AN EVALUATION OF E-LEARNING STANDARDS

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Abstract

The aim of this investigation is to perform an independent study of the various emerging e-learning standards. This paper presents a summary of these standards in order to make them more accessible and understandable, and provide preliminary evidence as to their utility and adoption by the various UK higher and further education institutions. Recently there have been efforts to define standards for the e-learning contents and e-learning components like the IEEELOM, UKLOM, IMS, SCORM and OKI. Since it was not possible to cover all the standards in detail within the time available, so our independent study focuses on eight standards Although the results of the preliminary study suggest that the eight standards considered in the study may help interoperability, accessibility and reusability of the e-learning content and e-learning components, but it is yet to be seen how many of these are actually followed at UK higher education institutions.

Keywords: elearning (e-learning), metadata, standards, learning objects, OKI.

1.Introduction

The purpose of this paper is making e-learning standards more accessible and understandable. Whilst there has been interest in deploying ICT to support and enhance learning environments for a number of years results to date have been limited. Two of the reasons for this is the lack of standards for defining the contents for e-learning, which makes it difficult to reuse the e-learning contents within various departments of an institution or within different institutions and the lack of standards for defining the interfaces for the various components of the e-learning system, which makes it difficult to reuse the existing implementations of the components while dev[1]eloping a new e-learning system. However, recently there have been efforts to define standards for the e-learning contents and e-learning components like the IEEELOM, UKLOM, IMS specifications and SCORM, which basically define the specifications for the e-learning contents in order to make them reusable and interoperable, and the OKI standards which basically aim to make the various components of an e-learning system reusable. This paper is an attempt to guide and refine these standards. In this paper, we present a summary of the eight emerging e-learning standards in order to make them more accessible and understandable. We also present a set of recommendations, which we consider would hopefully help in refining the standards.

2.Methodology

This study mainly focuses on the eight emerging e-learning standards namely IEEE and UK LOM Standards, IMS Content Packaging, Simple Sequencing, Question And Test Interoperability, Learner Information Package Standards, Sharable Courseware Object Reference Model Standards, Open Knowledge Initiative Standards. The reason for choosing these standards for the study is that in our opinion are the most influential in the e-learning. To carry out this study, we have used the published documentation provided by the bodies that makes these standards which are IEEE (IEEELTSC), IMS (IMSQTI), ADL (SCORM) , OKI (OKI).

Also while carrying out the preliminary investigation, we chose one UK higher education institution namely Brunel University, because it was easily accessible. At this UK higher education institution, we have conducted two semi-structured interviews with key staff to explore factors relating to adoption. One of the interviewees is a

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senior administrator for UG Courses and Examinations" while the other is a lecturer. In future we intend to carry out the survey over a wider range of UK higher education community.

