LEARNING OBJECTS DEFINITION AND USE IN <E-AULA>

Towards a Personalized Learning Experience

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Abstract: This paper describes how learning objects are defined and treated in <e-aula>, a pilot e-learning system that aims to offer a personalized learning experience geared to individual student's needs. The term learning object (LO) has been on the educational agenda for several years now and has become the Holly Grail of content creation and aggregation in e-learning, promising smart learning environments, fantastic economies of scale and exciting learning experiences tailored to individual needs. Nevertheless, there are a number of aspects where more research is needed. First, there is a lack of conceptual clarity in the definition, standardization and use of LOs. Also, there has been limited emphasis on the need for introducing adaptable learning features within the LO construct. The objective of this paper is to contribute to the practical application of these concepts by presenting the <e-aula> learning objects and how the system handles personalization features to create an infrastructure for performing an individualized learning.

Key words: e-learning; learning objects; Adaptive systems; educational standards; markup languages.

1. INTRODUCTION.

The combination of Internet technologies, new learning design models and usage of markup technologies have largely enhanced the possibilities offered by traditional computer assisted instruction (Fernandez-Manjon, 1997). We are getting close to constructing learning applications that could make real the promises offered by "student centred" learning paradigm. This

means a customized education capable of accommodating the different learning styles, strategies, and preferences of diverse learners (Manouselis, 2002).

In this context, the concept of Learning Object (LO) plays a basic role. The term was first popularised by Wayne Hodgins in 1994, and the idea behind the LO concept is that educational materials are no longer structured in a monolithic way, but instead, are disaggregated into pieces of reusable learning chunks.

The LO approach for course development promises more efficiency in content management not only by preventing multiple development of the same content, but also because it facilitates content update and modification. In addition, the LO approach could enhance the possibilities of personalizing the learning environments: LOs could be dynamically assembled to create courses that meet individual needs.

For this vision to be achieved, instructional content must be developed as reusable, stand-alone objects, properly annotated with metadata so that they can be located and retrieved. Moreover, the learning objects, their associated metadata and the e-learning courses should be developed in a uniform manner according to standard guidelines.

In the past five years considerable efforts in the e-learning field towards the standardization have been made. As a result of these efforts several agreements have been reached among a number of organizations involved in the standardization process, leading to increasing the accessibility of the learning content that can be shared (e.g. Learning Object Metadata standard). These organizations include the IEEE Learning Technology Standards Committee (LTSC), the IMS Global Learning Consortium and the Advanced Distributed Learning initiative.

We have found two different problems in standardization proposals hindering the final LO objective model. First, there is a lack of conceptual clarity of what a LO should be: LOs are different things to different e-learning professionals (ASTD, 2002). Many inconsistencies in what is stored under the name of learning object, have been detected in the available LO repositories (e.g. see Educational Object Economy http://ww.eoe.org, or ARIADNE http://www.ariadne-eu.org/).

The second problem arises when trying to implement personalization features according to the existing standard specifications: the main focus of the standardization initiatives is LO interoperability. There has been limited emphasis on the need for introducing adaptive learning features within the LO construct. Under the current version of these standards, LO are treated as opaque entities that cannot yet be adapted to student's needs. Therefore, to obtain all the potential benefits offered by the LO approach more research

has to be done within the frame of adaptive applications implemented according to e-learnng standards and used in real educational contexts.

This paper aims to offer an experimental response to these problems based on the experiences obtained in the <e-aula> project. First we provide several guidelines for creating LOs, and then we address the shortcomings in the content of learning objects to suit the level of learners, accommodating the learning experience his/her profile and needs, and enabling a dynamic generation of personal learning.

2. LEARNING OBJECTS DEFINITION IN <E-AULA>.

<e-aula> is a pilot e-learning system conceived as a research platform to study the possibilities facilitated by educational standards and new learning design methodologies under two main features: content reuse of previously existing educational material, and content adaptation to meet individual needs (basically students' previous knowledge and his / her knowledge objectives).

Our objectives are to develop reusable, flexible, and scalable methodologies, contents and environments by using design specifications (educational standards), markup languages and web technologies.

