

## A Strategy for the Inductive Generation of Learning Objects in Low-Tech Contexts

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### Abstract:

This article proposes a strategy to create inductive and incremental LOs in tertiary education low-tech contexts such as the field of Humanities. We take a teaching context to be low-tech when the teachers are not computer specialists and also have poor IT support. This is the case with many university schools in Spain, such as the Faculty of Philology at the Universidad Complutense de Madrid (UCM), where the work reported here has been carried out. In a low-tech context, the use of Educational ICT is considerably expensive, if not impossible. However, university faculty feels more and more compelled to use ICT tools in their teaching, e.g. e-learning platforms. In the process of adaptation and integration of ICT into teaching, a basic issue is the transformation of good teaching materials into digital format in the simplest and most cost-effective way. Good results can be obtained by applying the Learning Object (LO) model when creating digital teaching materials, but the models and tools to build LOs are not easy to understand or use without prior knowledge, and their application requires computer support beyond what is usually available in low-tech contexts.

The results of the research carried out during the last decade thanks to a number of research grants show that, by using the appropriate models, tools and strategies, it is possible to bring ICT to IT-illiterate teachers and get excellent results regarding the educational use of ICT by these teachers. In the present work a solution has been designed and tested to disseminate teaching materials through the generation of LO collections in low-tech contexts. This solution is based on applying a novel strategy to inductively construct LOs from the original materials. This is done by applying a model and a repository of LOs, developed and tested in previous works, and a new quality model for LOs collaboratively developed with the beneficiaries of this strategy, i.e. IT-illiterate Humanities teachers. The authors of this paper are part of a mixed team of IT-specialist and IT-illiterate Humanities teachers who developed and applied this strategy. Our paper aims to provide a real and complete picture of the problem and the solution developed.

**Keywords:** Learning Objects, Repositories, Authoring, Digital Learning Resources, Educational ICT.

### 1. Introduction

Suppose you are a University Humanities teacher. In the current teaching context, class notes and textbooks are no longer the only necessary materials. Audiovisual media, even just a simple slideshow, are *de rigueur*. The increasing use of e-learning platforms requires that teachers convert all their precious analogical resources to a digital format. Furthermore, they need to enlarge their collections with new materials, as those virtual platforms are intended to provide *extra* learning resources beyond the classroom. However, those materials are not usually readily available, and instructors have to design their own material, despite their limited knowledge of the required technology and the lack of technical support.

The development of content-quality materials involves a clear commitment in terms of research, and, more often than not, the process also requires a considerable investment in time and effort to learn to handle the tools and computer programs used for the creation of those digital objects.

As a collection grows, a further concern is to find an efficient way to store and manage it. Whether it is for the author's own use or with the purpose of sharing materials with others, digital repositories of Learning Objects (henceforth LOs) are proposed as a solution (Neven and Duval 2002). However, new problems arise such as the need to comply with the quality requirements of the repository, mostly directed toward ensuring reusability (Bennett et al. 2006). This proves especially difficult when the mentioned requirements are expressed in terms that are not intelligible to IT-illiterate users. On the other hand, some technical knowledge is necessary to understand the quality, metadata and content models.

In this paper we present an experiment conducted at the UCM School of Philology. A Project for *Educational Innovation and Improvement of Quality Teaching* was undertaken for the collaborative creation of a Learning Object Repository (LOR) targeted at our faculty members. The paper is structured as follows. Section 2 presents the strategy, which is based on (2.1) an open Learning Object Model, (2.2) an accessible quality model for Learning Objects (LOs), (2.3) an easy-to-use LOR, and (2.4) an inductive methodology to create LO collections. Following this, section 3 sketches the experimentation and results. Finally, section 4 presents the main conclusions and outlines future lines of work.

## **2. Supporting university IT-illiterate teachers to create Learning Objects**

The idea of improving the profitability of digital materials appears in the field of Educational Technology and the related industry with the notion of LO reuse (Wiley 2000). The goal is to increase profitability by creating educational materials as pieces (LOs) that can be assembled together (Gibbons et al. 2000). It can also be applied to the case of university teachers who are, at the same time, developers and users of their educative material. However, the theoretical and technological knowledge to build LOs is beyond the reach of many faculty members. There are two main ways in which researchers tackle the quest for the efficient creation and use of LOs by instructors: one of them is the development of guidelines for the creation of LOs (e.g. Smith 2004; Jesukiewicz 2009); the other is the creation of devices such as templates and toolkits to guide instructors in the design of new LOs (e.g. Adorni et al. 2008; Watson 2010a). In spite of the unquestionable help that these resources represent, in low tech academic contexts there is a main limitation: IT-illiterate teachers can build LOs only with sufficient staff and infrastructure support. Unfortunately, at the moment this is not the case in some Spanish Universities and Schools (Uceda and Barro 2010). Therefore, with the aim of combining the effectiveness of the LO model with the needs of producing specialized digital academic materials, we have developed and implemented a new, straightforward strategy for the creation of LOs with minimal or no IT support. It is based on:

