Specifications and standards for use of educational digital content

Alenka Kavčič[*,1]

[1] Faculty of Computer and Information Science, University of Ljubljana, Tržaška 25, 1000 Ljubljana, Slovenia

The paper deals with the issue of standards and specifications applied to digital content that is used in education. Preparing digital content in a standardised way is an important issue, as it is crucial for content's interoperability, reusability, durability and accessibility. This way, content developers can construct courses that are independent of the Virtual Learning Environment under which courses are intended to run. In the paper, an overview of different available standards and specifications for digital learning content is prepared and their practical use is discussed. Although proprietary formats are widely used in Virtual Learning Environments, they do not provide the needed interoperability. Hence, Virtual Learning Environments should incorporate a standardised format for their content description or at least enable exporting of the content in a standardised way (e.g. a suitable converter into a standardised content package). There is no question any more, whether to follow standards in content development, but rather a new question arises: which standards to apply to assure wide interoperability.

Keywords Content Development; Content Packaging; Educational Content; E-learning; Standards; Virtual Learning Environments

1. Introduction

Many commercial companies, governmental bodies (e.g. Ministries of Education), schools, teachers and instructors, as well as other providers of educational content, they are all offering extensive catalogues and large repositories of online learning resources to schools, teachers and students. This educational digital content is being produced to support the teaching and learning processes, either for e-learning or for supplementing traditional classroom activities (blended learning).

Such educational content is typically used within the Virtual Learning Environment (VLE), usually referred to as Learning Management System (LMS) or Course Management System (CMS), which is designed to support computerized teaching and learning. VLE enables efficient management of electronic learning content and resources, as well as learning processes and students. It allows the students to access the content and resources, as it offers a set of services that can deliver learning material, track student's progress, establish the sequence of learning objects to be displayed to the student, or report on student's success in knowledge acquisition in the subject.

The educational content can be used in one system, discovered and retrieved to another system, and again transported to and reused in the third system. Thus, the content should be prepared in a suitable format to be recognized and run under different VLEs. The only way to construct content completely independent of the VLE is by adhering to standards, which promise and also deliver such interoperability.

Preparing digital content in a standardised way is therefore an important issue, as it is crucial for content's interoperability, accessibility, reusability, and durability. This way, content developers can construct courses that are independent of the VLE, under which the courses are intended to run.

2. Standards for digital content

Digital content in a broader sense covers digital educational content itself (i.e. learning objects) and its format, as well as the corresponding description of the content (i.e. metadata). There are many aspects of standards and specifications for digital content. If we focus only on the technical part, they can be divided into two groups, regarding the intended operation on the digital educational content:

- standards and specifications for content *discovery*,
- standards and specifications for content *exchange* and *(re)use*.

The first group comprises standards and specifications that facilitate the content discovery. They refer mostly to metadata, which describe the learning object, and to controlled vocabularies, which organize knowledge for subsequent retrieval. Standards like IEEE LOM (Learning Object Metadata) [1] or Dublin Core [2] deal with metadata definition and their description. Other standards apply for searching and exchange of metadata; widely used are SQI (Simple Query Interface) [3] and SRU/SRW (Search and Retrieve URL/Web Service) [4] in a federated search scenario, while OAI-PMH (Open Archive Initiative Protocol for Metadata Harvesting) [5] is

[*] Corresponding author: e-mail: alenka.kavcic@fri.uni-lj.si, Phone: +386 1 4768483

used for harvesting. Standards like XVD (Exchange of Vocabulary Definition Specification) [6], IMS VDEX (IMS Vocabulary Definition Exchange) [7], Zthes specifications [8] and W3C SKOS (Simple Knowledge Organization System) [9] all deal with vocabulary mapping and exchange, and address the semantic interoperability of metadata.

The second group deals with the standards and specifications for content exchange, its use and reuse, including retrieval and playing of the content. To assure successful exchange and (re)use, the educational content has to be interchangeable and playable in different VLEs. This problem is addressed by content packaging and content description formats. A pioneering work in this area was carried out in 1993 by Aviation Industry Computer-based Training Committee (AICC) in its CMI Guidelines for Interoperability [10], which defined a specification (interfaces and rules) for interoperability between Computer-Based Training content and Computer Managed Instruction (CMI) systems. Many other specifications followed, with SCORM [11], IMS Content Packaging [12], IMS Question and Test Interoperability [13], IMS Tools Interoperability Guidelines [14], and IMS Common Cartridge [15] being some of the most notable. Some of these specifications are described in the next section.

