance Learning) is an Intelligent Tutoring Framework highly re-usable and suitable to several knowledge domains, and has been realized in the context of the InTraSys ESPRIT project. It is able to support a Web-based Course Delivery Platform with a set of "intelligent" functions providing both student modeling and automatic curriculum generation. Such functions found their effectiveness on a set of rules for knowledge indexing based on Metadata and Conceptual Graphs following the IEEE Learning Object Metadata (LOM) standard. Moreover, in order to ensure the maximal flexibility, ABITS is organized as a Multi Agent System (MAS) composed by pools of three different kind of agents (evaluation, pedagogical and affective agents). Each agent is able to solve in autonomous way a specific task and they work together in order to improve the WBT learning effectiveness adapting the didactic materials to user skills and preferences [W08]

3.2. GESTALT (Getting Educational Systems Talking Across Leading-Edge Technologies)

For GESTALT (Getting Educational Systems Talking Across Leading-Edge Technologies), the emphasis is on delivery of learning within a managed process as part of the core business of the educational or training organization. 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. As can be seen from the above descriptions, these two projects have a very different view

of the role of on-line learning, but nevertheless they have co-operated (along with IMS and others) on the definition of the IEEE Learning Object Metadata. It is hoped that this will strengthen the LOM specification, enabling it to meet a wide set of requirements across user communities.
Other areas of development within GESTALT have included a European-focused implementation of the IEEE Public & Private Information (PAPI) specification from the Learner Model Working Group and the definition of a Unit Object Model for describing student progress between the Learning Environment and the Administration MIS. Aligning European R&D activity with the wider standards formation work has had clear benefits in terms of developing a common language for describing systems, components and functionality and generally encouraging the cross-fertilization of ideas around the globe [W09].

3.3. ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe)

The ARIADNE Project has been active both within the IEEE LTSC and in the formation of the Learning Technology Working Group under CEN/ISSS. The project Manager, Eddy Forte, is also the chair of the PROMETHEUS forum. The European Commission (DG III, DG XIII) and CEN have been instrumental in the formation of PROMETHEUS, a forum for exchanging ideas and driving consensus amongst actors in this area within Europe. In the international arena, ARIADNE has been a major contributor to the IEEE LOM work. The actual project has developed a range of tools for the delivery and support of on-line learning which are made available free-of-charge to the ARIADNE user community. Many both within and external to the project have authored content which is described using metadata and made available to tutors via the ARIADNE Knowledge Pool Sites. The ARIADNE distribution model seems based on co-operation between, and free access for, the academic community who will develop their own content and tools which will be freely exchanged. As such, the system model is very flexible as tutors simply select the tools they.wish to use [W10].

3.4. The L3 project

The L3 project (L3 stands for Life Long Learning, cf. [W11]) is a project founded by the German government with the goal to create a technical and organizational infrastructure for a lifelong further education. The solution approach emphasizes two different points: On the one hand the creation of an educational infrastructure which uses new media efficiently and can be used by all interested people, independently of there education or social position. On the other hand the development of organizational structured and economic business models with which the developed infrastructure can be operated at a medium term.

The central component of the educational infrastructure is a multimedia repository (cf. Kleinberger, Holzinger 2001) which manages online educational content, especially multimedia content like audio and video. The educational multimedia content consists of learning objects 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 definition 2.2 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.

Because the multimedia repository is designed in layered building blocks with different services for its functions, it can easily be embedded in educational environments like the lifelong learning environment build up in decentralized service centers and learning centers

4. Conclusion

There are some standardization initiatives for metadata in teaching and learning objects. Learning Object Metadata (LOM) seems to be the most powerful and most extensive mechanism to represent metadata, because of the great variety of the LOM Objects. There are some implementations which are using LOM already, but we weren't able to find an implemented System based on the LOM standard which contains an intuitive user interface for the definition and search for metadata. The other side of the very complex metadata-structure is the fact, that it is going to be difficult or confusing to determine the relevant elements for a satisfying result. Of course the decision to remove some of the Objects would be a difficult one, because of the danger to loose the functionality and flexibility of the current model. Exactly this seems to be the biggest advantage of LOM due to it's hierarchical and extensible approach.