3.Results

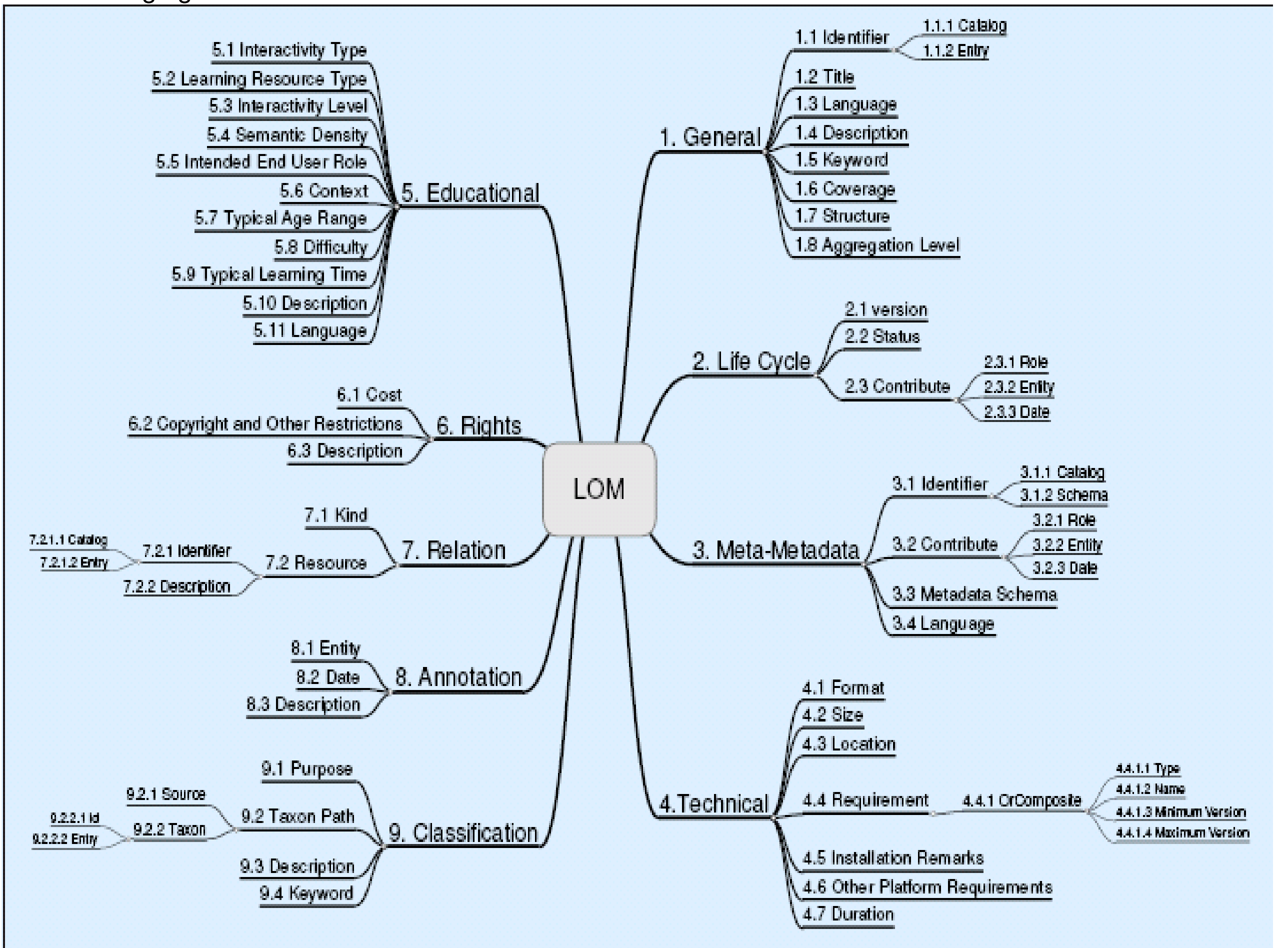
3.1Analysis of the standards

E-learning comprises of any type of learning activity that is based upon some electronic media. According to Wentling, "E-learning is the acquisition and use of knowledge distributed and facilitated primarily by electronic means. This form of learning currently depends on networks and computers but will likely evolve into systems consisting of a variety of channels (e.g., wireless, satellite), and technologies (e.g., cellular phones, PDA's) as they are developed and adopted. e-learning can take the form of courses as well as modules and smaller learning objects. E-learning may incorporate synchronous or asynchronous access and may be distributed geographically with varied limits of time."(Wentling, Waight et al. 2000). Following are some of the standards in the e-learning.

3.1.1IEEE Learning Object Metadata

According to Wiley, "Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science"(Wiley 2000). Metadata contains the data about the data and can be used to locate and manage the data. In order to allow the interoperability and the exchange of the Learning Object resources, the IEEE has defined the syntax and semantics of Learning Object Metadata (IEEELTSC). The first version of the LOM Standards was approved by the IEEE in June 2002. The latest version IEEE P1484.12.3, Draft 8 was released by the IEEE Learning Technology Standards Committee in February 2005.

The following figure shows all the LOM elements and the hierarchies.



a schematic representation of the hierarchy of elements in the LOM data model

Figure 1: The IEEE LOM structure (WhatIsLOMscreen)

Figure 1 shows the hierarchical structure of the various elements of the IEEE LOM standard. As can be seen in the figure that the LOM elements have been primarily divided into nine categories namely General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Annotation, Classification (IEEE 2005). Now each one of them may either represent a branch or a leave, a branch being an aggregate element containing sub elements and a leave being a simple element containing the data. For example, the General element represents a branch containing further eight sub elements namely Identifier, Title, Language, Description, Keywords, Coverage, Structure and Aggregation Level. Similarly the Identifier element contains two sub elements namely Catalog and Entry, both of which are simple elements that may contain value.

In the table 1 below, we give a brief description of the significance of the nine major elements of the IEEE LOM.