Interoperable repositories of educational content also play a key role in content exchange. The specifications like CORDRA (Content Object Repository Discovery and Registration/Resolution Architecture) [16], describe a model to design and implement federations of repositories that support discovery, sharing and reuse of learning content. Various specifications that deal with digital rights management (DRM) and licensing, like Creative Commons [17], are also rather significant.

3. Standards for digital content interoperability

Content interoperability here refers manly to content exchange and its (re)use. Digital educational content emerges in many different formats, depending on the developer and the tools used in its production.

As VLEs are mostly Web-based systems, HTML (HyperText Markup Language), together with pdf, Flash and JavaScript, has become one of de facto standards for digital content. The content can be played in any VLE, since these technologies are supported by all major Web browsers. Although the interoperability of the content is attained, such content lacks higher level lesson and course descriptions, tracking of learner's performance and communication with the VLE.

3.1 Proprietary formats

Many different VLEs are used to support e-learning, being open source or proprietary solutions. Most VLEs enable the user not only to manage and play digital content, but also to create it. Although standard formats like HTML are often used for the content, VLEs predominantly employ their own formats for describing lessons, courses and user's interaction with the system. These formats are usually not standardised and therefore not easily transferable to other systems.

Although such content can be saved and imported into another VLE that supports the same format (usually the same VLE product), is not widely transferable. The content created in Moodle [18], for example, cannot be used in ILIAS [19] without major modifications, and vice versa. The exchange of created learning materials is thus limited and causes many frustrations.

3.2 SCORM specifications

The most widely known and accepted standardised format for digital learning content is SCORM (Shareable Content Object Reference Model) from ADL (Advance Distributed Learning) initiative [11]. SCORM is a set of technical standards and specifications that regulate the development, packaging and delivery of learning objects, as well as their interaction with the learning management system. Hence, it enables the Web-based learning systems to find, import, use, reuse or export the learning material in a standardised way.

The specification covers the content aggregation model, as well as the interaction with the VLE: it defines an application programming interface (API) and data model for enabling communications between learning content and the system.

Portability and reusability of learning material in SCORM packages is ensured by its proper organization into content packages and description of this organization in manifests. The content is broken into reusable learning objects of a standardised form, called Sharable Content Objects or SCOs. They are used as building blocks to create content packages. SCOs are assembled in packages together with their delivery instructions. A separate description of the package is provided in the manifest file that declares the contents of the package and the locations of SCOs.

SCORM also supports sequencing, i.e. a set of rules specifying the order, in which SCOs are to be delivered (shown to the learner). Thus it enables separation of sequential tasks from the content and their treatment on the level of VLE.

The main disadvantage of SCORM is its obsolete model that was designed for self-paced computer-based training, thus lacking the support for immersive learning environments, collaborative learning, forums, social networking, wikis, etc. Consequently, the International Federation for Learning, Education, and Training Systems Interoperability (LETSI) [20] is currently working on the next-generation learning interoperability framework, called the SCORM 2.0 project.

3.3 IMS Common Cartridge

Another perspective player in the area of digital content standards is IMS Global Learning Consortium (IMS GLC) [21], which develops interoperability standards for distributed learning and facilitates their adoption practice. Some of their standards and specifications, like Question and Test Interoperability (QTI) and Content Packaging, are already quite widely used.

Modern learning technologies are assisted by a new generation of Digital Learning Services standards for organized and distributed digital learning content: IMS Common Cartridge (IMS CC) [15]. The specification is quite new, with its first release in October 2008. IMS CC is a set of open standards that enable strict interoperability between content and systems, support flexibility in the type of digital content (content can be also applications), and sustain distributed content (and applications) [22].

IMS Common Cartridge provides a standard way to represent digital course materials that is able to run on any compliant VLE [22]. It enables collections of learning resources of various types and sources (rich content and integrated assessments, with metadata and authorisation for protected content), and includes exchange standard for online discussion forums. Besides, it supports Web integration, lesson plans, competency maps, and accessibility support. IMS CC builds on IMS Content Packaging [12] specification (like SCORM), yet adds support for IMS Question and Test Interoperability (IMS QTI) [13] and IMS Learning Tools Interoperability (IMS LTI) [23].