- (i) Using already-tested existing materials, digital or not, rather than creating new ones.
- (ii) Applying an inductive methodology for the incremental construction of LOs from these materials based on applying: (a) an open LO model; (b) an accessible quality model; (c) an easy-to-use LO repository.
- (iii) Collaboratively developing the metadata and LO evaluation models best suited to philology.
- (iv) Providing basic ICT support, on site and long-term, by involving the Philology School's IT staff in this kind of projects.

This strategy has enabled the creation of two specialized LO collections: a historical collection with old multimedia language teaching material <macgalatea.sim.ucm.es/odafilol>, and a recent collection of philological LOs: <mediaserver.filol.ucm.com/ode> (Figure1).

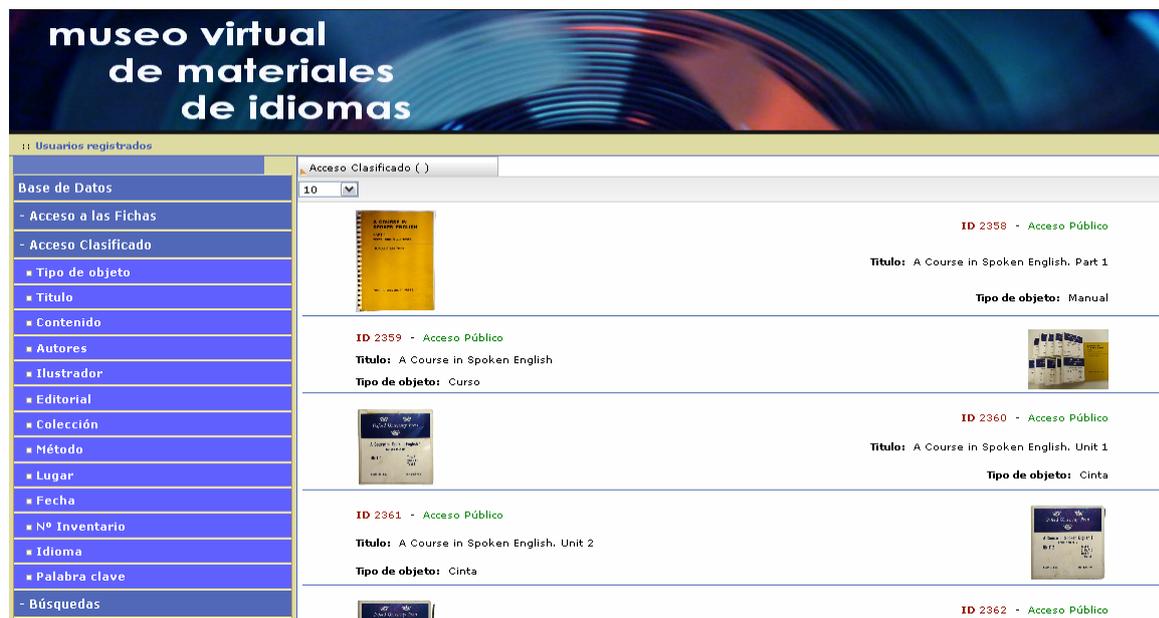


Figure 1: Language labs' Audiovisual LO historical collection

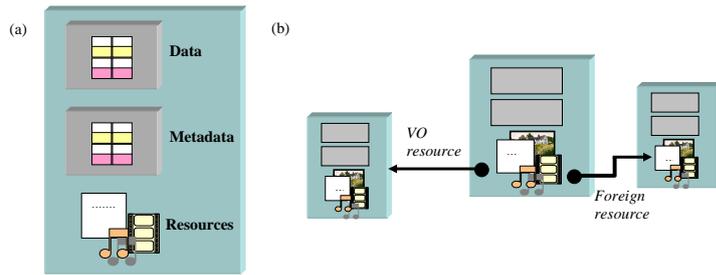
## 2.1 An open Learning Object Model

To facilitate the construction of reusable LOs, some international metadata standards (Duval 2004) as well as multiple content models (Verbert and Duval 2008) have been developed. However, the theoretical and technical knowledge necessary to understand and use LOs is beyond the reach of many teachers, primarily because: (1) specifications are difficult to understand and use without assistance, and also, it is unclear which one to use among the multiple content models and metadata schema, (2) specifications of standards are too general to concisely describe the semantic richness of specialized LO collections, such as Linguistics, Literature, Archeology, etc. (Boot 2005: 76,77), in spite of the extension mechanism the standards provide. Finally, (3) the LO support technology – authoring tools, tools for building LORs and LORs – are unknown and inaccessible to IT-illiterate teachers.

