Standardization in Computer Based Learning

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In recent years, the evolution of information and communications technologies (ICT) has given rise to a great many e-Learning systems and resources, bringing with it, as is customary, problems of reuse and interoperability. As a result of this situation, a number of international institutions and groups have embarked on a process of standardization in order to obtain a set of broadly accepted recommendations. This article aims to show readers the present state of the art and current trends in the standardization process of computer based learning.

Keywords: data models, e-Learning systems, interoperability, reuse, standardization.

1 Introduction

Many institutions have made use of the advances in multimedia technologies, online communication and software engineering to offer learning products and services at every level. Learning resources and systems abound and, as a result, there is a clear need for some form of standardization. As in other initiatives aimed at creating a standard, the standardization to be applied to educational technologies must enable reuse and interoperability among systems.

In this article, which is intended as a first point of reference for the researcher or anyone involved in the field of standardization in e-Learning, we provide an overview of the current state of the art in this field, identifying the key aspects in this process (sections 2–9) and describing the most interesting issues: formats and data models, description and representation of learning resources, organizations, educational modelling languages and management matters. In section 10 we go on to look at other aspects to do with the standardization of learning technologies which are currently in a less developed state than those dealt with earlier.

In the following section we start by taking a look at the institutions and organizations involved in the standardization of educational systems.

2 Institutions Involved

The institutions and organizations involved are typically in the USA or Europe using a large number of software products and, more specifically, educational software applications.

2.1 Institutions in the USA and Other non-European Countries

The Learning Technologies Standardization Committee (LTSC, <http://ltsc.ieee.org>) of the IEEE (Institute of Electrical & Electronics Engineers) is concerned with practically every aspect of computer based learning. Its main aim is to develop technical standards, recommended practices and guidelines for software components, tools, technologies and methods to aid the development, implementation, maintenance and interoperability of educational systems.

The "36th subcommittee of the first joint International Standardization Organization and International Electrotechnical Commission" (ISO/IEC JTC1 SC36, <http://jtc1sc36.org>) was set up in 1999 to deal with all aspects related to the standardization of the learning technologies. Its main interest lies in interoperability, not only at a technical level but also taking into account cultural and social issues.

In 1997 IMS Global Learning Consortium, <http://www.imsglobal.org>, emerged as a project within the National Learning Infrastructure Initiative promoted by EDUCAUSE, formerly EDUCOM, a consortium of educational institutions in the USA plus corporate partners, to define technical standards for the interoperability of distributed learning services and

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applications. Nowadays IMS's most important work is in the fields of meta-data, content packaging, EMLs (Education Modelling Languages), questionnaire definition, and the management and handling of group and learner information.

The Aviation Industry CBT Committee (AICC, <http://www.aicc.org>) is the natural response to the challenge of educational standardization from one of the most important consumers of educational software. AICC's activities are aimed at, inter alia, the definition of software and hardware requirements for learners' computers, their needs in terms of peripherals, multimedia formats for course contents and properties of the user interface. The AICC is closely involved in the United States Department of Defence's ADL initiative and has been serving the aviation industry since 1988.

In 1997, the United States Department of Defence and the White House Science and Technology Bureau launched an initiative named Advanced Distributed Learning (ADL, <http://www.adlnet.org>). From its outset ADL has been centred on Web based education. It coordinates its work with other organizations like the IEEE, IMS and AICC. Among the results of this collaboration is the Sharable Content Object Reference Model (SCORM). This proposal includes a reference model for shareable educational software objects, a runtime environment and a content aggregation model.

The project Gateway to Educational Materials (GEM, <http://www.geminfo.org>) provides a working framework for the publication and location of learning resources available on the Internet. This project began in 1997 as a special project under the auspices of the ERIC Clearinghouse on Information & Technology.

Education Network Australia (EdNA, <http://www.edna.edu.au>) is aimed at promoting the Internet as a support tool for computer based learning among the Australian educational community, from learners to content providers. Like GEM, EdNA's main aim is to provide access to educational services and resources.

