

# Learning objects, instructional architectures and digital libraries: new perspectives on interoperability.

Miguel Ángel Marzal<sup>1</sup>  
Javier Calzada Prado  
María Jesús Colmenero Ruiz  
Aurora Cuevas Cerveró

Library & Information Science Department  
Carlos III University of Madrid

## Abstract

This paper presents the theoretical basis and practical implications of the incorporation of learning objects to Higher Education learning architectures. Assuming that in order to improve their cost-effectiveness such architectures should benefit from the richness of resources that instructional digital libraries have available, the problem is found in interoperability, and proper content description is proposed as a solution from the Library & Information Science (LIS) area. A model for the implementation of a learning object repository in an online doctoral course as part of an ongoing project in the Carlos III University of Madrid, Spain, is finally proposed as main contribution.

## Introduction

In a time when rapid knowledge updating is becoming an increasingly vital competency for students and professionals to achieve in order to properly enter the Knowledge Society, learning environments should be adapted to these requirements. One of the main challenges these environments are facing has been issued by the Information & Communication Technologies, specifically the Internet, which has changed the nature of educational resources (Marzal et al., 2003). The traditional, static concept of didactic materials has given way to a new and highly interactive conceptualization of these resources. Recent research (Marzal et al., 2003) has pointed to Learning Objects (LO) as an ideal model of *document for education* in the Knowledge Society, not only for their interactive nature, but also for their reusability, which seems to be the key to make flexible and cost-effective online learning environments feasible.

The goal of this paper is to provide a theoretical framework and a prospective model for the incorporation of *learning objects* to the educational context of Higher Education, and specifically to one of our doctoral courses in the Carlos III University of Madrid. We consider that such learning objects might be included -by means of a proper content description- in learning architectures that allow them to additionally benefit from the richness of the open source learning resources available on instructional digital libraries.

---

<sup>1</sup> Miguel Ángel Marzal: [mmarzal@bib.uc3m.es](mailto:mmarzal@bib.uc3m.es); Javier Calzada Prado: [fcalzada@bib.uc3m.es](mailto:fcalzada@bib.uc3m.es); M<sup>a</sup> Jesús Colmenero Ruiz: [mcolmene@bib.uc3m.es](mailto:mcolmene@bib.uc3m.es); Aurora Cuevas Cerveró: [accerver@bib.uc3m.es](mailto:accerver@bib.uc3m.es).

## The Learning Environment: Online Learning Management Systems

The e-learning environment has witnessed the appearance of two technologies specifically designed for the management of learning: *Learning Management Systems* (LMS) and *Learning Content Management Systems* (LCMS). These systems have been efficiently proven not only in distance education, but also as support for traditional learning. The first of them -the most generic- are designed for the management of e-learning education, and the second have been created to manage the creation, storing, grouping and personalized development of learning contents. Both of them could be considered the merging of contents and technical architectures (García Manzanedo, 2003). On the side of technical architectures we find the own web platform and software -among other elements-, and on the side of contents we find learning object repositories.

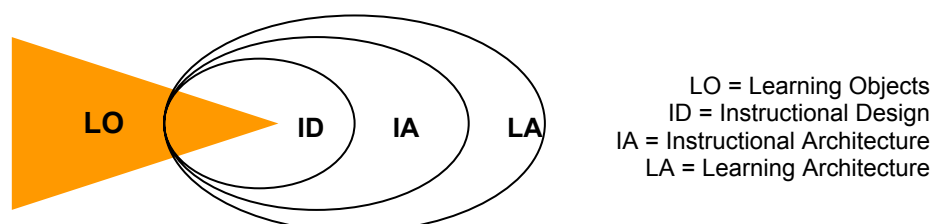
### Learning Objects in Online Learning Environments

Many definitions of learning objects have been provided, though the most widely accepted seems to be the one offered by the IEEE (2002) “a learning object is defined as an entity, digital or non-digital, that may be used for learning, education or training”. Wiley (2001) restricts his definition to “any digital resource that can be reused to support learning”, while Downes (2003) goes further and simply argues that “an object is a learning object if it is used in learning”. From these and many others, we have identified three definition elements that we believe might serve as a base for epistemological consensus and action of Information Science (LIS) in the Education field: instructional design, their predicative properties and their functionality.

### Instructional Design & Architecture

Learning objects are designed by teachers and instructional designers according to a global understanding of the curriculum in order to make them a veritable reusable tool in the different instructional situations they may serve and the depth level in which they want to be analysed. It is only when learning objects are combined with others following a certain instructional architecture (figure 1) that they acquire full semantic value for meaningful learning. We've observed two determining factors in their design: *granularity* and *visualization*. The former determines the way in which a concept is represented and its relation to others; the latter determines the order of integral instructional components.