To deal with the first two problems, an open and flexible LO model has been developed: the Virtual Object Model (VOM) (Sierra and Fernández-Valmayor 2006). This model allows users (teachers and researchers) to: (1) easily define specialized metadata and vocabularies as well as using metadata standards; and (2) freely build LO content by using any resource: other LOs or even resources from other LOs. From a conceptual point of view, a LO has three parts (Figure 2a):

- (i) **Object Data.** A set of *specialized* attribute-value pairs to describe the specific features of the object in its scientific or humanistic domain.
- (ii) **Object Metadata.** A set of attribute-value pairs to document and classify the LO. It can be taken from any standard proposals such as LOM or Dublin Core, or can be user-defined.
- (iii) **Content.** A set of resources (digital files) with an individual set of attribute-value pairs describing each of those resources. Resources and resource metadata are freely added by teachers. Resources can be: (a) *own resources*, (b) *foreign resources*, which are references to resources owned by other LOs; and (c) *LO's resources*, which are references to other LOs. Foreign and LO

resources allow the establishment of basic relationships between LOs and the construction of more complex LOs by adding simpler ones (Figure 2b).



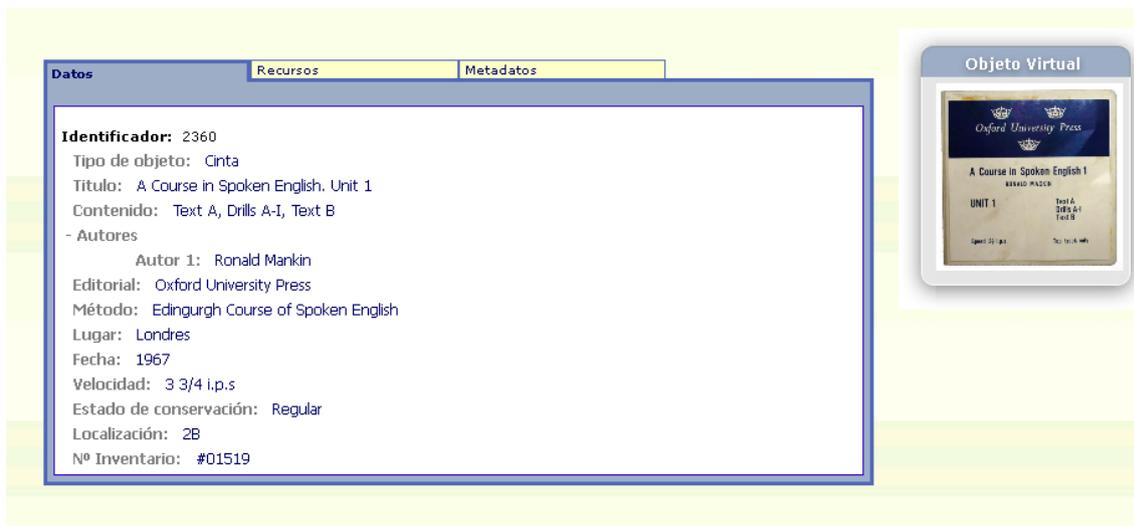


Figure 4: Example of domain-specific metadata (Second Language Teaching)

