RESEARCH ON LEARNING-OBJECT MANAGEMENT

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Abstract: Although LO management is an interesting subject to study due to the current interoperability potential, it is not promoted very much because a number of issues remain to be resolved. LOs need to be designed to achieve educational goals, and the metadata schema must have the kind of information to make them reusable in other contexts. This paper presents a pilot project in the design, implementation and evaluation of learning objects in the field of university education, with a specific focus on the development of a metadata typology and quality evaluation tool, concluding with a summary and analysis of the end results.

1 INTRODUCTION

Many studies have been done on the concept of learning objects (LOs) but no consensus has been reached on a standard definition or on the technical and pedagogical requirements. Specifications are being developed but have yet to be normalized, and the use of metadata schemas is still under discussion. This has prevented LO creation and management from becoming common practice.

This paper presents our research on the design, implementation and evaluation of a prototype LO management tool for e-learning systems, containing quality criteria designed to enable LOs to be standardized and attuned to educational needs. The prototype was built on the basis of our own knowledge model, and comprises specific metadata value spaces for classifying LOs into the LOM "5. Educational" metadata category (IEEE LOM, 2002).

The paper begins by outlining the development of an initial prototype learning object (LO1) and determines what type of metadata should be applied (section 2). It goes on to describe how we implemented and evaluated LO1 using our LO evaluation tool (section 3); then describes how the results of those trials were used to produce a second prototype (LO2), which was also implemented and evaluated (section 4). Finally it presents our conclusions and plans for the next stages of our work (section 5).

2 LO DESIGN AND PROPOSED METADATA TYPOLOGY

The first task to create our initial prototype learning object (LO1) was to chose a context in which to conduct our trials: the Object-Oriented Programming (OOP) option of the Computer Science course at Salamanca University (Morales, García, Barrón and Gil, 2007c). We then defined a set of specific learning objectives with which we built a knowledge model (figure 1) that served to produce a basic unit of learning for designing LO1, entitled "Object-Oriented Programming: General Issues" (Morales, García and Barrón, 2007b).

One of the key goals here was to enable a knowledge model to be used to standardize LOs, which is crucial for them to be tailored to educational needs, taking into account key elements for learning (Morales, García and Barrón, 2007a).

Sound LO management requires the incorporation of reliable metadata, but the viability of the only metadata schema currently regarded as a standard (IEEE LOM, 2002) has been called into question because it uses vast quantities of ill-defined types of data, and some of its metadata categories do not make it clear what kind of information has to be added, thus further complicating the task of LO management (Morales, García and Barrón, 2006).
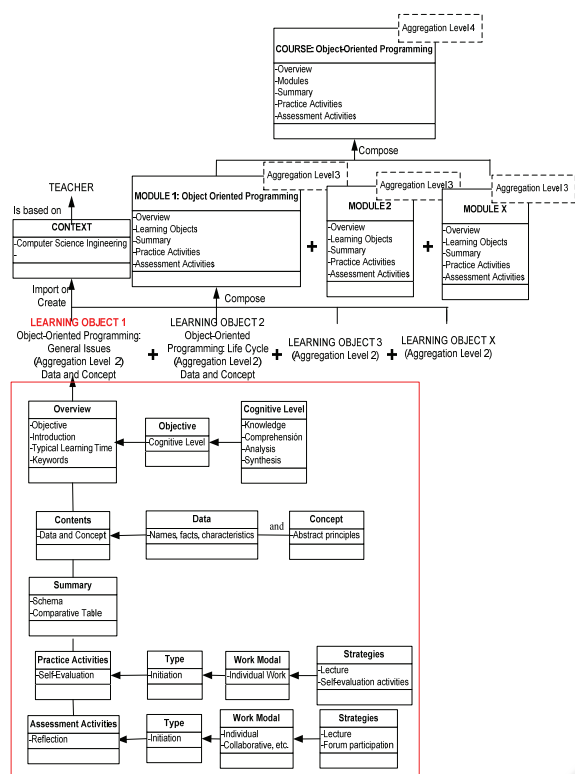
Figure 1: Knowledge Model of LO1.

