Chapter 19
A Methodology for Developing Learning Objects for Web Course Delivery

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ABSTRACT
This article presents a methodology for developing learning objects for web-based courses using the IMS Learning Design (IMS LD) specification. We first investigated the IMS LD specification, determining how to use it with online courses and the student delivery model, and then applied this to a Unit of Learning (UOL) for online computer science courses. We developed an editor and runtime environment to apply the IMS LD to a UOL. We then explored the prospect for advancement of the basic IMS LD UOL. Finally, we discussed how to construct ontology-based software agents to use with the learning objects created with the IMS LD Units of Learning.

INTRODUCTION
There has been research effort directed far and wide towards defining learning objects, their standards, and building tools for developing web-based courses using learning objects with standards such as the IMS Learning Design (IMS LD) specification (Koper & Olivier, 2004; Paquette et al., 2005). However, at the time this research was undertaken, in early 2004, locating a runtime environment for learning objects that would work with these standards was a much more difficult task. In the beginning of the project, we needed to determine how to create learning objects, what the granularity of the learning objects should be, how to fit these learning objects together to form units in a course, and how to actually create learning object files using the IMS LD specification.
The need to create a runtime environment for the learning objects was the next facet to consider. Finally, because intelligent search and selection capabilities are possible with learning objects, the question of how to use agents and ontologies with learning objects was studied.

The goal of this research was, therefore, to develop a methodology for developing Extensible Markup Language-(XML) based learning objects for Web-based courses using the IMS LD specification and to design a runtime environment for these learning objects. The contributions of this project are the following: developing the means of creating Web-based courses using learning objects at various levels of granularity, developing the means of delivering courses online using learning objects, and initially exploring agents and learning objects using ontologies.

This chapter addresses the process of developing this methodology from the research stages through to the development and implementation of the IMS LD units of learning (UOL). As well, the final discussion looks at how the specification used for the learning objects can be extended by using intelligent agents and more advanced levels of the IMS LD.

LITERATURE REVIEW

One of the greatest strengths for institutions using learning objects lies in sharing and reducing redundancy in the distance learning development effort. There are a variety of standards based on XML that involve various organizations and aspects of learning objects. The standards for interoperability have been addressed by the Shareable Content Object Reference Model (SCORM) (http://www.adlnet.gov/scorm/). The IMS Global Learning Consortium, Inc. (IMS) (http://www.imsglobal.org/) and CanCore (http://www.cancore.ca) look after cataloguing learning objects for searches. Organizations such as the Multimedia Educational Resource for Learning and Online Teaching (MERLOT) (http://www.merlot.org/) and the Campus Alberta Repository of Educational Objects (CAREO) (http://www.careo.org/) address repository standards. Furthermore, the Learning Object Review Instrument (LORI) addresses learning objects evaluation to help users determine which ones are worthwhile and which ones are not (Nesbit & Li, 2004).

The IMS Learning Design specification was chosen for this project because it nicely addresses the issue of defining the learning object files in its simplest format at Level A of the specification. It also has the ability to expand to Levels B and C and offer many more interesting and interactive capabilities. Koper and Olivier (2004) describe the IMS LD UOL as containing the learning objects and services that are needed in the process of learning and teaching. At the time of the study, there were tools being developed to work with the IMS LD specification, with the most promising tools under development, specifically CopperCore (http://coppercore.sourceforge.net/) and Reusable Learning Object Authoring and Delivery (RELOAD) (http://www.reload.ac.uk/). These tools are now available in stable release from these websites.

As well, the IMS LD can be enhanced with the Learning Object Metadata (LOM), defined by the Institute of Electrical and Electronics Engineers (IEEE) (http://ltsc.ieee.org/wg12/20020612-Final-LOM-Draft.html), to enable expansion of the specification for more advanced methodology using the created learning objects. The IMS LD specification has future development potential in the integration of ontologies through the W3C Web Ontology Working Group (http://www.w3.org/TR/owl-features/). This would allow the use of software agents in supporting both developers and learners (Koper & Olivier, 2004; Richards, 2002). Finally, using ontologies could provide the model of the conceptual structures of learning objects and Web courseware authoring (Aroyo, Dicheva, & Cristea, 2002).
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