METADATA, REPOSITORY AND METHODOLOGY IN LEARNING OBJECTS

M. Fernández-Diego, M.L. Gordo, A. Boza, L. Cuenca, L. Ruiz, M.M.E. Alemany, F. Alarcón

Universitat Politècnica de València (SPAIN)

Abstract

Many universities in different countries are redesigning their degree and master programmes on the basis of new academic and professional profiles incorporating a number of competences. One competence can be acquired through several learning objects. A wide variety of learning repositories that provide resources for education in the form of learning objects can be found. These resources are normally stored in learning object repositories where they are catalogued with metadata facilitating retrieval by end users. The aim of this paper is to describe the elements associated to learning objects: metadata, repositories and their related methodologies.

Keywords: Learning object, learning object metadata, learning object repository.

1 INTRODUCTION

Learning requires an effort to know how to select and apply appropriate resources for their achievement. On this basis, resources should be proposed aimed at developing skills, helping to adequate recovery and reuse of these resources [1]. To develop the skills, it is important that teachers have access to appropriate learning resources, which can be adapted to the different educational needs of their students.

In this context, the concept of Learning Objects (LO) arises. The fundamental idea behind LOs is that instructional designers can build small (relative to the size of an entire course) instructional components that can be reused a number of times in different learning contexts [2]. Two useful metaphors offered by Wiley [3] present LOs in a simplistic model as pieces of Lego and, in a more developed model, as an atom. In [4], LOs are defined as minimal learning content units, with self meaning, formed by interactive and multiple format information packages, identifiable through metadata, designed to reach a single learning objective, integrating learning content, assets, activities and evaluations. Their relation with digital technologies is clear, thus, LOs are also defined as any digital resource that can be reused to support learning [5] and also as any entity, digital or non-digital which can be used, re-used or referenced during technology supported learning [6].

According to [7], the The Le@rning Federation defines their LOs as i) one or more files or modules of learning material; ii) reusable in multiple settings and for multiple purposes; iii) potentially usable in classrooms as components of units of work accompanied by digital and non-digital materials; and iv) accessible from digital repositories, as referenced, located and accessed by metadata descriptors. So, an important point of LOs is their accessibility, and metadata and repositories play an outstanding role.

The aim of this paper is to describe these outstanding elements associated to LOs: metadata, repositories and their related methodologies. This paper is structured as follows: Section 2 addresses the main concepts related to LO metadata. Section 3 describes the role of the LO repositories. Section 4 identifies methodologies that deal with LO metadata and repositories. And finally the conclusions are presented in Section 5.

2 METADATA

Thus, LOs can be identified and described with LO metadata. The most common definition of metadata is that "Metadata is data about data" [8]. However, in a LO context, since the metadata's main purpose is to relieve the potential users of the data objects from having to have full advance knowledge of an object's existence or characteristics [9], the metadata describe structures and functions such as location, discovery, documentation, evaluation, selection, etc. [8]

Nowadays we can access very different kind of information. Metadata is then another strategy to drive the effort needed to manage the bulks of resources available on the net [8]. Thus, metadata is

required to be "machine processable". Its main usability advantage remains in its structure in the way that the data represented by metadata can be collected, processed, analysed based on the metadata's well-defined semantics and structure [10]. The reasons for the metadata trend can be based on some generic technology-related factors such as: (a) the need to increase automation of the production of descriptions, (b) the need to reduce the semantic divergence of these descriptions in a complex environment, and (c) the need for common descriptions whose access is device independent.

Moreover, LOs can be described in a common way using standards. Many learning resources created nowadays conform to some of the existing standards for the description of these educational resources, e.g., SCORM, LOM and IMS [11].

SCORM 2004 4th Edition is the newest version of the Sharable Content Object Reference Model released by ADL [12]. The vision of the ADL initiative is to provide access to the highest quality learning and performance aiding that can be tailored to individual needs, and delivered cost effectively at the right time and at the right place. The SCORM 2004 defines Content Model as the content components of a learning experience and metadata as a mechanism for describing specific instances of the components of the content model.