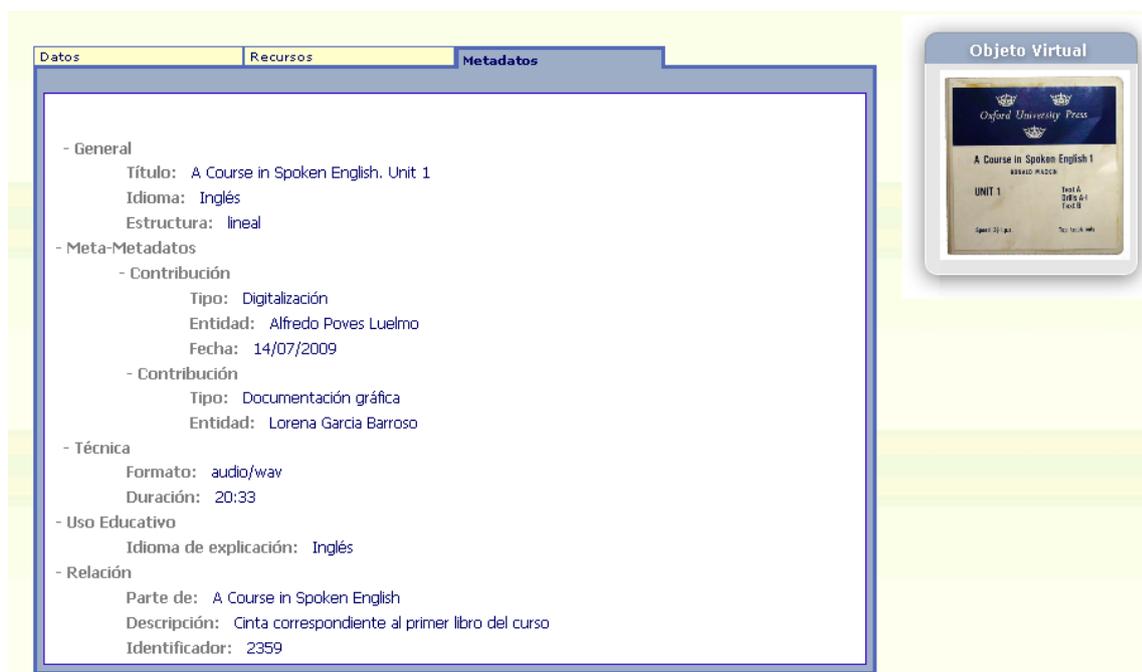


Figure 5: General metadata in the IEEE-LOM standard

## 2.2 An Accessible Quality Model for Learning Objects

A LO Quality Model is useful not only as an evaluation tool itself but also to address the construction of LOs if applied during the construction of digital learning materials. This type of evaluation, called *process evaluation* can be used to formatively assess the planning, design, development and implementation of LOs (Williams 2000). Thus, if a quality evaluation tool is applied as part of the task of creating digital teaching materials in order to improve their quality, it can guide teachers in the creation of LOs. However, the quality evaluation models available for instructors (Williams 2000; Taveira and Azevedo 2010; Watson 2010b), are not always easy to understand or apply by the mostly IT-illiterate Humanities teachers nowadays. Firstly, many educational software quality models focus on educational aspects at the expense of technical aspects (Vidal et al. 2010: 343). Secondly, these models are not user-friendly evaluation tools, convenient for instructors with no theoretical knowledge

or expertise in the creation of LOs. Thirdly, there is a lack of consensus regarding the concept of quality applied to teaching materials (Dondi and Moretti 2007).

To overcome this problem in low-tech contexts, we have developed an accessible Quality LO tool, called COdA (Fernández-Pampillón et al. 2011a). Under COdA criteria, a LO is good quality if it helps instructors and students to learn more and in less time, and if it is used frequently — which ultimately means that it is reusable. To apply COdA, teachers have to fill in a questionnaire of ten quality criteria with the help of a short manual with instructions and examples. COdA is based on LORI (E-Learning Research and Assessment Network 2010), and educational content quality evaluation models developed in Spanish Universities, notably the UNED (Universidad Nacional de Educación a Distancia 2011), UCM Virtual Campus (UCM-OCW, 2011), HEDOAR (Morales et al. 2009) and the University of Murcia (DIGITUM 2011). It also includes basic content accessibility recommendations from W3C (Chisholm and Vanderheiden 1999) and the IMS Global Learning Consortium (IMS guidelines 2002).

### **2.3 An easy-to-use Learning Object Repository for Specialized LO collections**

To organize and storage the specialized collections of LOs, LORs have been used. A LOR stores both LOs' content and metadata, either by storing them physically together or separately in an on-line database. Typically, A LOR uses fixed metadata scheme (usually IEEE-LOM or Dublin Core profiles) to support simple and advanced queries as well as browsing through the material by subject discipline (Neven and Duval 2002). However, LORs do not permit the custom and dynamic definition of domain-specific databases for the authoring of specialized LO collections or their searching according to their specific characteristics (Tzikopoulos et al. 2009). Furthermore, in Spain there is a lack of university LORs (REBIUN 2007). Therefore, teachers end up installing and maintaining their own educational and scientific collections of digital materials, which is far too demanding for the IT-illiterate teacher.

*OdA* repository is an easy-to-use LOR for the management and definition of specialized LOs. *OdA* is a UCM software tool in whose development some of the authors of this paper participated. Its development was funded through national research projects and its purpose is to provide teachers, researches and students with a simple and flexible computer system to disseminate their educational and research materials (Sierra and Fernández-Valmayor 2006). Apart from the typical LOR's basic functionalities, *OdA* also provides:

- 1) The possibility to dynamically define customized data, metadata and content for LO collections according to the knowledge domain and the specific didactic needs of users (Figure 6);
- 2) Because of (1), an intuitive mechanism for domain experts (teachers and researches) for the location and selection of LOs based on their discipline's specialized attributes and terminology. Hence, when exploring and searching LOs in *OdA*, students use language and conceptual domain classifications of each discipline, which helps to improve the learning of terminology and conceptual structure of that domain.
- 3) The possibility to export LOs to an IMS Content Package to publish them in other e-learning tools such as Learning Management Systems (e.g. Moodle).

