An Experience on Learning Objects 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 evaluate tool, concluding with a summary and analysis of the end results.

Key-Words: Learning Objects, Management, Quality, E-learning, Metadata, Evaluation

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 [1].

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 choose a context in which to conduct our trials: the Object-Oriented Programming (OOP) option of the Computer Science course at Salamanca University [2]. We then defined a set of specific learning objectives with which we built a knowledge model that served to produce a basic unit of learning which, in turn, served as the basis for designing LO1, entitled “Object-Oriented Programming: General Issues” (see figure 1) [3]. 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 [4].

Sound LO management requires the incorporation of reliable metadata, but the viability of the only metadata schema currently regarded as a standard [1] 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 [5]. Although the lack of clarity in the IEEE LOM standard makes its value spaces hard to interpret, most metadata editors today continue to use that standard without seeking to explain the meaning of each space.

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” metadata 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)
- **5.3 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 – using Dreamweaver MX – we then set about implementing it with Moodle, introducing the following supplementary 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 [6]; [7] and multimedia tools, [8], and other proposals have been made for assessing the quality of LOs taking into account their instructional use-oriented design [9] and sequencing [10]. 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
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). Here is a selection of their comments:

- Add a glossary of key concepts and list of acronyms.
- Add examples to illustrate/clarify abstract concepts.
- Avoid table cells in web page design (as it impeded accessibility for sightless users).
- Highlight main points (e.g. in bold).
- Avoid too many references in short texts.
- Adjust window resolution to avoid too many scroll bars.
- Provide more detailed information on what aspects of the criteria the tool is evaluating.

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. First we developed the LO quality rating scale shown in Table 1 (below).

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 1.5</td>
<td>very poor: too low. LO to be eliminated</td>
</tr>
<tr>
<td>1.6 – 2.5</td>
<td>poor: low, with much room for improvement</td>
</tr>
<tr>
<td>2.6 – 3.5</td>
<td>satisfactory: could be better</td>
</tr>
<tr>
<td>3.6 – 4.5</td>
<td>high: good but could be better still</td>
</tr>
<tr>
<td>4.6 – 5.0</td>
<td>very high: good, with no need for further improvement</td>
</tr>
</tbody>
</table>

Table 1 sets out the various LO ratings on the evaluation scale and explains their corresponding quality levels. We believe that quality measurement using a scale like this should be introduced into the “9. Classification” metadata category. Table 2 (below) shows our prototype adaptation using the final quality score taken from the LO1 evaluation results (figure 2).

<table>
<thead>
<tr>
<th>9.1 Purpose</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2 Taxon Path</td>
<td></td>
</tr>
<tr>
<td>9.2.1 Source</td>
<td>Table 1. LO Eval. Rating Scale</td>
</tr>
<tr>
<td>9.2.2 Taxon</td>
<td>CA*: 3.64 (high)</td>
</tr>
<tr>
<td>9.2.2.1 Id</td>
<td>CA: 3.64 (high)</td>
</tr>
<tr>
<td>9.2.2.2 Entry</td>
<td>High</td>
</tr>
</tbody>
</table>

| 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; avoiding use of table cells in LO design; using fewer references in text; and improving screen resolution |

| 9.4 Keyword | Quality, value, high, CA_3.64. |

*CA: CALIDAD (quality)

Table 1, LO Quality Rating Scale

Table 2, LO1 quality rating incorporated into LOM
Our thinking was as follows:

- 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.) and alphanumeric values (e.g., CA_3.64). An alphanumeric value makes it possible to define a specific vocabulary for running an LO search.

- Using specific kinds of values would provide a means of developing more sophisticated search methods, e.g., using an intelligent agent to find and compare LOs according to quality criteria. This would require a multi-agent architecture enabling personal retrievals from multiple sources.

- LO management would be facilitated by incorporating LO quality ratings into semantic profiles [11],[12].

- IEEE LOM metadata categories at present do not consider classifying LOs according to quality ratings and, hence, most metadata editors do not offer the possibility of adding other types of classification criteria.

- 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 (see figure 3). 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 (see figure 4).

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 category (see table 3), using the LO classification scheme based on our proposed metadata typology [4].

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.

<table>
<thead>
<tr>
<th>EVALUATION CRITERIA CATEGORY</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSYCHOPEDAGOGICAL ISSUES</td>
<td></td>
</tr>
<tr>
<td>MOTIVATION</td>
<td>3.43</td>
</tr>
<tr>
<td>DIFFICULTY</td>
<td>3.63</td>
</tr>
<tr>
<td>PARTICIPATION</td>
<td>3.63</td>
</tr>
<tr>
<td>DIDACTIC CURRICULAR ISSUES</td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>3.91</td>
</tr>
<tr>
<td>OBJECTIVES</td>
<td>3.69</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>3.63</td>
</tr>
<tr>
<td>ACTIVITIES</td>
<td>3.91</td>
</tr>
<tr>
<td>TIME</td>
<td>3.63</td>
</tr>
<tr>
<td>FEEDBACK</td>
<td>3.34</td>
</tr>
<tr>
<td>TECHNICAL AND FUNCTIONAL ISSUES</td>
<td></td>
</tr>
<tr>
<td>INTERACTIVITY</td>
<td>3.34</td>
</tr>
<tr>
<td>NAVIGATION</td>
<td>4.00</td>
</tr>
<tr>
<td>DESIGN</td>
<td>3.74</td>
</tr>
<tr>
<td>LO QUALITY FINAL VALUE</td>
<td>3.66</td>
</tr>
<tr>
<td>COMMENTS (Describe some examples where this LO can be reused)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3, LO2 quality rating incorporated into LOM

Finally, the “9.4. Keyword” item gives users the search words for finding and retrieving the best possible LOs to suit their needs [5].

5 Conclusion

The research outlined in this paper set out to test a model for enhancing LO management through evaluation of LO quality. 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.

Our sample students at Salamanca University appreciated the pdf file, the self-assessment component and the forum because these features enabled them to print copies of the content, to assess their knowledge and to exchange views, all of which helped them gain a clearer understanding of the LO content. 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. Finally, we are aiming to promote intelligent agent-based automated working methods by developing a prototype multi-agent architecture for quality-based LO management.

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