Figure 1: Learning objects' input in learning architectures



### **Predicative Properties**

Predicative properties are based on two fundamentals: *learning intention* and *reusability*. *Learning intention* refers to those characteristic aspects that constitute a LO: *form* and *relation*. It implies that when a knowledge object acquires a form and provides the student with relations to understand it, then that object can be considered a LO. On the other hand, *reusability* implies separating LO's creation and dissemination in order to make it potentially available to be used in different instructional situations.

### **Functionality**

LO's functionality is targeted to achieve *accessibility*, *interoperability* and *applicability*. Allert et al. (2002) have provided several ways of applying LO to different educative environments, but the feasibility of such *applicability* depends highly on *accessibility* and *interoperability*, which is now trying to be made possible by the different specific learning object metadata standards that are being developed.

## **Learning Objects Description through Metadata**

As Downes (2003) states, what is defintory about learning objects is the combination of an object and its description of the educational contexts in which it has been used and could be used again. Several educational metadata schemes have been developed until now to try to properly describe educational resources, from which we would like to highlight some of the most widely accepted and commercially adopted:

a) *IEEE LOM*. Based on original work from ARIADNE and IMS, it is now an approved standard (IEEE, 2002) that defines the overall structure -syntax and semantics- of the metadata schema for learning objects. IEEE has also developed XML and RDF binding specifications.

b) *IMS Content Packaging Specification*. The Instructional Management Systems consortium developed its specifications from the IEEE LOM, adding some slight modifications. As the IEEE, IMS has also developed an XML/RDF Binding Specification, a DTD and a Best Practices and Implementation Guide for its model.

c) *SCORM* (Sharable Content Object Reference Model). Developed by the Advanced Distributed Learning (ADL) Initiative originally in the context of military and training applications, it is claimed to be a unified "reference model" or *lingua franca* for related specifications.

## **Instructional Digital Libraries as Sources of Learning Resources**

Some instructional digital libraries –basically, repositories that can store educational resources or the links to that resources- have already adopted LO metadata schemes to describe their collections. CAREO, for instance, is a repository being carried out by three Canadian universities in order to create a searchable, web-based collection of multidisciplinary teaching materials. It uses CanCore for the description of the objects stored, which is a LOM metadata profile or version, which is compatible with IMS and has been developed to attend to the specific requirements of public and continuing education. ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe) is the European initiative on sharing and reusing LO in educational contexts through its Knowledge Pool System (KPS). It has been involved in the development of many of the existing and before mentioned LO metadata standards, which are used for the description of the objects stored in it. Another example is MERLOT (Multimedia Educational Resource for Learning and Online Teaching), an IMS specifications-compliant repository maintained by a consortium of U.S. higher education institutions, which provides faculty and students of higher education with annotated links to online educational contents.

It is important to stress that these initiatives anticipate and show the great potential that LO sharing has in LCMS as a means to cost-effective course development. Exchanging LO between educational institutions will definitely benefit teachers and students (Vladoiu, 2003).

### **The Interoperability Problem: The LIS Perspective**

Knowledge organization and retrieval is the main problem that Library & Information Science has dealt with from the very beginning of its existence. The current problem of interoperability between LORs is a parallel case to the one that has already been solved in our field in relation to online cataloguing. In that case, the cost of manual cataloguing and classification promoted the adoption of internationally accepted description standards -the MARC format- and classification systems to allow the exchange of records between libraries through the Z39.50 protocol. Similarly, the use of metadata standards in digital libraries might suggest the possibility of an easy exchange and fast reuse of their resources in a certain learning architecture, but some problems arise concerning syntactic and semantic interoperability (Friesen, 2004):

a) *Syntactic interoperability*. Most of the existing LO metadata standards and recommendations provide the equivalences –mapping- of their schemas and bindings to other main standards in order to secure interoperability, not always achieved, as Friesen reports (2004).

b) *Semantic interoperability*. Some authors have noted that LO metadata standards do not support appropriate content representation, since they are designed to describe objects at the document or collection level and thus do not support the finest level of LO granularity, which is basic to foster reusability. Qin and Finneran (2002) defend the adoption of ontologies to represent functional

information, which is for them the missing content. An ontology could be defined as a model of entities and their relationships from a particular domain of knowledge that is used to assist knowledge sharing by creating an agreed-upon vocabulary for the exchange of information. These ontologies should be constructed according to specialized educational vocabularies. In fact, LO metadata standards recommend the use of specific-domain vocabularies, though most of the times the right vocabularies do not exist or they are too general. An alternative approach to this problem is the use of specific formal ontologies –specialized thesauri- for terminology control and topic maps as a basis for the automated construction of thesauri.