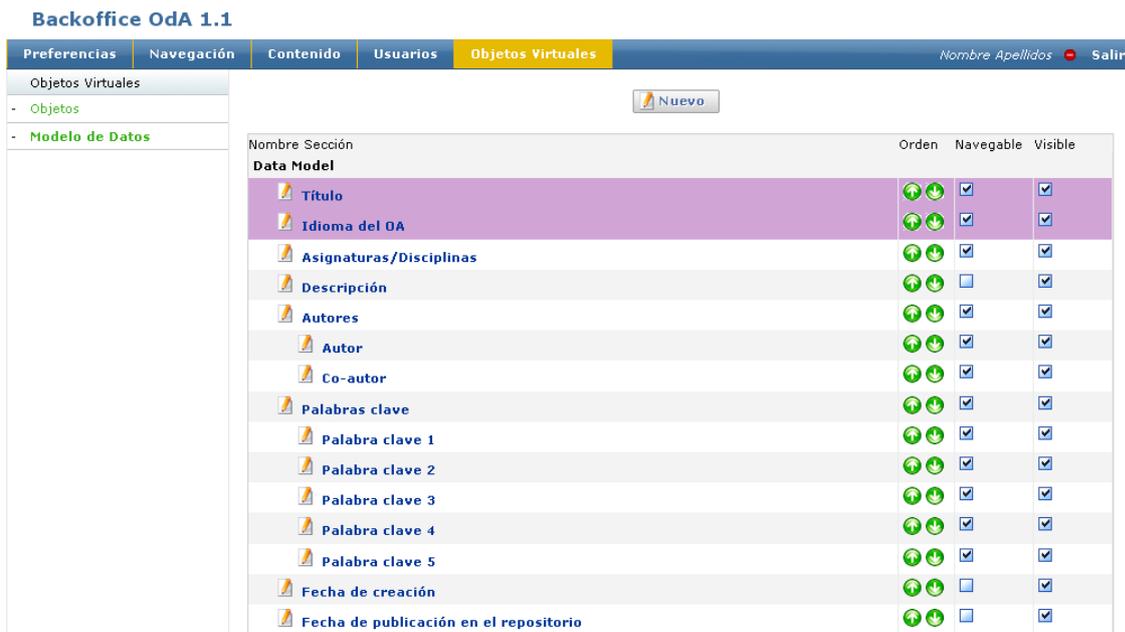


Figure 6: Metadata schema management interface

4) Finally, a minimal set of technical requirements is needed, concerning both IT equipment and skills. OdA can be installed in a personal computer with a self-installing version.

Therefore, OdA is a software solution to easily create and manage specialized LO collections in tertiary education low-tech contexts (where teachers are not computer specialists and usually have poor IT support). It offers an alternative to international repositories, with greater functionality and interoperability but more complex to use, less flexible to precisely store and manage specialized LOs and requiring larger equipment and staff infrastructures.

## 2.4 An inductive methodology to create Philology LO collections

The incremental construction methodology of LO collections is based on the above-presented elements – an open LO model, an accessible quality tool and an easy-to-use LOR – to inductively and systematically generate tertiary LO collections in six stages:

- 1) Creation/reuse. The teacher or team of teachers create or digitize their teaching materials according to the usual procedures.
- 2) Inductive creation of metadata schema. Each faculty member involved in the collection defines a metadata record for their materials. A minimum set of metadata to describe and classify all the initial materials is selected from all the metadata records.
- 3) Evaluation. Teachers evaluate the quality of the materials they have created, or are creating, by means of the COdA tool. Once evaluated, they can continue with this step, or stop if the evaluation has been satisfactory.
- 4) Fine-tuning. If during the evaluation the material does not meet some criteria, it is modified so as to obtain a higher score. After fine-tuning the material, the teacher usually returns to step 3 to re-evaluate the new version.
- 5) Storage and Documentation. Instructors store LOs in the repository. This action involves the use of the set of metadata created in step 2 to describe the LO collection. If new metadata are needed, teachers add them. Changes or deletion are agreed on by the different teachers working on the same collection.

6) Teachers can edit or delete their LOs and metadata schema at any time. They can also include the result of the evaluation as one more LO resource.

### **3. Experimentation and Results**

The proposed strategy was tested in the UCM School of Philology because: (i) it is a low-tech context, (ii) we had institutional support, and (iii) there was a demand from faculty members for help to reliably create good digital teaching materials for use in the UCM's Virtual Campus and the new digital language labs (Fernández-Pampillón et. al. 2011b).

