E-learning specifications. An introduction

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Introduction

The move to e-learning has been a major development in the recent history of education, involving changes in pedagogy and in the way in which technology is used to support learning. New approaches to education are emerging which promise improvements in provision and learning. Open source and free software and resources are also increasingly important in e-learning and e-teaching, in contrast to the 90´s, when proprietary code and software were dominant. This development is in part driven by economic and policy issues, but also by a desire to make knowledge more accessible.

Our intention in this article is to draw attention to two specific aspects which can make a key contribution to making these wider developments in e-learning successful. Firstly, in parallel with the changes we have mentioned, a number of institutions have collaborated to provide specifications and standards that address several widely recognised problems in e-learning. One key focus for this effort has been on interoperability and re-use, making it possible to use the same information package or learning scenario in several different tools, and to create new units of learning re-using some existing content. This is seen by many as being a key requirement for making e-learning an effective solution, and the main body of this article is taken up by a an introduction to some of the specifications which have been developed to address this need. Particular attention is given to IMS Learning Design, as its pedagogic expressiveness, and its function as a co-ordinating specification, give it a particularly important role.

Secondly, any successful e-learning effort (platform, specification, repository, editor…) needs to be supported by an active community, which is often partly or wholly virtual. The community requests information and raises problems, and provides answers and solutions. In the most cases, the community is open and free and the drive to participate is pure altruism and/or a need of information interchange (Hummel et al, 2005). At the end of the article we briefly describe how the UNFOLD project has contributed to supporting the communities which are working with e- learning specifications.

Standards and specifications

A standard is an international or national method, technology or format, documented in detail, commonly accepted, and backed-up by ISO (International Standards Organisation), CEN (European Centre of Normalization), IEEE or some other recognised standards setting institution. The establishment of a specification is a prior step, and is often carried out by a company or organization, and not yet certified by any standards setting institution. It may, however, be widely or universally adopted, and be accepted as a *de facto* standard (i.e. a specification which is so widely adopted that in practice it is recognised as an essential standard, even though it has not been given any special formal status).

The definition and publication of a specification can often generate a great deal of research and corporate activity in testing its effectiveness, identifying shortcomings and carrying out debugging. This can lead to a process of revision, and perhaps finally to a formal standardisation process. (Cetis, 2005) (see *Figure 2*). IMS Global Learning, Inc. (IMS) has taken a leading role in publishing e-learning specifications. IMS is a non profit making organisation based in the US, and incorporating over 50 industrial and academic partners from around the world.

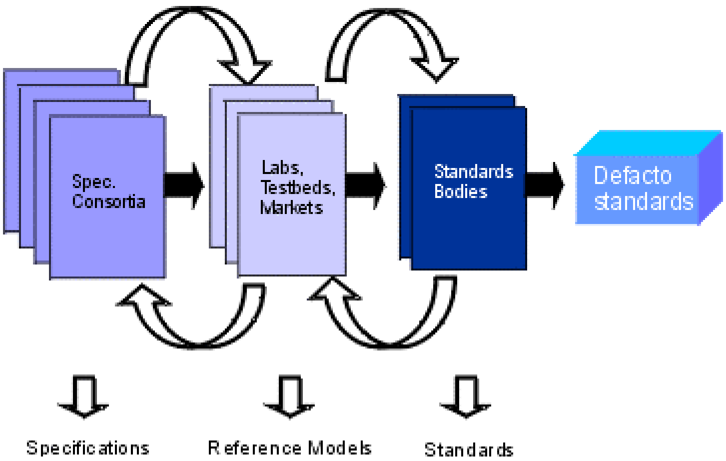

Figure 2. Full process to obtain a standard (Source: Cetis, 2005)

Thus, the typical full process consists of the identification of a need in a professional environment, the creation of a specification to meet this need, widespread adoption as a *de facto* standard, and finally (if appropriate) a formal standardisation process. Current e-learning specifications are *de facto* standards.

There have been several efforts to create useful specifications that meet the needs of the various actors in the e-learning process, such as teachers, learning providers, learning designers or system developers. These include Content Packaging, Simple Sequencing, SCORM, Learning Information Package and a number of others. The UNFOLD project (in which the authors have been involved) has focused in particular on IMS Learning Design, because its ability to model almost any lesson plan, including roles and activities for learners and teachers, give it the potential to transform the current panorama of e-learning applications.

We now provide an introduction to Learning Design, followed by a survey of the some of the other most well established and relevant e-learning specifications.