Some requirements for achieving these objectives are:

- To design a content oriented methodology to create the system. This allows the environment to be quite independent of the contents. Adding new contents to the system should be easy, so <e-aula> becomes easily scalable (See Figure 1).
- To develop the necessary system architecture to create and deliver courses based on user profiles. By using e-learning standards as a reference, we will do research on user centred learning.
- To develop several courses with real contents and test them in a university-learning context.
- To implement different prototypes taking into account different standarization proposals and evaluate their possibilities in a real environment.

Even though <e-aula> is conceived as an e-learning infrastructure aimed at testing e-learning standards at all the levels in the course creation process, this paper is mainly focused on the LO aspects. In this section we first analyze the existing confusion when trying to determine what a LO is (Sosteric, 2002; Polsani, 2003), then we provide several guidelines collected from the LO literature to create LOs as consensuated as possible, and finally we offer the <e-aula> vision for constructing LOs.

2.1 But, what is a learning object?

There is a broad understanding among the members of the LO community about the functional requirements a LO should have (Polsani, 2003):

- Accessibility: the LO should be tagged with metadata so that it can be stored and referenced in a data base.
- Reusability: once treated, a LO might be used in different instructional contexts.
- Interoperability: the LO should be independent of both the delivery media and learning management systems.

But this is very much all the consensus reached up to date about the concept of LOs. There is still a great vacuum in descriptive, analytical and critical examinations of LO technologies.

Derived from the impractical overarching definition offered by the Learning Object Metadata v6.1 standard, which describes a Learning Object as "any entity, digital or non digital, that may be used for learning, education or training", many authors and institutions have given their own vision of what a learning object should be in practice. See for example (Wiley, 2002; Wisconsin Online Resource Center http://www.wisc-online.com; L'Allier, 1997).

Like in other research works (Friesen, 2001; Polsani, 2003; Sosteric, 2002), we think that there is an important predicate in the LO concept that cannot be left out: learning and context. Contrarily, other authors depict LOs as instructionally neutral (Downes, 2001).

For a digital object to acquire the status of a LO, it should be wrapped in a learning intention. For example an image of a picture can be used during technology-supported learning, and even reused in different educational contexts. But, just looking at the picture teaches nothing. It needs to be wrapped with contextual information. In a traditional educational setting, the instructor would provide this information, would interpret the object and would reorganize the context creatively, which requires a vast amount of background information.

Let's now state what are the necessary requisites to design a course that fulfils the LO philosophy. Firsly content creators have to construct the LOs, attaining a high level of abstraction, in order to enable reusability, and wrap them with enough contextual information for them to be instructionally useful. Second, instructors and course designers have to decide according to their learning objectives, the pedagogical methodology and instructional design theories how LOs have to be related in a certain course. Finally, the design has to be flexible enough to suit individual students, permitting, for

instance, those concepts that don't fit their knowledge needs to be skipped and the learning experience to be adapted to their own preferences.

If this is not enough, LOs have to be properly marked with standard metadata in order to enable interoperability, accessibility and reusability: the construction of recovery mechanisms according to different criteria for LOs is needed to enable LO reuse.

No wonder why the LO economy objectives are still elusive.

2.2 LO definition in <e-aula>

<e-aula> LOs are self-contained units designed to be instructionally independent. When designing <e-aula> LOs we try to keep in mind the concepts stated in section 2.1: abstract enough to be reusable (that means, they must be as independent of use as possible) and wrapped with contextual information to meet the "learning" principle (aimed to teach a particular concept or ability).

Another feature we have taken into account is granularity: having small units of LOs increases the annotation effort, but implies better reusability.

Our own demands in personalization and reutilization together with the basic principles outlined in point 2.1, have led us to create learning objects for <e-aula> as an aggregation of digital resources consisting of: core material (typically <e-aula> files encoded in XML) containing mainly textual and graphical explanations with the scope of a learning topic, a set of examples, notes and a set of assesments.