2.2 European Institutions

In the European Union there are four major initiatives concerned with the standardization of computer based education. The Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE, <http://www.ariadne-eu.org>) formed part of the IV Framework Programme of the European Commission. Among the most important fields of work undertaken by this alliance are computer networks for education and learning, methodologies for the development, management and reuse of educational contents, study plans for the definition of computer based learning, and educational metadata.

The project GESTALT, Getting Educational Systems Talking Across Leading edge Technologies, <http://www.fdgroup.co.uk/gestalt/>, also part of the IV Framework Programme of the European Commission, sets up a working framework for the development of compatible, scalable, heterogeneous and distributed educational systems. Its main aim is to enable users to discover learning resources, as well as providing an access to those resources and an appropriate management of the network infrastructure.

PROMETEUS, PROmoting Multimedia access to Education and Training in EUropean Society, <http://www.prometeus.org>, is another European initiative bringing together more than 400 institutions involved in the standardization of computer based education.

The Information Society Standardization System (ISSS) is a subcommittee of the European Committee for Standardization (*Comité Européen of Normalisation*, CEN). The ISSS's activities in pursuit of educational standardization take place in the Learning Technologies Workshop (CEN/ISSS/LT, <http://www.cenorm.be/sh/lt>). Their main efforts are aimed at the reuse and interoperability of learning resources, collaborative education, metadata for educational content and quality in the learning process, while taking into consideration the cultural diversity of Europe.

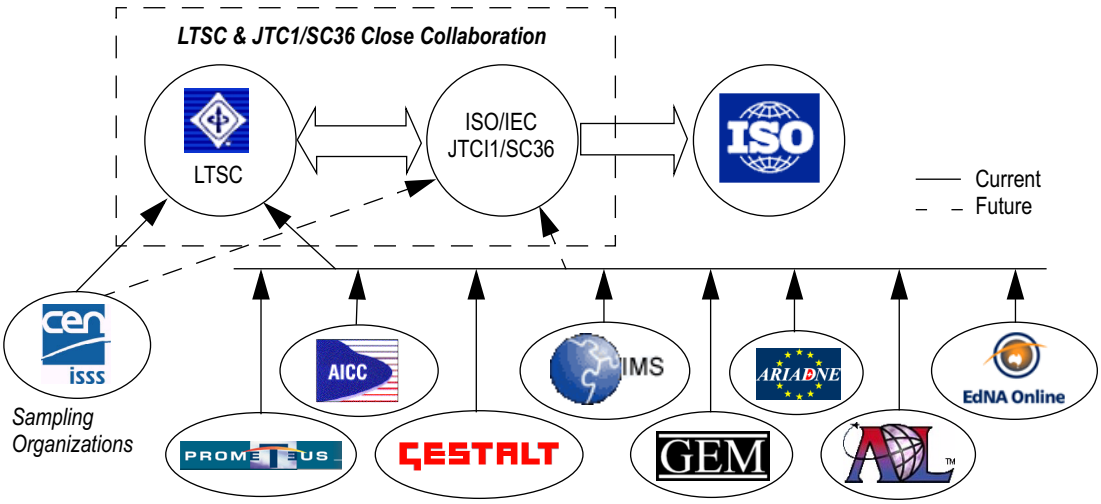

Figure 1: Major Contributors to the Standardization Process in e-Learning.

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2.3 Joint Initiatives

As the reader may gather from the various proposals discussed in the following sections of this article, in many cases they are the result of the joint efforts of several institutions involved in the standardization process. Normally an activity is initiated simultaneously in various institutions and, in the course of the process, contact is made between them in order to decide on final recommendations. In most cases the LTSC gathers together the proposals from all the players and then converts them into common recommendations after reaching a common consensus. Eventually, proposals approved by the IEEE begin a more rigorous process in order to become ISO or ANSI standards (see Figure 1). Table 1 gives a breakdown of the all contributions discussed in this article, contributions which, in most cases, have become basic references in the field of e-Learning.