#### **3.1 Participants**

Experiments were conducted with a group of 33 participants belonging to three different types: (i) faculty from nine different philology departments; (ii) the School IT Technicians and (iii) UCM e-education researchers.

Participants were organized into three working groups:

1) Teaching Resources Team (TRT), with 20 faculty members in charge of testing the strategy. Only one of the team members had advanced IT skills; two of them had average IT skills; the other seventeen had low to intermediate IT skills. None of the members had LO expertise.

2) Modelling Team (MT), responsible for developing the quality guidelines tool (COdA), and also in charge of inducing the general descriptive model of teaching resources prepared by the TRT. All group members had low to intermediate IT skills. None of the members has LO expertise.

3) Technical Team (TT), responsible for providing the necessary support to use the LO repository, advising the other teams on technical matters and training the School's technician in the maintenance of the repository (backup and possible failures). Only one of the members had LO expertise.

#### **3.2 Methodology**

The experiment was carried out in five phases:

Phase 1. Preparation of a quality evaluation tool draft by the MT.

Phase 2. a) Preparation of two samples of digital teaching materials and validation of quality guidelines by the TRT (COdA guidelines). By the end of this phase, the existing version of the COdA tool was considered to be final.

Phase 3. Writing up the documentation and classification of materials by the MT, done inductively. By the end of this stage, the existing version of the basic documentation model (metamodel) was considered to be final.

Phase 4. Building the LO collection in the OdA repository. By the end of this phase the preparation of the first LO collection of the Philology School was considered to be complete and ready to be open to the rest of the faculty.

Phase 5. Strategy evaluation. The following results are collected and analyzed: a) the LO collection content models; b) the LO metamodel and surveys on the usability of OdA and COdA with feedback from the TRT team's teachers. Conclusions are then drawn.

#### **3.3 Analysis of results**

1) LO collection Content Model. Concerning the content model, this has been observed to evolve as teachers gain experience in the use of the repository regardless of their initial IT skills. They are very simple models at first: a list of own-resources (Figure 3, above); more complex LOs are then created which include other related LOs forming small networks of LO resources (Figure 7).

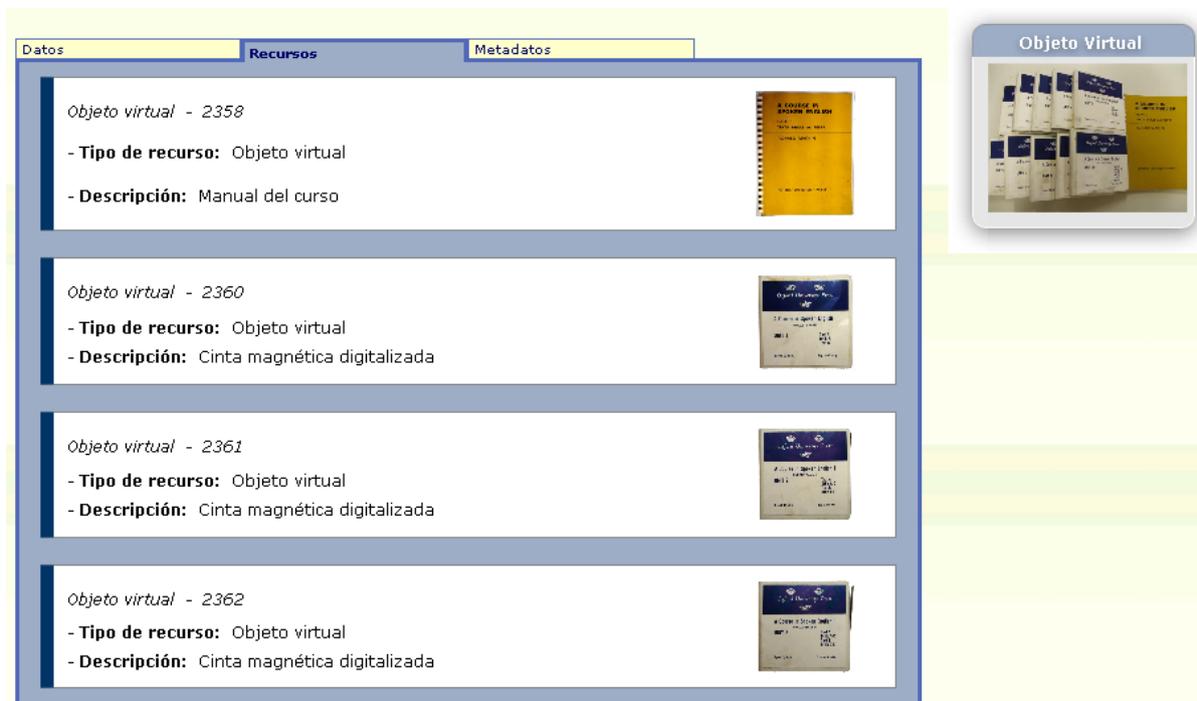


Figure 7: Example of a LO representing a language course consisting of other LOs (book and audio)