### **Putting Theory into Practice: The Online Doctoral Course Project**

Now we will try to put into practice the paradigm exposed in our own learning environment. The Online Doctoral Course Project (ODC) of the Carlos III University's Doctorate Program in LIS, is part of the ongoing project "Documentation and information technologies: tools for information literacy and the organization of educational resources" (BSO2003-04895), which is financed by the Spanish Interministerial Commission of Science and Technology. Its main goal is to turn the Doctoral course "LIS and Educational Resources in the Information Age" -taught by Prof. Marzal- into a virtual and interactive one, as a reference for the rest of doctoral courses in the Carlos III University. We believe that one of the features of our ODC should be a learning object repository (LOR) in order to boost its didactic effectiveness.

#### **Aula Global, the LCMS of the Carlos III University of Madrid**

Campus Global is the LMS of the Carlos III University of Madrid, and it contains a LCMS called Aula Global, which has been designed to foster distance education and student-teacher interaction. Supplied with editing, publishing, communication and assessment tools, Aula Global provides an ideal framework for the incorporation of LO to our ODC project.

#### **Practical Implications**

As part of the process of pedagogical renewal that intends to adapt teaching labour to the *Bologna Declaration on the European Space for Higher Education*, the ODC is supported by a program-agreement between the LIS Department and Carlos III University. Such program is intended to update didactics through the incorporation of digital resources. From this and the theoretical framework described above, we have planned the following prospective model for the implementation of a LOR in our online doctoral course:

1. The repository should comprise in-house developed LO or links, but will also aim to import them from instructional digital libraries.
2. The repository should adopt widely used LO metadata schemes for the description of the collection.
3. Specific domain ontologies and vocabularies will have to be developed in order to achieve a proper content description according to the granularity level required by these materials.

## Conclusions and Future Work

The incorporation of learning objects to learning architectures is an upward trend. Learning Content Management Systems like ATutor or LNR -used in several universities worldwide- are becoming LO metadata standards compliant and adopters of the LOR idea. The ODC project is trying to join this trend and thus make our university benefit from the LO paradigm. Preliminary vocabulary and topic map tests will be conducted during the following months.

## References

- Allert, H. et al. (2002). Learning Objects on the Semantic Web: Explicitly Modelling Instructional Theories and Paradigms. ELEARN 2002. Retrieved February 12 from [http://www.aace.org/dl/files/ELEARN2002/paper\\_3009\\_3359.pdf](http://www.aace.org/dl/files/ELEARN2002/paper_3009_3359.pdf).
- Downes, Stephen (2003). Designing Learning Objects. Australian Flexible Learning Community. Retrieved 13 February from <http://learnscope.flexiblelearning.net.au/learnscope/golearn.asp?Category=11&DocumentId=4077>.
- Friesen, Norm (2004). Semantic & Syntactic Interoperability for Learning Object Metadata. In Hillman, H. (ed.) Metadata in Practice. Chicago: ALA Editions. Retrieved February 10 from [http://www.cancore.ca/semantic\\_and\\_syntactic\\_interoperability.html](http://www.cancore.ca/semantic_and_syntactic_interoperability.html).
- García Manzanedo, Javier (2003). El e-Learning en España: Modelos actuales y tendencias de actuación. Madrid: EOI.
- IEEE (2002). IEEE Standard for Learning Object Metadata 1484.12.1-2002.
- Marzal, Migel Ángel; Cuevas Cerveró, Aurora; Colmenero Ruiz, Maria Jesús; Calzada Prado, Javier (2003). El recurso educativo como documento: learning objects. *III Jornadas Andaluzas de Documentación Jadoc'03*, 20-23 November, Seville, Spain.
- Qin, Jian; Finneran, Christina (2002). Ontological representation of learning objects. In: *Proceedings of the Workshop on Document Search Interface Design and Intelligent Access in Large-Scale Collections*, JCDL'02, July 18, Portland, OR. Retrieved February 8 from <http://xtasy.slis.indiana.edu/jcdlui/papers/qin.pdf>.
- Vladoiu, Mihaela-Monica (2003). Learning Objects Need Badly Instructional Digital Libraries Support. *Informatics in Education*, 2 (2), 291-316.
- Wiley, D. A. (2001). Connecting learning objects to instructional design theory: a definition, a metaphor and a taxonomy. In Wiley, D. A. (ed.). *The Instructional Use of Learning Objects*. Bloomington: Association for Educational Communications and Technology.