TOWARDS THE LEARNING OBJECT MANAGEMENT SYSTEM AND DYNAMIC USE OF METADATA

GENTILE, Manuel
FULANTELLI, Giovanni
TAIBI, Davide
ALLEGRA, Mario
Italian National Research Council
Institute for Educational Technology, Palermo, Italy
{manuel.gentile, giovanni.fulantelli}@itd.cnr.it
{davide.taibi, mario.allegra}@itd.cnr.it

Abstract

In this paper we illustrate a dynamic approach in the use of the metadata and how this concept can dramatically improve the management of Learning Objects.

Specifically, the ideas elaborated in this paper rise from the experiences in managing Learning Object Repositories during three European funded projects: Sloop, Tenegen, and Sloop2desc.

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ACM classification: K.3.1

1. Introduction

Over the last few years we have witnessed a rapid evolution of ICT-based solutions in education. In this scenario, specific issues concerning the production and sharing of learning resources and, more in general knowledge management have been extensively analyzed.

The proposal to structure learning contents according to the model of the Learning Object (LO) has evolved out of this context. The characteristics of durability, interoperability and reusability and the related standardization process needed to achieve these goals, have played an important role in the diffusion of the Learning Object model. In particular the standardization process has focused on two main aspects: the description of LOs to provide efficient search and retrieve mechanisms; the model of LO to guarantee the reusability and interoperability of educational resources in the hundreds of learning platforms and learning systems available worldwide.

Amongst others, the IEEE Learning Object Metadata (IEEE LOM) [1] and the Shareable Content Object Resource Model (SCORM) standard [2] are rapidly being adopted by Learning Management System (LMS) constructors as well as by digital content developers. The LOM standard facilitates description, search, evaluation, acquisition and use of LOs, while the SCORM provides the technical specifications in order to guarantee learning content interoperability and reusability. However, the debate about the pedagogical effectiveness and adoption of Learning Object metadata models is a long-lasting one. Actually, the difficulties experienced by teachers in the use and management of metadata models risk to

compromise the potentials offered by these models. The e-learning environments and tools that have been developed so far rarely take into consideration some important factors such as: the life-cycle of the resources to be described, the intrinsic differences existing between the typologies of information (descriptive, management, structural, and so on) related with the resources, and how each kind of metadata should be associated to the resources.

Several studies (Cardinaels, 2007) highlight a dynamic view of the concept of metadata that would foster innovative ways of using and managing educational resources. In this context, not only does the definition of the OpenLO model (Fulantelli et al, 2007) strengthen the vision of dynamic metadata, but it also requires a further step towards the definition of a comprehensive methodology to define the management of dynamic information and, at the same time, to develop the appropriate technological tools.

Starting from an analysis of the state of the art about learning object metadata, we analyse the recent research on the concept of dynamic metadata. Then, we present the results of the research work forming part of the activities of the EU-funded project SLOOP: Sharing Learning Objects in an Open Perspective (Masseroni and Ravotto, 2005), aimed at encouraging the definition, development and management of Open Educational Resources based on the Learning Object paradigm (Wiley, 2000). In particular, we present the Open Learning Object (OpenLO) model and the consequences on the life cycle of learning resources; afterwards, we analyze how a dynamic vision of the metadata should be integrated in the design of effective environment to manage LO, called LOMS in order to improve the management of Learning Objects.

Finally, we illustrate the evolution of a LOMS developed in the framework of the Sloop project, named FreeLOms (Gentile et al, 2006), based on a dynamic vision of the metadata concept and the advantages offered by this approach for teachers and educational professionals in terms of effectiveness and usability of Learning Objects.

2. **Lifecycle of Learning Resources: the OpenLO perspective**

Different research works analyze the life cycle of learning resources. In (Strijker, 2004; Collis and Strijker, 2004) a general model of the life cycle is proposed. The stages of this model appear complex, and do not allow the task identification that is necessary to carry out within each phase. For example, the "Using" phase could also contemplate the adaptation of the resource. In (Van Assche and Vuorikari, 2006) a scenario for learning resources is proposed; it draws attention to the complexity of the learning resources life cycle and to the different paths and cycles that a learning resource can follow. Starting from several works (Strijker, 2004; Van Assche and Vuorikari, 2006), (Cardinaels, 2007) proposes a life cycle called "dynamic life cycle". This model aims to stress two main concepts: *the reusability of learning resources* and *the dynamic view of learning object metadata*. In particular after the "Repurposing" stage, the user can directly integrate the resource in its own learning context or can edit the resource to adapt it or creating a new learning object and the creation of new learning object. Moreover, the "Labeling" stage becomes a transversal stage to allow the generation of metadata in parallel with all the other phases. These changes point out that the description of a learning resource may benefit from the analysis of the information

collected from different sources, such as the information related to the context of use gathered from the learning management system.

Finally, in (Lehmann et al, 2008) it is possible to find an analysis of the life cycles previously proposed, and a re-establishment of the models previously listed, distinguishing 4 fundamental phases which are called Authoring, Provisioning, Re-authoring, Learning and Consumption according to a scheme that allows the creation of different scenarios. All these works aim at iterative life cycles in which it is possible to reuse educational resources through composition and/or adaptation (and therefore editing) of existing resources. These models of life cycle presuppose that there is the possibility to modify the learning resources at a "content" level.

At the moment, the used models for Learning Object (e.g. SCORM) (ADL, 2001)consider the re-usability only in terms of composition of existing resources in complex teaching units, according to the Lego model (Wiley, 2000).

