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# Reusable Learning Resources for Virtual Learning Environments

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## INTRODUCTION: THE PARADIGM OF LEARNING OBJECTS

The evolution of Web-based learning has fostered the search for methods and technologies that enable a degree of reuse of learning contents and learning activity designs. Such attempt is intended to facilitate both the reuse of quality resources and the development of automated resource-search tools, and it may eventually reduce the cost of devising learning activities. The concept of *learning object* is at the center of a new instructional design paradigm for Web-based learning. This new paradigm emphasizes reuse as a quality characteristic of learning contents and activities. For example, the often-cited definition of learning object by Polsani (2003) explicitly includes reuse in his definition: "an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts." In one of the most referenced articles on the field, Wiley (2001) also mentions the term reuse in his learning object definition: "any digital resource that can be reused to support learning." Nevertheless, the concept of learning object reusability as a key quality factor for content design is difficult to characterize and measure, since it encompasses not only the evaluation of the contents themselves (Vargo, Nesbit, Belfer, & Archambault, 2003), but also a balance between their usability in specific contexts and the range of educational contexts it explicitly targets (Sicilia & Garcia, 2003).

In practical terms, a learning object is a piece of Web content of arbitrary type and structure described by a metadata record. This metadata record provides information about the object and its prospective educational usages. Learning object metadata, thus, is the key to reuse.

## LEARNING OBJECT STANDARDS AND SPECIFICATIONS

In recent years, a number of specifications and standards that describe or make use of the learning object concept have evolved. However, even though an important effort of cooperation has been made, some confusion still remains, derived from the existence of numerous organizations that create, develop and implement these specifications. The CEN/ISS Learning Technology Standards Observatory (www.cen-ltso.net), a "Web-based repository that acts as a focal access point to projects, results, activities and organizations that are relevant to the development and adoption of e-learning technology standards," represents one of the most significant clarification efforts in the field.

Regarding metadata, the basic elements associated with learning objects have been described in the IEEE LOM standard (IEEE, 2002). This standard, based on the well-known Dublin Core Metadata Element Set (Dublin Core, 2003), organizes its conceptual metadata schema in nine categories: General, Lifecycle, Meta-Metadata, Technical, Educational, Rights, Relation, Annotation and Classification. *General* and *Annotation* cover basic description—title, coverage and so forth—and general-purpose annotations. *Lifecycle* and *Rights*, contributors, change control and property matters. The category *Technical* covers technical characteristics of the Web contents. *Meta-metadata* covers the description of the metadata record itself. *Educational* describes the envisioned educational characteristics of the object, including type of interactivity, typical educational context, typical age of the intended learners and the like. The *Relation* category describes relations between learning objects, which could be seen as a form of "linking" the described learning object to educational characteristics; for example, related learning objects that constitute prerequisites or that cover semantically related elements (Sicilia, García, Aedo, & Díaz, 2004). Finally, the *Classification* category serves several purposes, including stating the objectives of the learning object, the prerequisites of the learner and the overall classification of the contents inside taxonomical schemes or ontologies.

As a descriptive standard, LOM enables catalogers to provide metadata values for the abovementioned categories. However, it is not mandatory for the annotator of a LOM conformant metadata record to specify a minimum number of values, because LOM is just committed to provide a conceptual model. The so-called *application profiles* provide useful guidelines for the implementation of practical subsets of LOM, addressing the requirements of particular user groups and recommending the use of certain LOM elements for local implementations. The most relevant examples of application profiles are the Canadian Core (www.cancore.ca), UK LOM Core (www.cetis.ac.uk/profiles/uklomcore), the Le@rning Federation metadata application profile (www.thelearningfederation.edu.au) and FAILTE metadata (http://failte.ac.uk).

On learning design, the recent IMS Learning Design specification (IMS, 2003), whose objective is "to provide a containment framework of elements that can describe any design of a teaching-learning process in a formal way," addresses the description of activity-based designs of learning activities. In each activity, several roles are joined together and interact with learning objects and services (similar to chat services) to accomplish some goals. Current IMS Learning Design implementations—like the *CopperCore (*http://coppercore.org) engine—provide a coordination support needed to effectively deliver the activities to the specified learners in the order and under the conditions specified in the learning design.

Regarding the learners, a number of specifications have been developed to allow the exchange of learner information between systems. Among these, it is important to mention both the ISO SC36/WG3 Learner Information, an information model based on the earlier LTSC Public and Private Information (PAPI) specification, and the IMS Learner Information Package, an interoperability protocol for Internet-based systems.

Another remarkable effort is the influential ADL Sharable Content Object Reference Model (SCORM). Regardless of IEEE and IMS Learning Design, SCORM is not a different specification, but "a model that reference a set of interrelated technical specifications and guidelines, designed to meet high-level requirements for learning content and systems." As part of the specifications compiled by SCORM, IEEE LOM has been adopted as the metadata language for learning resources, but SCORM also includes specifications oriented toward achieving a degree of interoperability in the functioning of *Learning Management Systems* (LMS). On the one hand, the SCORM content packaging specification determines an interoperable format for the interchange of learning contents structured as hierarchical units. On the other hand, the SCORM run-time specification states a common protocol and language for the Web browser-LMS communication, including the delivery of some kind of learning objects (called *Sharable Content Objects* in SCORM) and the recording and tracking of the activities of each user. Finally, the most recent sequencing and navigation specifications go further by providing a language in which complex navigational patterns can be devised, including learning paths that adapt to the accomplishment of some objectives by the learner.

IEEE LTSC, IMS and ADL, among other organizations, are currently active in the evolution and extension of the body of learning technology standards. Other areas currently covered and not discussed here for brevity include educational portfolios, learner descriptions, tests, digital repositories and competency specifications.

## LEARNING DESIGNS AS MODELS OF COMMUNITIES OF LEARNERS

Learning objects are considered as reusable elements that can be utilized as part of *learning designs*. IMS Learning Design provides a powerful language for the expression of learning designs targeted at the realization of activities. Here, an *activity* is considered a piece of interaction among a number of specified *roles*, played by persons, that produce a tangible *outcome* by using a concrete environment. The so-called *environment* of a given role is made up of learning objects and services available at runtime. Activities can be further decomposed into sub-activities. They are also aggregated into *methods*, which specify the conditions for application of the learning design, along with the planned objectives that will eventually match the outcomes of the activities. Methods can be structured around concurrent *plays* and these in turn in sequential *acts*, the latter allowing the specification of execution conditions. This schematic description of IMS Learning Design gives an idea of the flexibility that this specification provides for describing activity-based learning programs. The practical use of Learning Design-based tools would then allow the definition of the activities resulting from a process of instructional design that takes, as point of departure, a concrete perspective about learning that drives the crafting of the activities.