3 Educational Metadata

Educational metadata is one of the most prolific fields in the standardization of technologies applied to learning. Metadata provides descriptions, properties and information about educational objects, allowing them to be described so as to simplify their use and management.

One of the main collaborators in the definition of educational metadata is the LTSC committee of the IEEE. In 1998, the IMS initiative and the ARIADNE project carried out a joint proposal with the IEEE which went on to become the current Base Document of the Learning Object Metadata (LOM) specification.

Since June 2002, LOM has been the first officially recognised standard resulting from the standardization process described in this article. LOM specifies the syntax and semantics of an educational object's metadata. This set of metadata defines the attributes required to fully describe an educational object. LOM is focused on the minimum set of attributes needed to allow these educational objects to be easily managed, located and evaluated. This set of metadata may also include such attributes as learning and interaction style, educational level or prerequisites.

The core set of metadata known as the Dublin Core, <http://dublincore.org>, is a widely used, general purpose metadata schema, the main purpose of which is to facilitate the location of resources. In August 1999 the DCAC (Dublin Core Advisory Committee) founded the Dublin Core Education Workgroup with the aim of developing and carrying out a proposal for the use of Dublin Core metadata in the description of learning resources. Its task is basically to make proposals for expanding the Dublin Core set to describe this particular type of resources, taking LOM and the IMS proposal as a basis.

The IMS project found that one of the primary tasks to consider in the standardization process was to reach a broad consensus on learning resource metadata. Since 1998, when LOM was created as a result of IMS's first joint proposal with ARIADNE, the consortium has been collaborating on a regular basis on its development.

The ADL initiative proposal is closely linked to the IMS and LOM proposals. However, its main aim is to fill the existing gap between metadata specifications and implementation oriented content models. Although in many cases XML (eXtensible Markup Language) implementations are available, the LOM based specifications listed earlier provide no description at all of how to apply the metadata to each particular system. The ADL initiative's metadata proposal is based on LOM and is defined within SCORM specifications. Basically, metadata is used to describe the three basic components of the SCORM model: assets, SCOs and content aggregation (see the next section on packaging and organization).

In 1998 ARIADNE developed, jointly with the IMS project, the initial metadata proposal which would eventually become LOM. Its aim was to develop a metadata schema which could be used in a multicultural and multilingual environment, neutral with regard to the language used by either the learning resource or the metadata instance itself. ARIADNE's metadata is currently being developed in parallel to LOM, while retaining some of its own elements.

The main aim of the GEM initiative is to provide a solution for the location and publication of learning resources available on the Internet. GEM provides a tool which helps content providers to catalogue the resources they make available to the public. The cataloguing process is supported by a metadata model whose latest version, released in March 2002, fully integrates the Dublin Core metadata set and the recommendations of Dublin Core's Education Workgroup.

Along the same lines, the Australian project EdNA has defined a Dublin Core based metadata schema, expanded with new elements, whose aim is to provide descriptive information for the classification of learning resources.

As readers will have gathered, these last two proposals are centred on solving the specific problem of the location and retrieval of learning resources in each particular application environment. The role they play in the standardization process is not as apparent as in the previous proposals.

4 Packaging and Organization of Learning Resources

A key factor in the process of exchanging learning resource aggregations among different systems is the maintenance of the existing relationships between the different units making up the aggregation. It is therefore essential to define data models which allow the structure of the learning resource aggregations to be represented with a view to enabling whole courses or parts of courses to be exchanged.

The most interesting recommendation in this respect is the proposal from the IMS consortium: the IMS Content Packaging specification. The key element in this model is the *package*. A package represents an aggregation of learning resources which is treated as a single entity. This aggregation may include an single course, one or several parts of a course or even a collection of courses.