Although the lack of clarity in the IEEE LOM standard makes its value spaces hard to interpret.

We set out to address this issue – and, hence, to enable suitable LO management data to be introduced into learning environments – by devising a set of definitions to clarify the content of each value space in the LOM "5. Educational" category:

- **5.1 Interactivity Type**: expositive
  LOs featuring a very low interactivity level, with students receiving information yet remaining unable to interact with the content
- **5.2 Learning Resource Type**: web pages
- **5.3 Interactivity Level**: low
  LOs with an expositive interactivity level – minimal student participation (web pages with few links)
- **5.4 Semantic Density**: medium
  LO content designed to promote smooth learning and application of knowledge
- **5.5 Intended End User Role**: learners
- **5.6 Context**: university level
- **5.7 Typical Age Range**: Unspecified
- **5.8 Difficulty:** easy
  Information is easily associated with previous knowledge

We then incorporated these definitions into our prototype LO1.

3 LO1 IMPLEMENTATION AND EVALUATION

Having designed LO1 based on our knowledge model and incorporating our proposed metadata typology, we set about implementing it with Moodle together with the following additional elements:

- a pdf file: so that our sample students could print out the LO content
- a self-assessment section: so that they could see how much they knew about the content, and to repeat the test whenever necessary
- a forum: so that learners and teachers could discuss the content
- an evaluation tool: for the students to rate the quality of LO1.

Current proposals for learning resource evaluation tools include web sites (Marqués, 2003; Torres, 2005) and multimedia tools, (Marqués, 2000), and other proposals have been made for assessing the quality of LOs taking into account their instructional use-oriented design (Williams, 2000) and sequencing (Zapata, 2006). We drew on these to design an instrument that would enable learners to assess the value/quality of their LOs (see figure 2).

Our sample students were able to access the LO and the evaluation tool via Moodle and to rate them on a scale of 1 to 4: 1= very poor; 2=poor; 3=satisfactory; 4=high; 5=very high.

As seen in figure 2 (above), the evaluation tool was designed to gather qualitative and quantitative data about LO1.

The qualitative results show a general agreement on its quality. The highest scoring value was the difficulty level (3.87), followed by the objectives and content (3.82). These results reflect our sample students' approval of the content in terms of its quantity, consistency, reliability and so on. Navigation was considered well-designed and user-friendly (3.79).

The students were slightly less happy with the overall design of LO1 (3.74), and suggested a number of possible improvements. They also made a number of positive comments on the feedback (3.66). 'Activities' and 'interactivity' were rated satisfactory (3.51), as was the lowest scoring criterion: 'motivation' (3.41).

The feedback gained from the space provided in LO evaluation tool for students to make comments provided very useful pointers for us to see what needed to be improved when developing our second prototype (LO2).

Table 1: LO1 quality rating incorporated into LOM.

9. Classification	
9.1 Purpose	Quality
9.2 Taxon Path	
9.2.1 Source	Table 1. LO Eval. Rating Scale
9.2.2 Taxon	CA*: 3.64 (high)
9.2.2.1 Id	CA: 3.64 (high)
9.2.2.2 Entry	High
9.3 Description	LO considered high quality by sample students. Lowest scoring quantitative items were 'motivation', 'activities' and 'interactivity'. Qualitative feedback suggested adding a glossary and examples…
9.4 Keyword	quality, value, high, CA_3.64.

*CA: CALIDAD (quality)

To input the quantitative and qualitative data on the quality of LO1 into our metadata typology, we used the LOM "9. Classification" metatada category in combination with our own LO quality rating classification scheme. We believe that quality measurement using a scale should be introduced into the "9. Classification" metadata category. Table 1 shows our prototype adaptation using the final quality score taken from the LO1 evaluation results.