The IEEE LOM (1484.12.1 2002 Standard for Learning Object Metadata) is an internationally recognised open standard, published by the IEEE, for the description of LOs. LOM-ES [13] is the IEEE LOM official version for the education sector in Spain. The IEEE LOM provides a hierarchy of properties for learning resources in nine different categories which include technical, educational and other characteristics. This adaptation of LOM into Spanish language has more "educational purposes", which includes educational and pedagogical characteristics, such as: recipients, difficulty, level of interactivity, etc. [14]

Common Cartridge is a set of open standards developed by the IMS member community that enable interoperability between content and systems. It provides a standard way to represent digital course materials for use in online learning systems so that such content can be developed in one format and used across a wide variety of learning systems. The second is to enable new publishing models for online course materials and digital books that are modular, web-distributed, interactive, and customizable. Currently, the IMS Learning Resource Meta-data Information Model 1.2.2 Public Draft has been replaced by the IEEE LOM [15].

However, the annotation of learning resources to standard packages, such as IEEE LOM and the publication of related active services used to retrieve those packages, is not the first step to build a LO. The annotation and publication are performed in the implementation-time phase of learning specification [16]. Nonetheless, metadata should go beyond a basic description of LOs in this phase. Adapting the metadata to the needs of each person, identifying the quality of a LO metadata, knowing as it should be reused, or collecting data from the users themselves are some proposals in this line.

The User Profiles are basically the "data on a person". The task of accessing knowledge customized to the user is optimised by reducing the effort needed to locate the appropriate information, assuring that the information is in the suitable form and adapting to learner's knowledge evolution and learning focus [8]. Similarly, in [2] the authors use the Learner Information Profile (LIP) specification and the LO metadata specifications in order that learners can find the appropriate LOs to suit their needs.

Moreover, how can a person intending to use a given learning resource determine its quality? The quality and reusability of metadata specifications for e-learning objects is discussed in [11]. The authors use SCORM as a framework for their research where there is no category explicitly intended for storing data concerning resource quality. Some quality information can be deduced from currently existing metadata, but it seems to be insufficient, and the prospective user of a given learning resource should have direct access to the information concerning its quality. For that reason, they propose changes to the SCORM metadata definition extending some of the existing categories (e.g. educational) and introducing two completely new categories: (1) Quality, which should contain measures for evaluating a resource's quality. To some extent, the set of measures would be based on the existing SCORM metadata, but also some new aspects should be addressed; for instance, the characteristics of a resource's didactic structure with regard to the support for correct learning processes. (2) Reusability, which should deal with the reuse potential of a given resource; where the reuse potential means the possibility to use an e-learning resource to create another resource. In [17] the authors identify the need for a reusable and interoperable metadata model for sharing and reusing evaluations of learning resources.

Metadata are used not only for LOs, but also for learning design objects, that is metadata for reusable knowledge, and also knowledge for reuse. There is a current trend towards using Learning Design (LD) as a means of sharing best teaching practices. In [18] Chick proposes to enrich the learning design objects with additional theoretical and practical structures, such as standards, theories and templates, which can provide support to instructors over the entire development life cycle. He defines the LOM+ as an extension of LOM to help designers retrieve the contextual knowledge and enhance their reuse.

The administration of LOs in repositories and data bases was achieved by adding metadata according to standards suggested by the authors themselves and required advanced informatics skills. Annotea was one of the first projects to replace this rigid way of managing web resources by incorporating collaborative metadata generated from users' annotations and tags [19].

And finally, do the metadata have enough quality for their reusability? This issue is addressed in [20] with the LO quality indicators. These indicators are classified into three categories: i) Explicit. Includes all explicit evaluations carried out by experts and users. ii) Implicit. Taken from the implicit usage data for the materials, such as number of visits, number of times it is bookmarked by users, number of times it is down- loaded, etc. iii) Characteristical. Descriptive information on the characteristics of the materials obtained from the metadata. The characteristical category covers indicators based on the metadata that can draw on the potential of the information describing an educational resource. The idea that underlies this proposal is to identify the factors that most influence greater reusability of LOs and then match them with metadata that offer information on them. Depending on the value of the metadata encountered, the reusability could be quantified.