2) With respect to the quality evaluation tool (COdA), beyond our initial expectations teachers have reported that, through evaluation, they have managed to differentiate *learning object* from *teaching material*, which was not always clear before. The implementation of some minor changes — i.e. the incorporation of a template to grade an exercise and thus give feedback to the student, or a clearer statement of the didactic goals in the LO to raise the punctuation of some criteria — appeared to improve the reusability of the final product (Figure 8).

However, not all the COdA criteria were easily applicable. For instance, the specification of accessibility has been reported at times not to be suitable for audiovisual objects targeted at auditory perception tasks (see Arús et al. 2011).

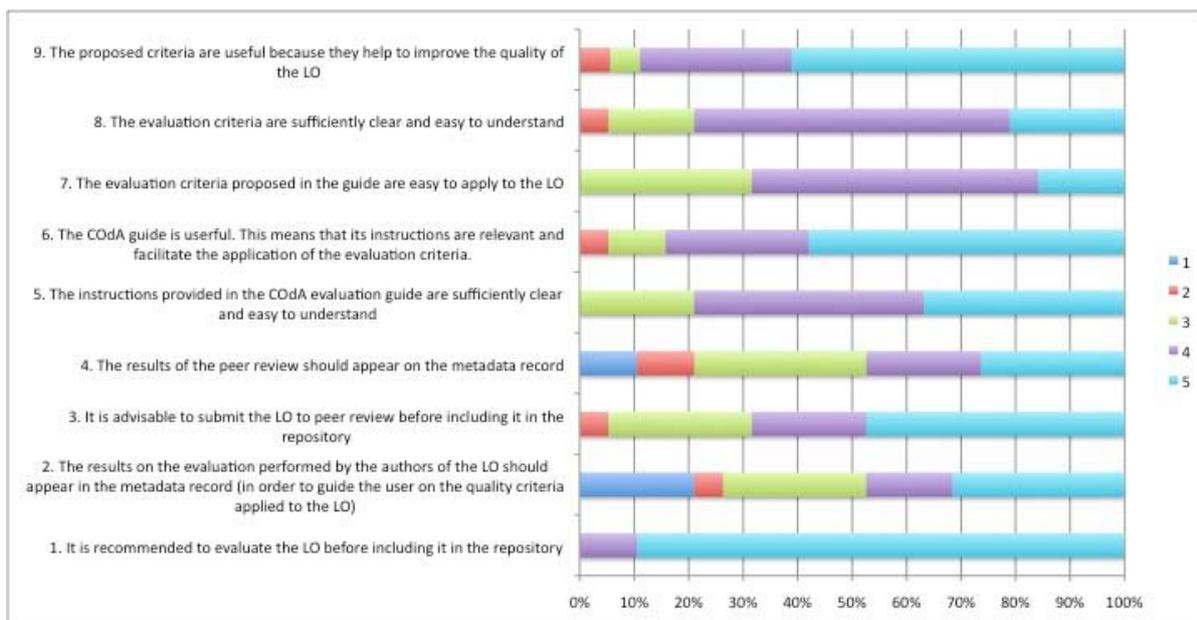


Figure 8: COdA criteria evaluation results (from 1 to 5)

3) Concerning the quality of the LOs (Figure 9), around 84% of the teaching materials that have been built according to the Quality Learning Object (QLO) building procedure can actually be considered QLOs (3 out of 35 do not meet the reusability criterion).