Adding a quality value to the LO metadata category would help locate and retrieve an LO through a search based on keywords (e.g. quality, value, high, etc.) An alphanumeric value (e.g. CA_3.64). makes it possible to define a specific vocabulary for running an LO search.

The sample students' comments provided useful pointers for producing an enhanced and more user-friendly design for our second prototype (LO2), with a different font, larger characters and links to further reading.. The actual content of LO2 followed on from LO1, taking the learning objectives to a more advanced level.

4 LO2 IMPLEMENTATION AND EVALUATION

LO2 was implemented in the same learning environment as LO1, and was evaluated with an enhanced version of our quality evaluation tool (figure 2).

The final score reflects a similarly high average quality rating on the part of our sample students (3.66). The highest scoring item was 'navigation' (4.00), followed by 'description' and 'activities' (self-assessment) (3.91), both of which figure in the Didactic Curricular Issues category.

Content design was considered high quality (3.74), as were three other didactic-curricular issues: – achievement of objectives (3.69), learning time, and LO content (3.63) – and one psycho-pedagogical issue: 'difficulty' (3.63) .

Student comments were even more positive for LO2 than LO1, expressing their approval of the new section with references, links to further reading, a glossary and a list of acronyms.

Some, however, considered that the screen resolution was better but needed further improvement: there were still too many scroll bars and accessing table cells remained an impediment to sightless users.

Having completed our evaluation, we incorporated the overall LO2 quality rating into the corresponding LOM "9. Classification" metadata

EVALUATION CRITERIA CATEGORY		SCORE
PSYCHOPEDAGOGICAL ISSUES		
MOTIVATION	I felt motivated during the lesson	3,43
DIFFICULTY	Was suited to my learning level.	3,63
PARTICIPATION	My role in the lesson was clearly explained	3,63
DIDACTIC CURRICULAR ISSUES		
DESCRIPTION	I understood clearly what I was expected to do	3,91
OBJECTIVES	I have achieved the learning objectives	3,69
CONTENTS	Sound, suited to objectives, clearly explained, well referenced.	3,63
ACTIVITIES	Forum discussions, self-assessment, etc. were effective and useful for learning	3,91
TIME	Adequate for achieving objectives	3,63
FEEDBACK	I had ample opportunities at all times	3,34
TECHNICAL AND FUNCTIONAL ISSUES		
INTERACTIVITY	Suited to achieving the learning objectives	3,34
NAVIGATION	User-friendly	4,00
DESIGN	Clear and easy to follow	3,74
LO QUALITY FINAL VALUE		**3,66**
COMMENTS (Including examples of how/where this LO can be reused)		

Figure 2: LO2 Evaluation Results.

category, using the LO classification scheme based on our proposed metadata typology (Morales, García and Barrón, 2007b).

Our proposed adaptation of the LOM "9. Classification" metadata category comprises the key quantitative and qualitative data collected with our LO quality evaluation tool. In presenting a summary of learners' comments on LO quality, item "9.3. Description" provides a useful means of further improving that quality.

5 CONCLUSIONS

Our prototype knowledge model sought to demonstrate how LOs can be established as a basic unit of learning, taking into account key educational needs. It can be used to adapt an LO to a specific type of course at university level.

The LO quality evaluation tool enabled us to collect a wide range of information useful for improving both LO1 and LO2. In attributing a numerical value to LO quality, the rating scale helped specify exactly which data to incorporate into the metadata schema.

It is important to remember that metadata editors today only classify LOs according to specific established purposes. We used the LOM "9. Classification" metadata category because we believe it useful for defining and adapting new LO classification schemes that would allow users to acquire and manage LOs suited to their own individual needs.

Finally, the results obtained with the LO quality evaluation tool helped highlight exactly what improvements needed to be made. Sorting evaluation criteria into different categories made it possible to evaluate the LOs from both pedagogical and technical points of view.

Our future work will focus on developing an LO creation tool based on our knowledge model. We will also seek to improve the quality of LOs by taking into account the accessibility issues that are crucial to LO management.

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