IMS LD: Learning Design (IMS, 2003)

IMS Learning Design, or simply IMS LD, (IMS, 2003) is a specification focused on modelling lesson plans and courses, and making them available online as Units of Learning (UoL). It is one of the more recent IMS specifications, and also one of the most ambitious in scope. A wide variety of pedagogical models can be represented by IMS LD, enabling teacher to adapt their resources and learning scenarios to virtual lessons in a flexible way. Far from only sequencing activities or using repositories of learning objects, IMS LD provides several features to create adaptive, dynamic and personalized learning (Burgos et al, 2005; Koper and Burgos, 2005). Through this description of different roles, activities, environments, methods, properties, conditions and notifications, IMS LD can be used to transform lesson plans into formally specified Units of Learning (UoL).

Thus the specification is a flexible way of representing and encoding learning scenarios for multiple or individual learners. It may help to think of it as a way of creating interoperable lesson plans which can be read by an application called a *player*. The player can take on responsibility for coordinating the learners, teachers, learning resources and activities as the learning process goes forward (Burgos et al, 2005a).

Learning Design does not offer a particular pedagogic model or models, but can rather be used to define a practically unlimited range of scenarios and pedagogic models. Because of this it is often referred to as a *pedagogic meta-model.* Some previous e-learning initiatives have claimed to be pedagogically neutral. Learning Design does not aim for pedagogic neutrality, but seeks to enable pedagogically aware e-learning.

Learning Design uses the metaphor from the theatre to clarify the encoding of Units of Learning (although the teacher or learner does not have to be aware of this, or ever see the code). A play is performed by a number of actors, who may take up a number of roles at different times in the play. Similarly in learning design a learner can take up different roles at different stages of a learning process. At the end of each act the action stops, all the learners are synchronised, and then something new can begin.

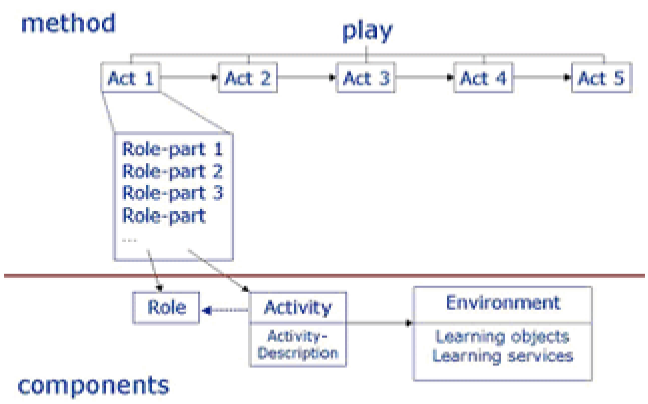

Figure 1. Diagram of a play (Source: Olivier, 2004)

There are several tools available to support the specification, such as CopperCore (Vogten and Martens, 2005), the first engine capable of running UoLs, or the editors CopperAuthor (Van der Vegt, 2005) and Reload LD Editor (Bolton, 2004). This first generation of tools provides the basic infrastructure which makes it possible to create lesson plans and manage resources. The teacher or learning designers can also use ready made UoLs and adapt them for his/her own objectives and structure. Repositories such as Learning Network for Learning Design (OUNL, 2004) or Dspace (OUNL, 2002) provide several of these information packages ready to use. In short, IMS LD enables the teacher and the learning designer to create e-learning itineraries which are expressive enough to support a wide range of drives, styles and pedagogies.

How the specification is structured

IMS LD is divided into three implementation levels: A, B and C. These are incremental, so a level C compliant application must also implement levels A and B.

- <u>Level A</u>
  This level defines roles, activities and environments. It is the core of the specification, and contains the description of the elements that define the UoL: people, activities and resources, and the coordination between them through the method, plays, acts and roles. Using these elements a sequence of learning activities can be defined. These are carried out by learners and teachers, using learning objects, services and resources.

- <u>Level B</u>
  This level adds properties, conditions, global elements and monitoring services to Level A, and enables learning designers to define more complex structures. The properties store information about a person (preferences, results, …), about a role or about a learning design. If properties are local, they are called internal and they persist during a single run of the learning design (i.e. are global), they are called external, and can be accessed from different runs and learning designs. The state of the properties at any moment can determine the learning flow.