Element Name	Significance Description
General	It contains the general information about learning content resource like its title, the language in which it has been written etc. One of its sub elements is 'Identifier' that contains the primary key value identifying the learning content resource.
Life Cycle	It contains information about the history and the present status
Meta-Metadata	It contains information about the metadata that represents the learning content resource
Technical	It contains information about the format, size, steps to install, technical requirements and other characteristics.
Educational	It contains information about the pedagogic aspect.
Rights	It contains information about the copyright and costs.
Relation	It contains information about the relationships with other learning content resources.
Annotation	It contains information about the creators or authors of the learning content resource
Classification	It contains information about the purpose, taxonomy and keywords for the learning content resource.

Table 1: The IEEE LOM element significance.

For each element, the data type and the value space are defined. The various allowed LOM data types are LangString, DateTime, Duration, Vocabulary, CharacterString and Unspecified. The elements that contain further sub elements have the data type value as Unspecified. For the elements whose data type is Vocabulary, LOM defines the set of the permissible values. As with the General element section, for the sub element Structure the set of permissible values are atomic, collection, networked, hierarchical, linear. Similarly in the Life Cycle section, for the sub element Status the set of permissible values are draft, final, revised and unavailable.

The IEEE LOM categorises the learning object as “Strictly conforming LOM XML instances” and “ Conforming LOM XML instances”. A learning content will qualify as “Strictly Conforming LOM XML instance” if it does not include the following:

- The vocabulary values that are not defined in the IEEE LOM standard.
- The XML elements or attributes that are not defined in the IEEE LOM standard.
- The mixed content.

A learning content qualifying as “Conforming LOM XML instance” can contain the following values:

- The vocabulary values that are not defined in the IEEE LOM standard.
- The XML elements or attributes that are not defined in the IEEE LOM standard by using the extension mechanism.
- The mixed content.

All the LOM data elements are optional and use the namespace defined at “http://ltsc.ieee.org/xsd/LOM”. The learning content expressed in the LOM format can be exchanged between various systems using the Open Archives Protocol (Nelson, Warner 2002-06-14).

“The Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH in the remainder of this document) provides an application-independent interoperability framework based on metadata harvesting” (Nelson, Warner 2002-06-14). The OAI-PMH protocol uses XML and HTTP, and involves two types of participants namely Data Providers and Service Providers. The ‘Data Providers’ expose the metadata for the various resources. The client application generally known as ‘Harvester’ and operated by a ‘Service Provider’ can then build the value added services, by issuing the OAI-PMH requests to the Data Providers in order to collect the metadata about the various resources.

A resource can be a physical or digital in nature. The 'Data Providers' maintain a repository server that can process OAI-PMH requests. The repository server consists of several items, each item being associated with a unique identifier. The 'Items' can dynamically generate the metadata for the various resources. This metadata in a specific metadata format is known as the 'Record'. So initially the client application 'Harvester' issues one of the six OAI-PMH Protocol requests to the 'Data Providers'. As a response of this request the Data Provides send an XML format 'Record' containing the metadata about the resource.

The six OAI-PMH Protocol request types are 'GetRecord' that returns individual metadata record from a repository, 'Identify' that returns information about a repository, 'ListIdentifiers' that returns only headers, 'ListMetadataFormats' that returns the various metadata formats available from a repository, 'ListRecords' that returns the records from a repository and 'ListSets' that returns the structure of a repository.

3.1.2UK Learning Object Metadata Core

There have been efforts by the Centre For Educational Technology Interoperability Standards (CETIS) to optimise the IEEE LOM for the UK educational communities, by defining the UK Learning Object Metadata Core (CETIS 2004). The CETIS has, as a result optimised the IEEE LOM for use by the education community in the United Kingdom by identifying common practices and issuing guidelines for the values for the various metadata elements.

3.1.3IMS Content Packaging

The IMS which was known as ’Instructional Management Systems (IMS) project’ in 1997 is a non-profit organization of more than fifty contributing Members and affiliates and develops open technical specifications for interoperable learning technology. According to the IMS Content Packaging Overview, “IMS Content Packaging focuses on defining interoperability between systems that wish to import, export, aggregate, and disaggregate IMS Packages.” (IMSCP 2005). The IMS Content Packaging defines specifications for encapsulating the various learning objects along with their metadata and the information about manner in which the content is to be delivered to the learner into a single entity. Thus the various content resources along with the supporting information and structure are encapsulated into a single entity which is known as an IMS package. This IMS Package file often known as “Package Interchange File PIF”, is interoperable between various IMS compliant systems and basically consists of various content resources and an IMS Manifest document “imsmanifest.xml” containing information about the content resources. The “RELOAD Content Package and Metadata Editor” (RELOAD 2004), an Open Source project funded by JISC (JISC) as part of the Exchange for Learning (X4L) Programme, which allows to create content packages, implements the IMS Content Packaging specifications. This project has been developed in Sun Java Platform (Microsystems). The following 19 elements have been specified as mandatory by the IMS Learning Resource Metadata:

1. general.title
2. general.catalogentry.catalogue
3. general.catalogentry.entry
4. general.language
5. general.description
6. lifecycle.version
7. lifecycle.contribute.role
8. lifecycle.contribute.entity
9. lifecycle.contribute.date
10. metametadata.metadatascheme
11. metametadata.language
12. technical.format
13. technical.location
14. rights.cost
15. rights.copyrightandotherrestrictions
16. rights.description
17. classification.purpose
18. classification.description
19. classification.keywords

3.1.4IMS Simple Sequencing

The IMS Simple Sequencing (IMSSS 2003) defines specifications to represent the intended behaviour of an authored learning experience. These specifications allows the learning designer or content developer to declare the relative order in which elements of content are to be presented to the learner and the conditions under which a piece of content is selected, delivered, or skipped during presentation. Thus it helps to describe the flow of learning activities according to the outcomes of a learner's interactions.

3.1.5IMS Question And Test Interoperability (QTI)

The IMS Question And Test Interoperability (IMSQTI) defines specifications to represent the question, test and the test results, which enable to exchange the questions, test, and the test between various authoring tools, item banks, test constructional tools, learning systems and assessment delivery systems. The "TOIA Assessment Management System (AMS)" (TOIAAMS) , a project funded by JISC (JISC) as part of the Exchange for Learning (X4L) Programme, which allows creating and administering online assessments and repositories of question bank, implements the IMS QTI (IMSQTI), IMS Content Packaging (IMSCP 2005) and IEEE Learning Object Metadata (IEEE 2005) specifications. This project has been developed in Microsoft dot NET platform (Microsoft). The "QAed Questions & Assessments Editor" (Universitat Pompeu Fabra), as Open Source project developed by the GTI group of the Universitat Pompeu Fabra (UPF), Spain under the European Union funded project SCOPE (SCOPE), which allows creating and managing the repositories of assessments, implements the IMS QTI specifications (IMSQTI).

3.1.6IMS Learner Information Package

The IMS Learner Information Package (IMSLIP) defines specifications to represent information about the persons involved during the various stages of e-learning process such as an individual learner or a group of learners, learning content creators, providers and vendors. This information can then be exchanged between the various IMS compliant Learner Information server and Learning Management Systems.

3.1.7Sharable Courseware Object Reference Model SCORM

The SCORM (SCORM is basically a comprehensive suite of e-learning standards to enable interoperability, accessibility and reusability of the e-learning content. SCROM incorporates the various IEEE and IMS e-learning standards and produces recommendations for consistent implementations by the e-learning vendor community. SCORM defines 'Content Aggregation Model (CAM)', 'Run-time Environment (RTE)', 'Sequencing and Navigation (SN)' for the e-learning content. The Content Aggregation Model specifies the way to assemble, label and package the e-learning content. The Run-time Environment specifies the way e-learning content is launched, content communicates with the e-learning system, tracking of learner's progress and error handling. The Sequencing and Navigation specifies the way e-learning content is sequenced and navigated.

3.1.8 The Open Knowledge Initiative

The goal of Open Knowledge Initiative is to facilitate the development and sharing of applications and implementations of various components of the educational software environment (OKI). OKI is a trying to solve the problem of reusability of the components of an e-learning system, so that we don't end up always reinventing the wheel.

An e-learning system is composed by integrating many different individual modules like one for management of learning content, one for assessment, one for admissions e.t.c. Now different institutions and vendors developing the e-learning systems end up developing their individual implementations for each one of these different modules, although each module is meant to do similar tasks. One of the reasons that the existing implementations of different modules developed for an e-learning system are not reused in other e-learning systems is the lack of standard service interfaces. To overcome this problem and facilitate the sharing of implementations of components by various e-learning systems, the OKI has defined the specifications for the standard service interfaces for the various modules of an e-learning system.

This approach has some other additional advantages, the first one being that the work of building the front end or presentation layer of an e-learning application can take place independent of the development of implementations of the various components. The second advantage is that any OKI complaint component of the educational software environment can be replaced with another OKI complaint implementation, without changing the presentation layer components.