Unlike SCORM, IMS Common Cartridge was developed specifically to sustain interactive and collaborative learning situations, typically guided by an instructor (teacher) [22]. Although the specification can be used to assist self-paced online learning, its main focus is on blended learning. In general, IMS Common Cartridge specifies the following [22]:

- a format for content exchange between systems (a common way to interpret what the content is and how it is organized; the content is described in a manifest);
- an authorization standard for components (i.e. access rules for all components in the package as some content or applications may require a license);
- a standard for metadata that describe the content (based on Dublin Core);
- a standard for test items, tests, and assessments;
- a standard for launching and exchanging data with external applications (such as social networking, wikis, external assessment systems, adaptive tutors, Web-based content libraries, or other learning systems); and
- a standard for populating online discussion forums for collaboration among students.

4. Adopting standards and specifications

Any standard or specification, as good as it might be, is of no value if it stays only on the paper, as it has to be brought into practice to fulfil the expectations and its purpose: to enable and facilitate educational content interoperability. This can be achieved only by widespread use of standards and their broad support from content providers, as well as teachers and other organizations that prepare the learning content.

The first breakthrough in this area had AICC with its CMI specification [10]. Although the specification was accepted and used mostly inside the US government and aviation industry, it prepared the ground for new standards and specifications that followed. Its successful successor was ADL SCORM [11] specification that gained a wide adoption not only in the government sector (especially in Ministries of Education and Defence Departments), but also in industry (from commercial content providers and publishers to designers of VLEs) and academia. This way, SCORM became widely used and accepted as de facto international standard for e-learning, since no viable alternative existed for the educational content, where the importance of interoperability and other benefits of SCORM would be recognized.

Over the years, new learning technologies (e.g. simulations, games and virtual worlds, intelligent tutoring, and especially social interaction components, like social Web, forums, chats, etc.) have developed and been incorporated into the e-learning. The old rigid e-learning specifications did not prove to be flexible enough to

cover the new demand. They are missing the support for new learning technologies as well as better integration with other learning architectures. IMS Common Cartridge [15] is a new upcoming standard that fills in the rising gap and has the potential to take over the primacy in this area. It has been designed with modern learning technologies in mind and thus covers all major shortcomings of its predecessors.

Yet, since only the preparation of standards and specifications is not enough, some effort has to be put also into their adoption and enforcement. Two Best Practice Networks supported by the European Commission's eContent*plus* programme, ASPECT: Adopting Standards and Specifications for Educational Content [24] and ICOPER: Interoperable Content for Performance in a Competency-driven Society [25] started last year and address this issue. They both promote the usage of learning standards in Europe. A year earlier, in 2007 a Thematic Network EdReNe – Educational Repositories Network [26] was launched, whose overall goal is to improve the provision of and access to learning resources. All these projects try to expose those standards and specifications that are most suitable in the area of educational content and seek for their adoption by major content providers and VLE manufacturers.

The projects try to achieve their goal also through the Learning Technology Standards Observatory [27], which is (cited from their Web site) "an accessible and sustainable Web-based repository that acts as a focal access point to projects, results, activities and organisations that are relevant to the development and adoption of e-learning technology standards".

5. Conclusion

The issue of standardised educational digital content is quite important, as it is the only feasible way towards achieving content's interoperability, reusability, durability and accessibility.

Although many different standards and specifications exist that describe the educational content, its format and its metadata, each have their own strengths and weaknesses, and there is still no perfect solution of standardization problem that would suit all involved parties. Existing older standards are widespread, but mostly obsolete, while new emerging standards, although well designed, are not yet generally accepted and used in practice.

Therefore, more energy will have to be put into design and adoption of e-learning standards and specifications. All major players from industry, government, and educational institutions have to join their forces not only in preparation of new standards and specifications, but also in their implementation and adoption. Well prepared standards that are accepted by developers and by users of the educational content can facilitate content's creation, use and reuse, and also significantly cut the costs of its development, maintenance and exchange.

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