- <u>Level C</u>
  This level adds notification of new activities. These notifications are triggered automatically in response to events in the learning process. For example, if a student submits an assignment, the teacher will automatically be sent an e-mail with a notification.

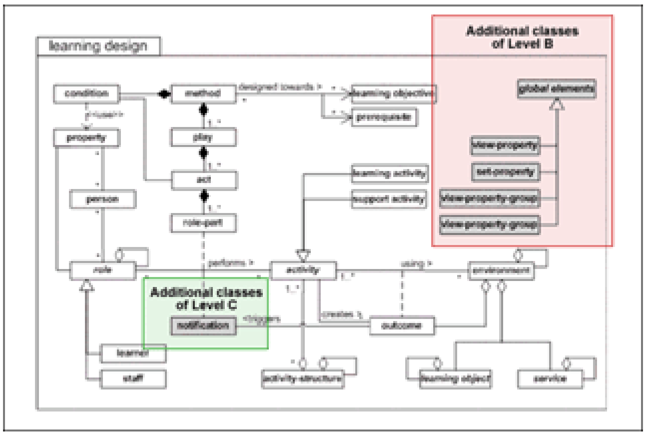

Figure 5. Architecture of IMS Learning Design specification, Levels A, B and C

We now go on to consider a number of other key e-learning specifications.

CP: Content Packaging (IMS, 2001)

Educational content often needs to be packaged in some electronic form, so as to support efficient aggregation, distribution, management and deployment of the content. Authors of educational materials need tools and technologies to assist them in creating content; learning management system vendors, computing platform vendors and learning services providers want efficient distribution and management of the educational materials created by authors; and students need good deployment and delivery of tools.

To meet these needs it is important that content is packaged in a known structure and file format, with good supporting documentation.. IMS Content Packaging meets these needs by describing the contents, structure, and location of online learning materials and defining some particular content types. It enables the author to encapsulate all the required resources, place them in a structure, and add metadata. The user can then describe and package learning materials, such as an individual course or a collection of courses, into interoperable, distributable packages.

Thus Content Packaging provides a structure that integrates a number of elements. A Content Package can group, for example, LD (Learning Design), SS (Simple Sequencing), Meta-data and QTI (Question and Test Interoperability).

Final Version 1.1.2 of the IMS Content Packaging Specification was released to the public in August 2001. A revised version 1.2 will be published in mid 2006

LIP: Learner Information Package (IMS, 2001a)

The Learning Information Package is a specification for the records of information held about learners.
It was designed in order to allow records relating to learners and their progresses to be transferred between different software applications and institutions. Version 1.0 of the IMS Learner Information Package Specification was published in March, 2001.

Using LIP a record of all the learner's achievements can be obtained, so LIP information on students' progress could even substitute for paper certificates. Information can also be stored about the learner's preferences, which can help, for example, to support the needs of learners with disabilities. All the information related to learners is stored in an XML file, which uses tags to specify what each piece of information in the record means.

In this way the LIP enables internet based Learner Information systems to interact with the other systems that make up the internet learning environment. It defines a series of packages that can be used to import and export data from an IMS compliant Learner server, so that they can be exchanged with Learning Delivery systems or other Learner Information servers. The Learner server allows the owner of the information to define which part of this information can be shared with other systems. The main structures of LIP are based on accessibilities, activities, affiliations, competences, aims, identifications, interests, qualifications, certificates and licences, relations, security keys and transcripts. LIP can be mapped to Learning Design properties.

SS: Simple Sequencing (IMS, 2003a)

This specification is used to define rules that determine the learner's path through learning content. Alternative navigation paths through a learning material collection can be defined, which are followed in response to users actions. It defines a method to represent the intended behaviour of a learning object so that any compliant learning technology will be able to sequence learning activities in a consistent manner.

The Simple Sequencing binding provides a unique namespace which is embedded in the *organization* element of an Content Packaging manifest. Because Simple Sequencing uses the Content Package structure, it is possible to integrate a sequence into a Learning Design.

The Simple Sequencing Specification was published in March, 2003.

QTI: Question and Test Interoperability (IMS, 2003b)

The IMS Question and Test Interoperability specification makes it easier to share assessment information such as questions, tests and results. It provides a standard way to share data defined in

XML, so that users can import and export questions, tests and results. The specification supports both simple and complex questions and tests, which are defined clearly and concisely so as to avoid ambiguity. In this way information about questions and about the learner and his or her results can be shared through different learning management systems and different software packages. Authors of assessments can create their own questions, or include questions designed for other IMS QTI users, making it easier to create question banks for reuse on different systems.