IMS packages are made up of two elements. The first is the 'manifest', an XML document which describes the encapsulated content and how it is organized. The second is the educational content described in the manifest, such as web pages, text files, evaluation objects or any kind of data material. When these elements are encapsulated in a single file (e.g., a compressed .zip, .jar, or .cab file), the resulting file is known as a Package Interchange File.

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Acronym	Proposal	Entity responsible	Reference	Date
			Metadata	
DCMI	Dublin Core Metadata Initiative	DC-Ed	<http://dublincore.org/groups/education/>	21/10/02
EdNA MD	EdNA Metadata	EdNA	<http://standards.edna.edu.au/metadata/index.html>	25/10/01
GEM MD	GEM Metadata	GEM	<http://www.geminfo.org/Workbench/gem2.html>	14/03/02
GEMSTONES	Gestalt Extensions to Metadata Standards for on-line Education Systems	GESTALT	<http://www.fdgroup.co.uk/gestalt/metadata.html>	26/04/99
IMS MD	IMS Metadata	IMS	<http://www.imsproject.org/metadata/<	01/10/01
LOM	Learning Object Metadata	LTSC	<http://ltsc.ieee.org/doc/wg12/LOM_1484_12_1_v1_Final_Draft.pdf>	12/06/02
			Packaging and Organization of Learning Resources	
CMI	CMI Guidelines for Interoperability	AICC	<http://www.aicc.org/docs/tech/cmi001v3-5.pdf>	02/04/01
IMS CP	IMS Content Packaging	IMS	<http://www.imsglobal.org/content/packaging/>	01/07/03
SCORM-CAM	Content Aggregation Model	ADL	<http://www.adlnet.org/ADLDOCS/Documents/SCORM_1.2_CAM.pdf>	01/10/01
IMS SS	IMS Simple Sequencing	IMS	<http://www.imsproject.org/simplesequencing/>	20/03/03
			Learner Information	
EPAPI	Extended PAPI	GESTALT	<http://www.fdgroup.co.uk/gestalt/D502v4.zip>	21/10/99
IMS Enterprise	IMS Enterprise	IMS	<http://www.imsproject.org/enterprise/>	01/07/02
IMS LIP	IMS Learner Information Package	IMS	<http://www.imsproject.org/profiles/>	09/03/01
PAPI	Public and Private Information for Learners	LTSC	<http://edutool.com/papi>	25/11/01
UOM	Unit Object Model	GESTALT	<http://www.fdgroup.co.uk/gestalt/D502v4.zip>	21/10/99
			Evaluation Models	
IMS Q&TI	IMS Question & Test Interoperability	IMS	<http://www.imsproject.org/question/>	26/03/03
			EMLs	
OUNL-EML	Educational Modelling Language	OUNL	<http://eml.ou.nl>	01/06/01
IMS LD	Learning Design	IMS	<http://www.imsglobal.org/learningdesign/>	20/01/03
			Runtime Environments	
CMI	CMI Guidelines for Interoperability	AICC	<http://www.aicc.org/docs/tech/cmi001v3-5.pdf>	02/04/01
SCORM-RTE	Runtime Environment	ADL	<http://www.adlnet.org/ADLDOCS/Documents/SCORM_1.2_RunTime Env.pdf>	01/10/01
			Digital Repositories	
KPS	Knowledge Pool System	ARIADNE	<http://ariadne.unil.ch>	01/06/02
IMS DR	IMS Digital Repositories	IMS	<http://www.imsproject.org/digitalrepositories/>	12/08/02

Table 1: The Most Important Proposals for the Standardization of e-Learning.

One of the most important components of the manifest is the sub-element *Organizations*. This element is used to specify one or several alternative organizations for the resources included in the package. Each organization defines the static relationships which exist between the aggregation resources in the form of a hierarchical tree, as can be seen in Figure 2, in which each item corresponds either to a learning resource or an aggregation of lower level items.