3   REPOSITORY

LOs and their metadata are therefore organized, classified and stored in Learning Object Repositories (LORs) [21]. A LOR is a kind of digital library which enables educators to store, manage and share digital resources for education in the form of LOs [22]. These repositories maintain objects and metadata on a centralized server by storing them physically together, or maintain metadata only and provide links to objects distributed throughout the internet [23]. In this case, the metadata and LOs are actually stored separately by presenting a combined repository to the outside world.

Nowadays, there is a wide variety of e-learning repositories [24], which have also grown in size and sophistication since their inception in the mid-1990s [23]. Most are interactive and user-friendly web-based. According to [23], there appear to be four functional categories:

- Commercial repositories that offer access as a customer service to instructors and course developers.

- Corporate repositories maintained by commercial eLearning providers to support their own course development and delivery activities.

- Corporate repositories used by large companies and military organizations to train and develop internal personnel.

- Open-access repositories usually established by consortia of educational organizations. The central infrastructures for these are often funded with research or development grants, with the LOs contributed by individual educators or participating institutions on distributed servers.

LORs can be used in a variety of scenarios to support educational needs of their users, with the most common being the use of repositories as collaboration and sharing tools for teams, for individuals or for online communities [25].

Various well known LORs developed worldwide include:

- AGORA (http://www.agora.uni-hamburg.de/en)

- ARIADNE (http://www.ariadne-eu.org/)

- CAREO (http://www.careo.org/)

- DLESE (www.dlese.org/)

- LRE for Schools (lreforschools.eun.org)

- MACE (http://www.mace-project.eu/)

- MERLOT (www.merlot.org)
- OER Commons (www.oercommons.org/)

The administration of LOs in repositories is achieved by adding metadata according to standards suggested by the authors themselves and required advanced informatics skills [26]. The data used to describe the LOs (i.e. its metadata) is a key enabler for the deployment of efficient search mechanisms and services on LORs in order to help users in the search for and selection of the LOs most appropriate to their individual needs. Searching for LOs is based on criteria that relate to LOM data elements. A LOR typically supports simple and advanced queries, as well as browsing through the material by subject or discipline [27]. LORs are being developed rapidly as a key element of research and education e-infrastructure [28]. However, several studies indicate the issue of poor quality of metadata records describing educational content in LORs, which has been addressed in [29].

In [27] the authors present a comparison of the features and architecture of repositories that typically contain LOs or references to them, as well as metadata based on the IEEE LOM standard. The metadata scheme a LOR uses is based on the IEEE LOM standard, through a process that is typically referred to as an "application profile" [30]. A specification for the interoperability of repositories is being developed by the Open Archive Initiative (OAI) [31]. According to [27], there are a number of criteria that apply to the LOs involved, like the subjects they cover, the metadata scheme used, and the number of LOs currently available. Another non-architectural distinction between LORs is whether they provide some kind of personal service to the user. More important are criteria that relate to the architectural properties of a LOR. One fundamental difference between LORs is whether they are client-server based or follow a peer-to-peer approach.

However, despite the extensive development of LORs, their impact on teaching practices in the classroom has been rather limited [18]. This limited impact may be due to a lack of systematic mechanisms for connecting LOs with their educational contexts [32].

4   METHODOLOGY

Some methodologies related to LO metadata and the repositories are introduced in this section. These methodologies focus mainly in LO quality measurement, comparison, and ranking.

In [33] the authors present the Aggregated Quality Index for assessing the quality of LOs, through the evaluation of quality of LOs from e-learning resources by defining a statistical method. Metadata standards for LOs are adopted as metrics for quality and their appropriateness is determined by statistical methods. The authors use the MERLOT repository as the source of data for the empirical tests. The approach of the study focusses on a quality measure based on metadata. The first step consists in identifying metrics for measuring quality in the metadata standards. A logarithmic adjustment of the data is done in order to obtain the Aggregated Quality Index.

In [29] a Metadata Quality Assessment Certification Process (MQACP) that addresses the way in which metadata quality can be improved in LORs is proposed. This process combines a number of quality methods and tools in the various phases of specifying the metadata schema to be used in populating the repository with metadata records that describe resources. Target users are any content provider who is planning the launch of a new LOR, from the very beginning of its development. Parts of the process may also be adopted in the case of existing repositories to improve metadata quality, taking into consideration that their results may be less significant than the ones presented here.