Today the IMS QTI specification is implemented in a large number of assessment systems and virtual learning environments. Some of these systems still record the assessment data in their own formats but also allow the user to export or import data in a QTI format, to provide portability to other systems.

IMS QTI aspires to being pedagogically-neutral, enabling users to develop online assessments with a range of question types and flexibility, and a number of frequently used techniques: multiple choice/response, true and false, image hot spot, fill the blank, select text, elide, drag object/target, order objects, match items, and connect points.

Version 1.0 of the IMS Question and Test Interoperability Specification was first released to the public in June, 2000. In January 2005 Version 2.0 was published, which introduced some significant changes to the specification.

SCORM (ADL, 2000)

The SCORM (Sharable Content Object Reference Model) is a part of the Advanced Distributed Learning (ADL) initiative strategy. The primary sponsors of this initiative are the United States Department of Labour, Department of Defence and the National Guard Bureau.

In 1997, the White House Office of Science and Technology Policy established the ADL initiative in order to enhance, standardize and modernize the way learning and training was delivered, so that learning content could be made portable through various systems.

SCORM was originally designed to support personnel instruction at the Department of Defence of the USA, and as a result the pedagogical assumptions which underlie SCORM reflect educational practice in these institutions. Previously the United States Department of Defence had experienced problems when trying to share courses among the different management systems used in the Department: truck drivers, fire-fighters and military and environmental personnel all had their own training materials and delivery systems, with slight differences between all of them. Moreover, the format for delivering training content, depended on the learning management systems, operating systems and authoring systems used by each organisation. If the organization needed to change one of these technologies, the training material might not work with the new system.

In order to address these problems, SCORM was designed to facilitate moving courses and information from one platform to another and to allow content to be reused in various courses by packing it into modular objects. SCORM is not a specification of the same type as those described above, but rather a model that references a set of published technical specifications, standards and guides. Indeed some of its components are themselves IMS specifications. It aims to ensure that compliant systems will provide reusable, interoperable, durable and accessible content, regardless of the content delivery and management systems used. In this way learning objects can be easily shared between different learning management systems, with the web generally seen as the main means of distributing information.

SCORM represents Sharable Content Objects (SCOs) as structures in XML. SCOs are individual units of learning to be combined to create a course of study, and they should be:

- Durable: electronic resources that do not need to be updated or modified with changing technology.
- Interoperable: resources that can be launched correctly by different Virtual Learning Environments.
- Accessible: resources that can be found when needed. SCOs are linked to a description of their content, making them easier to search for.
- Reusable: are developed only once and used in many courses.

In the SCOs the instructional material and meta-data is packed and can be imported and exported between different VLEs. SCORM documents are technical and specify the functionalities that systems must have in order to be compliant. They do not say how to create good SCORM material or effective e-learning. SCORM works well, but has limitations, because it is principally applicable to the multimedia, self-paced, stand-alone instruction traditionally accomplished with computer-based training. Training guided by a teacher or instructor is not within the scope of SCORM.

As mentioned above, SCORM is not simply a specification, but rather a framework for the web and computer based learning which is defined by guidelines, specifications and standards. These are grouped into three topics: Content Aggregation Model (CAM), Run-Time Environment (RTE) and Sequence and Navigation (SN). The model describes the creation, deployment and behaviour of the SCOs when running in web-based learning management systems.

First, SCORM defines the way that SCOs have to be created, this creation starts with the asset files: images, text, sound, or anything which can be rendered by a browser. The assets are then assembled into SCOs. Each SCO has a meta-data file which defines the assets. Once the SCOs have been created, SCORM defines how they will behave in a VLE.

Content aggregation is the process of creating, describing and packing SCOs in a course structure.
Run-time behaviour is the process of launching an SCO to a VLE, and then tracking the learners activity with the SCOs.

A manifest file, handles the packing of the SCOs into a course structure. SCORM defines that no SCO can have navigation links to any other SCOs, so the entire navigation structure has to be defined in a content table in the manifest file.

SCORM was first released in January, 2000. It has been extensively adopted, with the cooperation of the industry, government and academic participants.