Other institutions besides the IMS consortium have been working in this field. For example, the first task of the ADL initiative in this field was to adapt the format for the structure definition of courses developed by the AICC to XML. The latest official version of the SCORM reference model has adopted the IMS proposal. The SCORM Content Aggregation Model (CAM) includes an extended version of the IMS Packaging Model, incorporating, among other less significant features, the possibility of defining 'access prerequisites'. These prerequisites support the definition of simple dynamic behaviours in resource organizations by establishing a set of access conditions for each item depending on the learner's status in the other items in the aggregation. In this way SCORM provides simple sequencing and conditional browsing capabilities.

The IMS consortium has recently released a more versatile sequencing model called IMS Simple Sequencing Specification, <http://www.imsglobal.org/simplesequencing/index.cfm>. This specification defines a method of representing the author's

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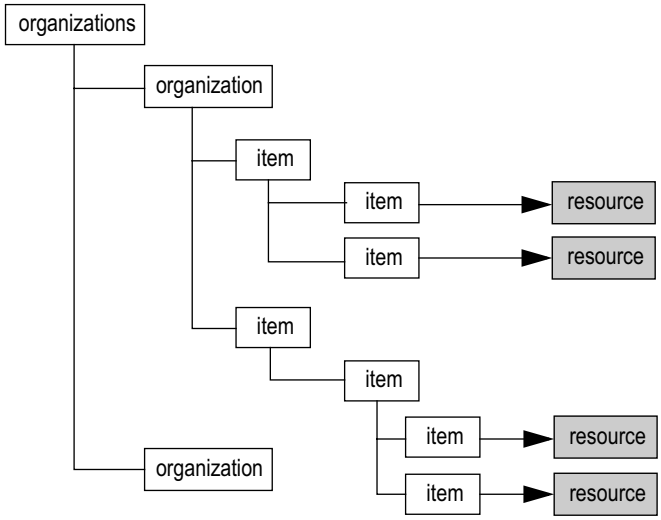

Figure 2: Organization of Resources in an IMS Package.

intended behaviour for a learning session, in other words, the sequence in which educational objects are delivered to the learner. The standard includes three data models:

Sequencing Definition Model: is used to describe the sequencing behaviour.

Tracking Model: is used to record information about the learner's interactions with the learning activities in order to control the selection and sequencing of other activities.

Activity State Model: records information about the situation or status of the learner with regard to the activities scheduled.

The general process of Simple Sequencing can be described as a combination of several behavioural models: Navigation, Exit, Roll Up, Selection and Randomization, Sequencing and Delivery.

5 Educational Modelling Languages

The OUNL EML (Open University of the Netherlands' Educational Modelling Language) defines a learning process as a set of activities for both learners and teachers without any specific link to any concrete approach. An EML describes not only the content of a study unit (text, questionnaires) but also students' and teachers' roles, relationships, interactions and activities. In this respect EML is designed so as to allow many different pedagogies to be expressed, and groups learning objects with learning objectives, prerequisites, learning activities, teaching activities and learning services in a workflow (or rather a learning flow) which models itself on a specific learning design.

The IMS Learning Design specification is based on OUNL EML, created by the Open University of the Netherlands, and was recently accepted as an IMS specification (January 2003). Its aim is to provide a framework of elements to formally describe the design of any learning-teaching process. It provides a flexible and generic language which supports the definition of learning designs under different pedagogical approaches. IMS Learning Design is a proposal which integrates with other IMS specifications: IMS Content Packaging (Section 4), IMS Meta-data/LOM (Section 3), IMS Question and Test Interoperability (Section 7) and IMS Simple Sequencing (Section 4).

There are other less important EMLs proposals for different approaches. The CEN/ISSS Workshop on Learning Technologies produced the CEN Workshop Agreement [1] in which interested readers can find a survey of EMLs. According to this survey, an EML is "*a semantic information model and binding, describing the content and process within a 'unit of learning' from a pedagogical perspective*". Both OUNL EML and IMS Learning Design fit this definition perfectly.