A methodology for the comparison of repositories is introduced in [27]. Primarily it focuses on the elaboration of a comparative analysis of the features and architecture of repositories that typically contain LOs or references to them, as well as metadata based on the LOM standard, and provide a non-exhaustive overview of the advantages and disadvantages of different features and architectural properties of a LOR. Regarding the criteria used in the comparative analysis, the goal of these criteria is not to select the "best" LOR but evaluating a LOR with context, purpose and target user group in mind. There are a number of criteria that apply to the LOs involved, such as the subject(s) they cover, the metadata scheme used, and the number of LOs currently available. Other criteria are the functionality provided to the users (simple or advanced search) or peer-reviewing which can facilitate the task of evaluating the quality of a resource when it appears in the result page of a query. Related to the architectural properties of a LOR, one fundamental difference between LORs is whether they are client-server based or follow a peer-to-peer approach. The authors only discuss the client-server

based systems. In short, this procedure could be interesting for an organization which decides to start with the implementation of a LOR.

In [34] the authors present DELPHOS, a framework to assist users in searching the most interesting LOs in repositories. They list the following advantages when compared with other similar recommender tools:

- all the additional information that is provided to the user about each recommended LO (to help in making a better decision about which LOs to select);

- the use of a hybrid approach with several filtering or recommendation criteria (to personalize the list of recommended LOs);

- dynamic calculation of adaptive weights that provide default values to the user (to use a hybrid recommendation system more easily).

DELPHOS is fully integrated in the AGORA repository but the proposed architecture and weighted hybrid recommender approach can be implemented in any other repository. Target users can be engineering students, such as electrical, civil and environmental engineering. Actually, experiments with a group of 24 civil engineering students were carried out in order to evaluate and validate the usefulness of this tool. Results obtained confirm that the proposed weighted hybridisation strategy for recommendation works well for searching LOs and DELPHOS interface is also useful and usable.

The aim of an overall quality indicator for ranking LOs available in repositories is to improve the solutions used to-date for recommending LOs [35]. This model mainly identifies quality indicators that might be used to provide information on which materials to recommend to users (e.g., overall rating, content quality, effectiveness, ease of use, comments, adaptation effort, reusability, etc.) and proposes a synthesized quality indicator that can facilitate the ranking of LOs, according to their overall quality. The advantage of the global quality indicator stems basically from the use of all identified quality indicators, regardless of how they are aggregated. The aggregate indicator could provide a measure of overall quality that took into account all available information, which would boost the reliability of recommendations. This measure could be calculated automatically, ensuring sustainability and allowing for all materials available in repositories to have a rating. Taking a set of LOs from the MERLOT repository, the relationships that exist between the different quality indicators is analysed to form an overall quality indicator that can be calculated automatically, guaranteeing that all resources will be rated.

5 CONCLUSIONS

LOs are being used as small parts of knowledge that can be reused. With this proposal, LOs are required to be identified, classified and stored. LO metadata allows collecting data about these LOs in order to provide to the users data about them. On the other hand, LORs store these LOs and their metadata in an organized way. Nowadays, there is a wide variety of LORs. Most are interactive and user-friendly web-based.

Technological factors have an important role in metadata since, nowadays, these metadata require being "machine processable". Thus, LOs metadata standards are being widely used. However, these standards (or their current uses) sometimes limit other potential uses of metadata. Metadata quality analysis, customized information, knowledge reuse integrating collaboration, are some examples of these metadata potential uses.

The big universe of LOs introduces the problem of how to get the most suitable LOs for our purpose. Several methodologies have been developed in order to help us in this regard.

Some of them focus in measuring the quality of LOs, others as DELPHOS presents a framework to assist users in searching the most interesting LOs in repositories or even an overall quality indicator is used for ranking LOs available in repositories, which aim is to improve the solutions used to-date for recommending LOs. Furthermore, concerning methodologies other purposes related to LO metadata and repositories are addressed, such as the comparison of repositories or the way in which metadata quality can be improved in LORs.

In short, more and more methodologies are being created as LOs are being consolidated as critical elements in the learning process. The list of such methodologies is extensive, although our aim was just to mention some of the most representatives and describe them briefly.

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