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There have been many individual efforts by various entities to develop various components of the e-learning system, which are often not used by others entities that are developing their own e-learning systems. Let's consider the IMSab QTI-Lite specification based tool QAed Questions And Assessments Editor developed by the GTI group of the Universitat Pompeu Fabra under the European Union supported project SCOPE, which is used to create and manage the repositories of assessments. Now since this module's business layer does not use standard interface, so it becomes difficult for other institutions to integrate this module in their e-learning system, without changing their presentation layers. The OKI has filled this gap by developing specifications for the communication between the components of an educational software environment.

Presently the OKI provides the Java versions of these service interface definitions.

3.2Recommendations to guide and refine the development of standards

From our understanding of the standards, we would like to suggest following points:

1. The IMS Questions and Test defines interoperable standards for the question, test and the test results. The IMS QTI covers the basis question types like Logical identifier like Standard True/False Multiple choice, X-Y co-ordinate like Standard Image Hot Spot & Connect-the-points, String like Standard

Single Fill-in-Blank & Standard Short Answer, Numeric like Standard Integer Fill-in-Blank and Logical groups like Standard Drag-and-drop. However for the String Short answers it does have automatic response processing. Three have been efforts in the computer assisted assessment (CAA) of the string answers like Perez research in the automatic assessment of Student's free text answers using the combination of a BLEU algorithm and Latent Semantic Analysis [4]. The IMS QTI specification should include the automatics assessment of the string short answers.

2. The OKI provides common interface definitions for various components, so that components can be reused. The idea of providing common interface for various components is reusability. So while developing an e-learning system, one might have to choose between two different implementations. OKI does not define any quality parameters that can be attached with the implementations. Such quality parameters would help decide in favour of some particular implementation. A few of these quality parameters could be minimum response time, line of code, cohesion parameter, coupling parameter, average uptime, scalability index, availability.

3. Different OKI compliant implementations will have same interface, but they might have different data storage structure. This might make it very difficult or impossible, to replace one implementation with another. The solution is to define standard storage structures (standard database schema). These standard database schemas might contain some extra fields, which different implementations would have the flexibility to use. The standard storage structure will help in implementing the dynamic binding of components. Also in case of some implementation being unavailable temporarily, another can be used as a temporary substitute till the original service is restored back.

3.3Independent information and evidence as to their utility, deployment and adoption at UK higher education institution:

We have conducted a small preliminary study using the Likert Scale Technique with the aim to gather evidence as to the utility and adoption of the eight e-learning standards, at the one UK Higher Education institution namely Brunel University. The results have been summarized in Table 2.

	IEEE LOM	UK LOM	IMS CP	IMS SS	IMS QTI	IMS LIP	SCORM	OKI
Organisation	IEEE	CETIS	IMS	IMS	IMS	IMS	ADL	OKI
Scope	Learning Objects	Learning Objects	Learning Objects	Learning Objects	Assessment	Participants	All E-Learning except Assessment	All E-e-Learning
Level Of Adoption	Low	Low	Low	Low	Moderate	Low	Low	Low
Level Of Preparation	High (86 entries)	Low (19 mandatory entries)	Moderate (19 mandatory entries)	High	Low	High	High	Low
Understandability	Low	Low	Low	Low	Moderate	Low	Low	Low

Table 2: The comparison.

The results suggest that the eight standards considered in the study help interoperability, accessibility and reusability of the e-learning content and e-learning components, but the level of adoption is low. Since the preliminary study considers only one UK higher education institution, clearly the results cannot be generalised over the whole UK higher education community. However, this preliminary study does indicate some possible factors that should be further investigated.

4.Conclusions

To summarise, this paper has considered the problem of multiple e-learning standards and issues to do with interoperability. To that end we have considered eight standards that we believe to be the most important in some detail. In addition, we have conducted two semi-structured interviews with key staff to explore factors relating to adoption.

From this study we have discovered:

1. There are many standards and standards bodies (and the proliferation is problematic leading to unnecessary complexity).
2. There are a wide range of areas that are being addressed.

3. However, in some areas at least (e.g. LOM), there is significant overlap and differences between standards. Fortunately this is generally well managed and the process is one of adoption to local needs (Application profiles).
4. From the results of our interviews and other anecdotal data there is little evidence of widespread adoption.

Thus we make the following three recommendations:

1. Explicit provision for automatic marking / assessment of subjective text based answers
2. Need for explicit quality parameters in component interfaces
3. Need for data schemas for OKI compliant components

The weakness of this work is that it only covers one UK higher education institution, because of which the results can not he generalised over the whole UK higher education community. Further investigation needs to be carried out at other UK higher education institutions in future, which would enable to generalise the results over a wider community

5.Acknowledgements

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