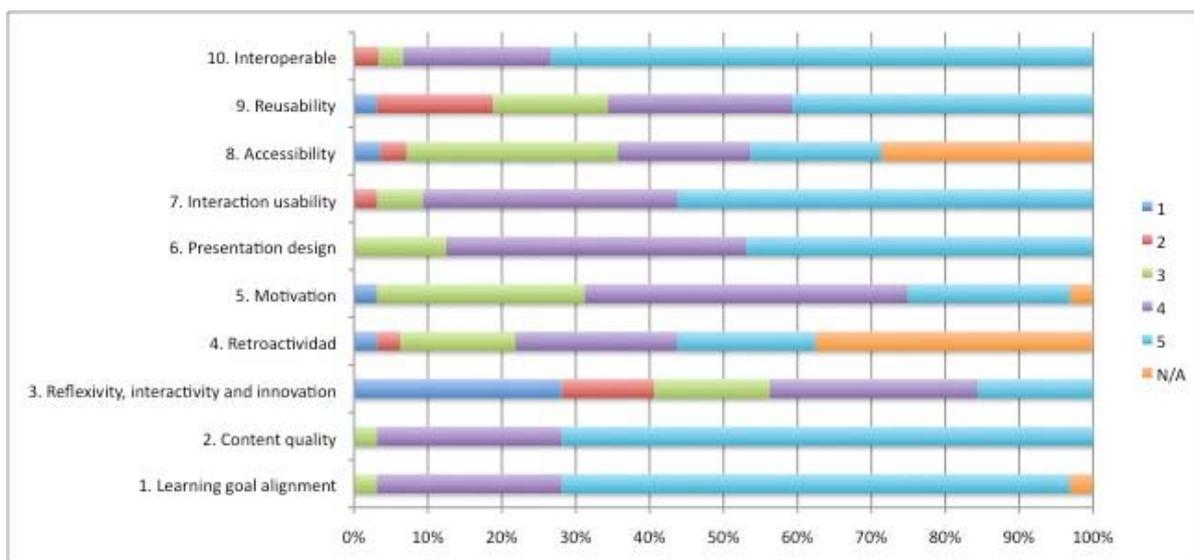


Figure 9: LO quality evaluation results (from 1 to 5)

4) Finally, with respect to the use of the flexible LO metadata model, it has been observed that teachers prefer developing specialized classification vocabularies and attributes rather than using the more general ones provided by the standards. Furthermore, data and metadata schema have been dynamically changed as the collection grows.

#### 4. Conclusions and future work

This work is a contribution to the efficient creation of good digital teaching resources in tertiary education by IT-illiterate or semi-illiterate teachers with few IT and technical staff resources. It is a

strategy for the inductive construction of LOs which has been created and tested in collaboration with IT-illiterate Humanities teachers.

In the generation of our LOR, faculty members were not given any predetermined content model or metamodel. Instead, they devised their own by means of an inductive method to obtain the minimal most specific data and metadata scheme that suited the needs of all the participants in the project. By so doing, we ensured that every scheme element was really necessary and that it could be understood by end-users. Furthermore, this methodology implies that the LOs and the models are scalable and can be expanded to suit future needs.

As seen, a quality-assessment tool was also designed to outline certain criteria for teachers to self-evaluate their LOs and thus enhance their quality and, ultimately, their usefulness. Since the wording comes from the instructors themselves, the usability of the tool is guaranteed. Interestingly enough, the need of self-assessment fosters the reflection on one's own LOs, which not only helps to improve the objects but also facilitates the intuition of the mere difference between a LO and a more traditional *teaching material*, which many instructors did not grasp at the beginning. It encourages the habit of sharing teaching materials, something not very frequent among instructors in Spanish universities. In this regard, we suggest that the institutions and committees working on the quality of education consider and value quality self-evaluation as a further indication of quality, very economical and with an important positive effect on the quality of teaching.

The LO-building methodology presented allows a high degree of flexibility, which makes it especially well suited for supporting author-driven, incremental and open approaches to LO production. It is particularly appropriate in a university environment where teachers are responsible for the creation of their specialized teaching material with little or no IT support. Indeed, in these scenarios the first stages of the LO building process were devoted to produce very simple LO counterparts of the pre-existing learning materials. Later stages produced higher-order LOs of more abstract nature (e.g. foreign language courses containing texts, audios, presentation and exercises related to different aspects of the learning process). During the successive stages the metadata model was also extended, fine-tuned and corrected to solve inconsistencies and redundancies.

Compared to other approaches, our proposal provides a solution accessible to any instructor or team of instructors with limited computer skills as well as human and technological support. The experimental results are satisfactory to the extent that 1) the feasibility of the procedure has been proven by means of a realistic project to build a LO collection in a non-technological field such as that of Philology; and 2) the procedure has succeeded in improving the quality of teaching materials in both the pedagogical and technological aspects.

It is not possible, however, to ensure that by applying this approach 100% of the materials in a collection created by a group of teachers will be LOs, since, as shown by the first experimental results, the success (84% in our case) depends on 1) the degree of involvement of instructors in improving the quality of their materials; 2) having some sort of technical support so as to know how to apply IT quality criteria such as accessibility and interoperability.

The next step in this research will be the study of the use (and reuse) of LO collections in the new electronic learning environments in non-technological fields of knowledge. In this sense, we will test the integration of the LO repository OdA into the UCM Virtual Campus with the aim of using it in virtual sessions, in the classroom or in the language lab. If IT-illiterate faculty incorporate LOs both into their classroom and virtual teaching in a natural way, and if the LOR keeps growing by the addition of new LO collections, then the LO creation strategy will have proven its usefulness in the creation, use and dissemination of digital research and teaching materials in non-technological domains.

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