6 Learner Information

Learner information comes basically from three different sources: personal information (e.g., address, telephone number), preferences (e.g., operating system, network connection, computer configuration) and academic information (e.g. courses completed, grades). As in the case of content or course structure specifications, learner data models facilitate the interchange of learner information among the various platforms of different institutions.

However, educational systems involve other structures which include learner information. Normally an educational process is organized around learner groups, a given schedule, etc. In other words, the available information about learners defines the individual properties of learners, but also defines the learner-learner and learner-other agent relationships that may exist.

As in other applications involving the handling of personal data, issues of security and privacy arise. Learner information should also be provided in terms of who requires access the information: learners, teachers, system managers, relatives, other colleagues, the general public, etc.

The PAPI (Public And Private Information) of the aforementioned Learning Technology Standards Committee (LTSC) of the IEEE, defines the syntax and the semantics for a learner information model as a set of records. PAPI is intended as the foundation of a Learner Model containing all the necessary information to describe a learner. IEEE LTSC has actually already sent a current version of PAPI (draft 8) to the ISO/IEC JTC1 SC36 for further standardization.

IMS is continuing with two lines of work concerning learner management information the first of which is a learner profile model, the IMS Profile initiative. They define Learner Information as "*a collection of information about a Learner (individual or group learners) or a Producer of learning content (creators, providers or vendors)*". This Learner Information Package (LIP) specification organizes learner information into 11 categories, is compatible with the vCard [2] specification and includes the results of the IEEE PAPI.

The second line of work concerns the definition of standard structures allowing interoperability between systems lodged in the same company or organization. This initiative, IMS Enterprise, complements the one described above. While IMS Profile provides support to describe the learner, IMS Enterprise

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provides a description of the information needed to manage those learners in a learning system.

Like IMS, GESTALT has developed two specifications concerning user data management: EPAPI, which defines learner profiles, and UOM, which manages groups and defines learning units. Basically EPAPI is an XML implementation of PAPI, adapted to the needs of GESTALT, and is based on version 5.0 of PAPI. The Unit Object Model (UOM) describes learning units as entities which relate learning objectives, access requirements, learner groups, teachers, tutors and learning process planning. In other words, this model allows users to specify all the agents involved in the learning process and all their relationships.

7 Learner Evaluation

IMS's specification, Question & Test Interoperability (QTI), deals with the matter of the exchange of evaluation material between heterogeneous learning systems, such as individual questions or questions grouped into questionnaires. This specification includes both the format of a set of structures to represent evaluation material, such as details about what questions to include and in what order, and all the information required to process students' results. It also includes structures for the exchange of the corresponding student evaluation reports. Thus the educational content administrators and developers have the necessary formats to import and export questions or whole questionnaires, including the results of the student evaluation process.

The QTI specification is very versatile and includes a wide repertoire of data structures enabling quite complex evaluation material to be represented (most types of questions commonly used in e-learning systems nowadays are supported by the specification). The possibility has also been considered of including proprietary extensions without compromising the integrity of the QTI specification, which will enable QTI to be adopted by existing tools. However, due to the complexity that this will involve, a simpler version, called QTILite, has also been released. This stripped down version of the specification only supports a subset of the structures described in the full version.

8 Runtime Environments

In order to enable the reuse of educational content, one basic requirement is the clear separation between the contents and the logic which manages them, in other words, their 'runtime environment'. The basic tasks of runtime environments are to deliver contents to the learner, to support the interaction between content and learner, and the decision of the next educational resource 'to deliver' depending on the static and dynamic structure of the course and on the prior actions of the student (see Section 4). In order to enable reuse, the logic needed to provide this functionality must be clearly separated from the learning resources themselves, such as multimedia elements, and even the software modules responsible for other functionalities (e.g., content transfer, communication between students, etc.).