In <e-aula> all the basic course contents are also represented directly in XML and not in HTML as is done in most e-learning systems. When a specific content is accessed in the web server an XSL transformation is applied to the content obtaining the HTML that is delivered to the web client (see figure 1). This approach is similar to the one used in other projects such as ARIADNE (ARIADNE, 2003). XML contents also simplify the automatic processing of LOs for coping with the frequent evolution and changes in e-learning standards and specifications. In many cases these changes can be automatically done by means of a XSL transformation.

3. <E-AULA>: TOWARDS PERSONALIZED LEARNING.

We believe that the learning object approach is the first step towards achieving personalized content which addresses the learning needs of each and every student. The idea is to segment existing course material (and

annotate it properly using IMS LOM metadata schema) to dynamically compose courses "on-demand" adapted to individual learning needs. Well-structured metadata can facilitate the search, retrieval and manipulation of LOs without compromising their integrity.

Many research works have been carried out to develop a system capable of adapting its learning strategies in agreement to the learning profile(Brusilovsky 1996a, Brusilovsky 1996b). Our approach is closer to (Atif, 2003) in which most of the intelligence is embedded in the learning objects themselves.

In our system, we have used LO personalization properties in two different ways: different organizations of the LOs into the course and LO content marked up according to different knowledge level of each user. These aspects are discussed in the next sections.

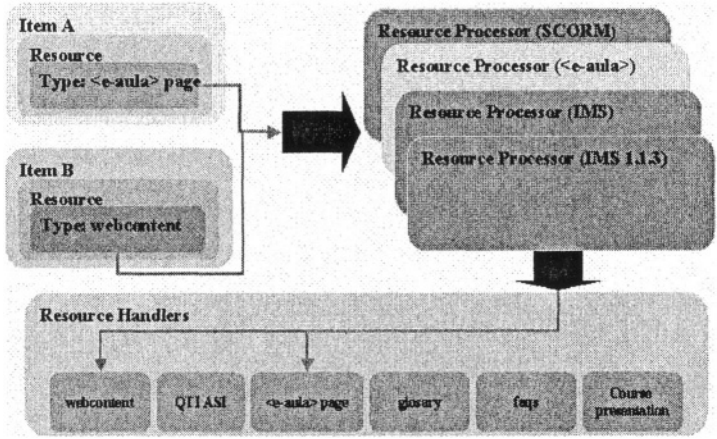

Figure 1. <e-aula> Delivery System Architecture that is able to deal with different LO formats

3.1 Learning Objects Metadata

Our objective is to facilitate an efficient pre-selection of the learning objects suitable for different learning needs. LOM metadata schema permits us to have a very rich and flexible file about LOs classified in 9 categories. However, this flexibility comes with a price due to its extension and the annotation effort it involves.

In our current implementation we consider that the following elements and sub elements are essential for our reutilization and personalization purposes:

- <general>
  - <identifier>
  - <title>
  - <language>
  - <description>
- <lifecycle>
  - <contribute>
- <educational>
  - <interactitytype>
  - <description>
- <classification>

As the LOM specification explicitly states, its scope does not include "how a learning technology system represents or uses a metadata instance for a learning object". It turned out that these elements are enough to annotate and query our resources, and represent a compromise between more abstract and more detailed annotation sets.

The main problem we have faced when trying to implement our system adaptation properties is that under the current version of the standard, learning objects are treated as opaque entities (Rodriguez 2003). The description of the LOs is intended to advance the goals of interoperability, but does not address the need for accessibility to the internal composition of the LOs which is essential for the goal of adaptation.

The intelligent discovery and assembly of learning objects require information not supported by the current set of elements of the LOM standard. A learning object has a context that is specific for its use. It is necessary for each learning object to specify exactly how that learning object is related to concepts in a particular domain within its context, i.e., an ontology of concepts in a particular domain.

We think a LO created using this annotation principle gets new dimensions of reusability and adaptivity. This way created LOs are more suitable for retrieving since their content can be inspected using ontology-based conceptualization. With this kind of knowledge, an agent can compare the course structure developed for a specific learner profile with the learning object, based on a common understanding of how they relate to each other.