5. Links

[W01] http://purl.oclc.org/dc (Dublin Core Metadata Initiative, last visited 26th March 2001)
[W02] http://purl.org/DC/index.htm.rdf (Dublin Core Metadata for [W1])
[W03] http://geminfo.org (Gateway to Educational Materials: GEM, last visited 24th Oct. 2000)
[W04] http://www.lub.lu.se/tk/warwick.html (Warwick framework and Dublin core set provide a comprehensive infrastructure for network resource description, last visited 24th Oct. 2000)
[W05] http://ltsc.ieee.org (IEEE Learning Technology Standards Committee (LTSC), Chair: James R. Schoening, last visited 23th Oct. 2000)
[W06] http://ltsc.ieee.org/wg12/index.html (WG IEEE P1484.12/D4.0, Chair: Wayne Hodkins, last visited 23 Oct.2000)
[W07] http://ltsc.ieee.org/doc/wg12/LOM_WD4.htm5 (February 2000, Draft Standard for LOM, last visited 23th Oct 2000)
[W08] http://virtcampus.cl-ki.uni-osnabrueck.de/its-2000/paper/capuano/ws2-paper-3.htm (ABITS: An Agent Based Intelligent Tutoring System for Distance Learning, Nicola Capuano, Marco Marsella, Saverio Salerno, ITS 2000 Workshop)
[W09] http://www.fdgroup.co.uk/gestalt/metadata.html (Getting Educational Systems Talking Across Leading-Edge Technologies, GESTALT, last visited 10.7.00
[W10] http://ariadne.unil.ch/ (last visited 24th Oct 2000)
[W11] http://www.l-3.de L3: Lifelong Learning – Education as a basic need, Leitprojekt des Bundesministeriums für Bildung und Forschung zum Themenfeld „Nutzung des weltweit verfügbaren Wissens für Aus- und Weiterbildungsprozesse".

6. References

Chander, P.G.; Shinghal, R.; Desai, B.C.; Radhakrishnan, T. (1997): An Expert System to Aid Cataloging and Searching Electronic Documents on Digital Libraries. *Expert Systems with Applications,* 12, 405-416.
Dorner, Dan (2000): Cataloging in the 21st century — part 2: digitization and information standards. *Library Collections, Acquisitions & Technical Services,* 24, 73–87.
Forsberg, Kerstin; Dannstedt, Lars (2000): Extensible use of RDF in a business context. *Computer Networks,* 33, 347-364.
Giladia, Ran; Glezer, Chanan; Melamoud, Nir; Ein-Dor, Phillip; Etzion, Opher (2000): The metaknowledge-based intelligent routing system (MIRS), *Data & Knowledge Engineering,* 34, 189-217.
Gupta, Amarnath; Baru, Chaitanya (1999): An extensible information model for shared scientific data collections. *Future Generation Computer Systems,* 16, 9–20.
Helly, John J.; Elvins, T. Todd; Sutton, Don; Martinez, David (1999): A method for interoperable digital libraries and data repositories, *Future Generation Computer Systems,* 16, 21–28.
Holzinger, A.; Kainz, A.; Gell, G.; Brunold, M.; Maurer, H. (2000): Interactive Computer Assisted Formulation of Retrieval Requests for a Medical Information System using an Intelligent Tutoring System. *Proceedings of ED-MEDIA 2000,* Charlottesville (VA): AACE, 431-436.
Holzinger, Andreas (2000): Basiswissen Multimedia, Band 1: Technik, Technologische Grundlagen multimedialer Informationssysteme. Würzburg: Vogel.
Hunter, Jane; Armstrong, Liz (1999): A comparison of schemas for video metadata representation. *Computer Networks,* 31, 1431–1451.
Kleinberger, Thomas; Müller, Paul (2000): Content Management in Web Based Education. *Webnet 2000 Conference on the WWW and Internet*, San Antonio, Texas, USA, October 30 - November 4, 2000
Kleinberger, Thomas; Schrepfer Lutz; Holzinger Andreas; Müller Paul (2001): A Multimedia Repository for Online Educational Content. *ED-MEDIA 2001 World Conference on Educational Multimedia*, Hypermedia and Telecommunications, Tampere, Finnland, June 25-30, 2001
Kirklin, John, W.; Vicinanza, Steven S. (1999): Metadata and Computer-Based Patient Records, *Annual Thorac Surgery*, 68, 23-24.
Lagoze C.; Lynch C.A.; Daniel R. Jr. (1996): The Warwick framework: a container architecture for aggregating sets of metadata. *Cornell University Computer Science Technical Report*, TR96-1593. June 1996. On-Line at: http://cs-tr.cs.cornell.edu/Dienst/UI/2.0/Describe/ncstrl.cornell/TR96-1593.
Marchiori, Massimo (1998): The limits of Web metadata, and beyond. *Computer Networks and ISDN-Systems,* 30, 1-9.
Martin, Phillipe; Eklund, Peter (1999): Embedding knowledge in Web documents. *Computer Networks*, 31, 1403–1419.
Schoening, James R. (1998): Education reform and its needs for technical standards. *Computer Standards & Interfaces,* 20, 1998, 159–164.
Sutton, Stuart A. (1998): Gateway to Educational Materials (GEM): metadata for networked information discovery and retrieval. *Computer Networks and ISDN Systems,* 30, 691-693.
Wantz, Jay L.; Miller, Michael (1998): Educational Metadata in use. *Computer Networks and ISDN Systems,* 30, 701-703.

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