The most important proposals in terms of runtime environments come from the AICC and of the ADL initiative. Recently the IEEE LTSC has set up a workgroup on runtime environments the specifications of which are based to a large extent on the work of the AICC.

The way to start up educational contents is known as the launch mechanism. This mechanism defines the procedures and responsibilities for setting up the communication between the delivered resource and the LMS (Learning Management System). Once this communication has been initiated, there should be a clearly defined procedure for the interchange of information. The communication between the LMS and the learning resources is channelled through an interface which standardizes the communication protocols, providing ways for the runtime environment to keep informed about the status of the educational content (initiated, ended, etc.), and to interchange information between the LMS and the resource. The common vocabulary used in this communication is defined in the runtime environment's Data Model. This model defines a standard list of elements used to describe the information to be interchanged, such as the status of the educational resource.

In order to ensure content reusability and interoperability, LMS developers must implement these launch mechanisms and their corresponding interface correctly, while content developers must ensure the proper use of the interface and data model provided.

The definition of runtime environments has evolved over several stages in recent years. In the beginning, when e-Learning systems tended to be autonomous, the AICC developed a file based communication interface to use in MS-DOS operating systems. Later, in collaboration with the ADL initiative, they replaced this with an interface based on the HTTP protocol. This new interface was clearly oriented towards TCP/IP networks. Finally, this model was revised to include an API (Application Program Interface) separating the runtime environment from the protocol layer (see Figure 3.)

9 Digital Repositories

"*ADL development envisions the creation of learning 'knowledge' libraries, or repositories where learning objects may be accumulated and catalogued for broad distribution and use. These objects must be readily accessible across the World Wide Web or whatever forms our global information network takes in the future*." [3]

Digital repositories store collections of resources which can be returned over the Internet without prior knowledge of the collection's structure. Digital repositories store both the resources themselves and the metadata describing those resources, although they may be physically stored in different repositories.

The basic functionality provided by a digital repository can be described, in a nutshell, as working on two levels. First level actions are carried out by the user while second level actions are performed by the repository itself: search/expose, gather/expose, submit/store, request/deliver and alert/expose.

Recently, the IMS consortium has released the final specification (three documents) on the interoperability of digital

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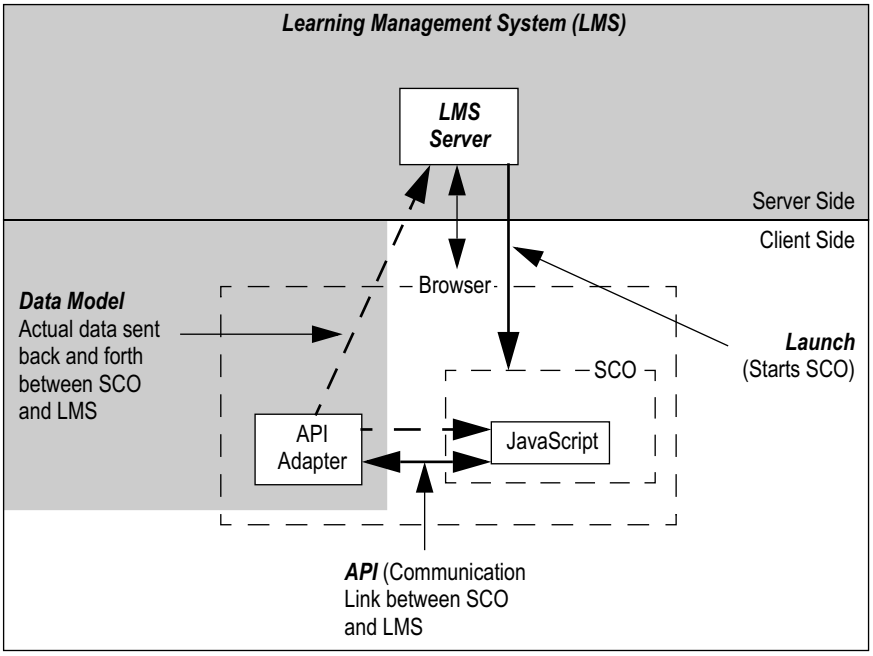