LOM Metadata records can be effectively linked to ontologies. We are using Meta-Metadata elements to declare dependencies of the metadata record with ontologies, and links to ontology terms in the Classification element as proposed in (Sicilia 2002). This permits data in learner profiles to be linked to ontology terms, which not only should enhance system adaptation features, but should also make personalization easier.

3.2 Learning Objects and XML

We have added a supplementary granularity level: the object content itself is marked using XML, which provides deeper and more detailed information that can be used for more extended adaptation mechanisms. The system is able to display the information contained in a learning object according to the student's level of knowledge (<e-aula> the system has three possible levels: low, medium and high) (see figure 2). As previously stated, XML contents also preserve content from external changes, even changes in standards specifications. XML contents provide our contents with structure instead relying on IMS recomentations (i.e. contents in HTML format).

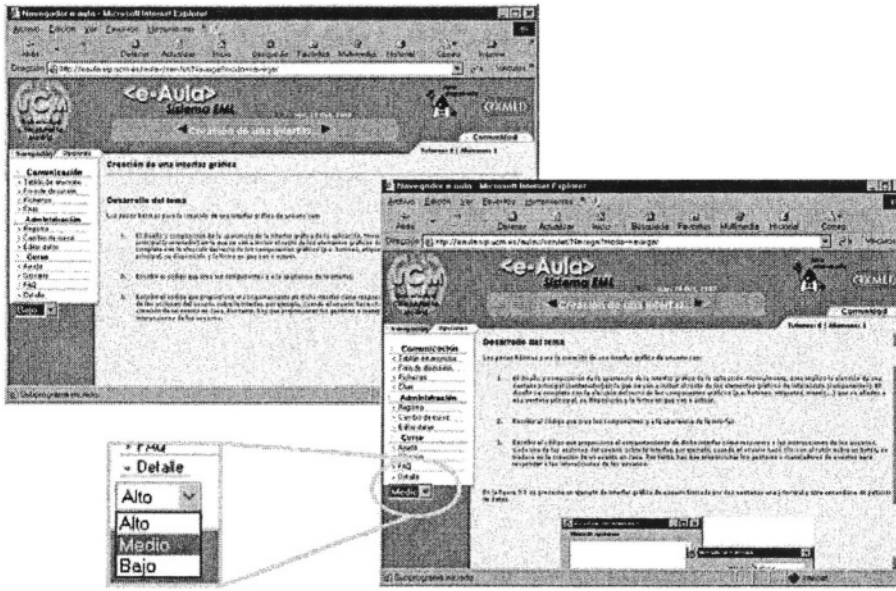

Figure 2. Different educational contents displayed for medium and low knowledge levels

4. CONCLUSIONS AND FUTURE WORK

<e-aula> is a pilot e-learning system conceived as a research platform to test and evaluate new learning technologies (learning standards, new learning design models (LO approach), markup and web technologies) in order to reach a personalized learning experience adapted to student's needs.

Based on our experiences working with these technologies we have reached the following conclusions:

- The first difficulty to be faced when trying to implement a LO approach, is the vacuum of conceptual clarity in LOs themselves. In our opinion, more work has to be done in order to reach a standard and within the LO community. Real interoperability can only be achieved if all the parties involved agree on what is behind the word LO.
- A learning object has a context that is specific to its use. An understanding of the many contexts in which an object is used, would result in the increase of its reusability. To make this possible, it would be necessary to articulate the relationship between the metadata associated with the object and the surrounding objects, and report that relationship to the repository. To compose a course from a set of learning objects, an appropriate modeling of conceptual dependencies between fragments is needed. We are developing a concept taxonomy to describe the structure of the concepts and to specify the conceptual relations between fragments and concepts.
- The information about content itself offered by IMS metadata is not enough in terms of defining adaptation methods based on students' knowledge level, knowledge objectives and learning method preferred. We consider that better results would be obtained reaching a deeper granularity level. We have obtained promising results marking up our LO's themselves using XML.

The next steps in the <e-aula> project are to fully implement the IMS Simple Sequencing specification and to study how the new functionality recently added to IMS LIP, called IMS Accessibility for LIP, could be used to customize and personalize the system for each student.

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