The UNFOLD Project, and support for the communities which work with e-learning specifications

When IMS publishes a specification the documentation is posted on their Web site, and the working group sits back for a well deserved rest, hoping that the rest of the world will pick up on their work and adopt the specification. Its fate may be to languish on a little visited web directory, or it may become universally adopted. Government agencies and influential commercial organisations, however, can and do promote specifications, and the most notable example is the SCORM, which has received over 84 million dollars from the US Government in funding for awareness raising and implementation, plus mandated compliance in Federal funded projects.

In this context the UNFOLD project was conceived of as a measure to promote and coordinate the adoption, implementation and use of IMS Learning Design and related specifications, as this appeared to be the best candidate for resolving the need for more sophisticated interoperability. This judgement has been confirmed by developments during the life of the project. UNFOLD was funded by European Commission as a Framework 6 IST Coordination Action, and project partners were Pompeu Fabra University [www.upf.edu], The Open University of the Netherlands [www.ou.nl], The University of Bolton [www.bolton.ac.uk] and EUCEN [www.eucen.org]. Extensive details about UNFOLD and its activities are available on the project website at [www.unfold-project.net], and so here we restrict ourselves to a brief outline of the project and its achievements.

Many different professional groups have to be involved if this specification is to be successful in providing better learning opportunities, but often these groups are not in contact with each other. Those developing specifications do not usually work with authors of learning materials, and tools developers do not usually work with teachers and learners. If progress is to be made then information needs to flow between these disparate groups of people. To meet this need the core activity of UNFOLD was to support and facilitate Communities of Practice (CoPs) which are groupings of people who come together around common interests and expertise, creating, sharing, and applying knowledge within and across the boundaries of tasks, teams and organisations. The CoPs were launched in July 2004 with the establishment of three communities, for Systems Developers, Learning Designers and for Teachers and Learning Designers. Project activities sought to facilitate communication and exchanges within these communities through a mix of face to face and online activities. Participation was open to all those active in the field, primarily in Europe but also from around the world.

In practice the boundaries between CoPs were not always been completely clear, in part because the same people take up more than one role, but also because the development of basic tooling took longer than anticipated. Indeed it was only towards the end of the project that a critical mass of Learning Designers was established, and the first pilots with learners were being run. As a result much of the work done in UNFOLD involved groups of researchers working on various aspects of Learning Design, exchanging their results and insights. This meant that project activities came to a halt before the model of support for adoption of specifications which the project proposed could be fully validated, but the experience was very encouraging. Participation was extensive with over 20 projects, over 20 tool developers, over 50 industrial organisations, over 300 individuals, and around 600 online participants who generously contributed to the UNFOLD Communities of Practice events and network. The project became a focus for developments around Learning Design which stimulated interest from around the world, bearing testimony to the quality of the discussions, seminars and papers which emerged from project activities. Most importantly, the project was the focus for exchange of information and experience within and between the Communities of Practice, leading to collaborations between research groups and between developers which would otherwise been extremely difficult to organise. The role of Open Source implementations was particularly important in this respect, enabling developers to build on each others achievements, and providing free access to tools for learning designers and teachers to try out.

The long term future of Learning Design is not yet assured, but important ground work has been done by the UNFOLD Communities of Practice. There is now a need to build on this by improving the usability of the tools available, providing a wider range of exemplars and patterns, and (the final goal) extending the use of the specification in learning.

Epilogue

Nowadays we are in an inflexion point on e-learning. More and more e-platforms and e-tools are coming up to the market and fight against each other to get the first position and spread their influence and use wide abroad. However, there is a large set of research groups, universities and institutions working in parallel to provide an open and free solution, based on interoperability of lesson plans and re-use of units of learning. This means a break-point between commercial vendors based on private software and a collaborative framework focused on teachers and students where both worlds, commercial and academic, can live together to provide the best approach or approaches to the new challenges on e-education.

Specifications and standards come to give the user the facility to translate regular lesson plans into Learning Design packages, and to provide the freedom to choose the best platform to edit, run, use or share these packages or previous ones, at the same time. There is still a huge work to do but the first tryouts are available, and they need an extensive use and debugging to improve themselves and get closer the facilities developed to users´ needs.

Further information

IMS Consortium, http://www.imsglobal.org/
UNFOLD Project, http://www.unfold-project.net
Moodle OpenUniversiteitNederland, http://moodle.learningnetworks.org/
Runnable Example Units of Learning, http://moodle.learningnetworks.org/course/view.php?id=20
DSpace, http://dspace.learningnetworks.org/index.jsp
Learning Networks, http://www.learningnetworks.org
OpenUniversiteitNederland, http://www.ou.nl
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