Figure 3: API Based Runtime Environment (SCORM).

repositories. The main aim of the specification is to define a set of common services allowing digital repositories to present a common interface. The specification also establishes a common functional architecture and a reference model for the capture of the common aspects of the most popular implementations of digital repositories. Another vital feature of this specification is that it does not aim to define a complete set of services but focuses on the definition of a set of common essential services so that external entities can store and access digital content in the repositories.

Basically the IMS specification takes into account all the important aspects of existing digital repositories. For that reason the specification does not define new schemas but makes use of existing ones: principally metadata and content packaging. The specification also makes suppositions about the underlying technologies for implementations: (1) SOAP as a message protocol, (2) XQuery as the query language for XML documents, and Z39.50 as the search protocol for generic digital repositories (i.e. those not specifically located within the scope of the e-Learning). However, these are candidate technologies and there is no commitment or agreement to include them in future versions of the specification.

There is also some other noteworthy work being carried out in this field (e.g. ARIADNE [4] or UNIVERSAL [5]) based on the concept of interoperable digital repositories. The main goal of these projects is to provide federated networks of repositories of educational objects with additional intermediation functionalities.

10 Other Proposals and Recommendations

In this section we take a look at other standards which are at an early stage of specification and that do not clearly fall into any of the categories previously mentioned. For each field of work we name the institutions involved.

10.1 Definitions of Competence

In order to have a common knowledge of the competence of learners we need universally accepted data models of competence definitions. There are currently definitions of terms such as Learning Objective, Competence and Skill, but very little agreement on how these definitions can be used to define reusable competence data models. The IEEE LTSC has a workgroup, the P1484.20, working on competence definitions. This group has published the document Competency Definition Data Objects [6]. The IMS has also published a document, IMS Reusable Competencies Definition Information Model Specification [7] which is very similar to LTSC's work.

10.2 Location

These specifications deal with matters relating to cultural and linguistic diversity. This includes translations of human languages (for example of learning documents or vocabularies of learning object meta-data), but also more technical matters (e.g., encodings and character sets, date formats) and also cultural matters of a more general nature (e.g., representations of appropriate icons or user interface metaphors). European institutions like PROMETEUS and CEN/ISSS, among others, are working on this issue.

10.3 Intellectual Property

Questions of intellectual property arise in several ways when we consider the role of information technology in education and training. These specifications aim to specify a contract between the holder of the intellectual rights of the resource and

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the users of that resource. PROMETEUS and the CEN/ISSS are also concerned with matters of intellectual property.

10.4 Accessibility

The first recommendations in terms of accessibility were published by IMS [8]. PROMETEUS and CEN/ISSS are also working on the development of recommendations and guidelines to enable people with disabilities to access quality e-Learning.

In addition to these, there are other fields of work under study by various groups. For example, the AICC is proposing guidelines and recommendations to facilitate the use of computer based learning systems. They have defined several elements concerning the user interface, media document format media or hardware systems.

11 Conclusions

The standardization of educational technologies is a challenging process. There are many issues to be considered, the most important of which we have dealt with in this article. From a strictly methodological viewpoint, this field is a mixture of traditional approaches to standardization, led by classic standardization groups, of slow and rigid evolution producing recommendations starting from zero, and approaches provided by users or the industry who develop standards from existing products and experience.

Eventually some of the contributions presented in this article will become generally accepted standards or recommendations, LOM being a good a example of this process. For this reason it is vitally important for the different players to collaborate with each other, a trend which can be seen at the present moment in time. Within the different fields of standardization we can already see some proposals which are a reference for the rest.

Translation by Steve Turpin

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