In (Fulantelli et al, 2007), the concept of OpenLO was introduced, according to the idea that facilitate the activation of processes in which the active role of teachers is essential, in order to move towards a pedagogical concept of reusability in which a LO can evolve to meet specific educational requirements. To this aim we have to facilitate the personalization, the changing and the adaptation of learning resources. Following the point of view of the OpenLO model, scenarios such those proposed in (Van Assche and Vuorikari 2006; Cardinaels, 2007; Lehmann et al, 2008) may actually take action.

3. **Learning Object Metadata: State of the art**

The importance of metadata in managing digital resources for learning is underlined in several works (Duval and Hodgins, 2003; Motelet and Baloian, 2005; Duval and Hodgins, 2006). Learning Object Metadata, initially proposed in order to facilitate the retrieval and the reuse of the digital resources for learning, are rising an increasingly interest in the research area and therefore are often reason of debate.

Different metadata schemas have been proposed as a solution for the description of learning resources; the two main models are the Dublin Core (ISO 15836: 2003.2003) and the IEEE LOM (IEEE, 2002). From a comparison between the two models, the IEEE LOM appears the most used in the field. In fact, since it was designed exclusively for the description of educational resources, it allows the management of the information which may be appropriate to such description.

The main reason for the success of the standard IEEE LOM is due to its extreme flexibility. In fact, as it is claimed in (Duval and Hodgins 2006) "LOM effectively standardizes how to structure metadata about learning objects, not which metadata elements to include". The extreme flexibility of the standard has encouraged the growth of proposals for the standard extension, usually named "Application Profile" (AP). An "Application Profile" is an extension of the standard which defines new elements or attributes or specifies the value space of some elements.

Despite the presence of about 76 different aspects by means of which it is possible to describe the educational resources, some works underline gaps in the expressive power of the standard, especially with respect to the pedagogical features of the resources in specific contexts. In fact these Application Profiles have been defined to adapt the IEEE LOM in particular contexts of interest. This variety of specific raises an obvious problem of interoperability between the

descriptions carried out following the guidelines imposed by the various APs. For a deeper analysis of this issue, refer to (Sampson, 2004).

From a technical point of view, different works highlight the limits of binding XML LOM, indicating as essential points of criticism, on the one hand, the lack of a shared vocabulary and by other the impossibility to bind to the descriptions the different contexts in which these descriptions are created (Brooks and Mccalla, 2006). (Forte et al, 1999) proposes a shared thesaurus of possible values in order to promote interoperability of the generated metadata. Other studies (Motelet and Baloian, 2005; Brooks and Mccalla, 2006) suggest an ontological approach and the use of the RDF binding (Brase et al, 2003) allowing the insertion of these descriptions into a graph of concepts. In this scenario (Mohan and Brooks, 2003) analyze the relations of LOs and the Semantic Web, identifying several kinds of ontologies related to LOs: domain ontologies, e-learning ontologies, teaching and learning strategy ontologies, and learning object structure ontologies.

Some authors (Jovanović et al. 2006) suggest adding a context ontology in order to describe the educational context where a learning object has been used; others propose the addition of an ontology related to the student, thus guaranteeing a personal content customization depending on a student's previous knowledge (Bouzeghoub et al., 2006). Other authors show how the correctness of the generated metadata by automatic instruments is however approximate (Greenberg, 2004). In this sense (Cardinaels et al, 2006) proposes a formal model for the LOM which allows the definition of "fuzzy" metadata in which value of confidence is associated.

4. **Automatic Learning Object Metadata Generation**

Different works, while stressing the importance of the IEEE LOM standard, highlight the excessive complexity of the labeling task; in fact people need time and expertise to assign all the values to the metadata attributes of the LOM schema.

For these reasons many researches look in detail the possibility of simplifying the description of learning resources by means of automatic generation of metadata. In the work of (Cardinaels, 2007) a framework for the automatic generation of metadata is proposed, that is based on a formal analysis of the nature of metadata defined in the IEEE LOM standard (IEEE, 2002).

Starting from the analysis of the learning object life cycle, it is possible to classify metadata in order to identify the set of metadata that can be obtained from the information generated by each stage of the life cycle. In particular, these information can be collected from various sources of data, e.g. the Learning Management System where these resources are used. While some works in the definition of tools for the automatic generation of metadata are concentrated only on single issues, such as, for example, the context of use of resources, in (Cardinaels et al, 2005; Cardinaels, 2007; Lehmann, 2008) several possible sources of data from which it is possible to extract information useful for the description of the resource are analyzed. Many works considered the authoring phase as a key element for the automatic generation of metadata. In this phase for example, the metadata can be analyzed in the light of the relationship that exists between the learning resource as a whole, and the parties that compose it. In the works of (Hatala and Forth, 2003; Cardinaels, 2007) the metadata IEEE LOM are classified to highlight when these may be inherited by the parties or vice versa when the metadata of the parties may contribute to the definition of metadata of learning resource (accumulate metadata).

Some works look in detail how some ontological relationships between educational resources may be translated into relations between the values of the related metadata. In this sense the ontological relationships between the learning resources may generate simple rules that may facilitate the automatic generation or the validation of metadata (Motelet and Baloian, 2005). The ontological relationships between the learning resources may take an important role in other phases of the cycle of life as the design phase or stage of retrieval. Starting from the learning unit syllabus and analyzing the relationships between the resources that make it up, the LessonMapper Toolkit (Motelet and Baloian, 2006) allows obtaining a description of the resource that it intends to find or create ex-novo.

Many researches insist on the relationship that exists between the learning resource and the users and on the information that may be obtained to describe the learning resource from the analysis of context of use or user profile. Some authors insist on subjective nature of metadata (Duval et al, 2002) and propose indeed an active role of users in the implementation of metadata. (Brooks and Mccalla, 2006) propose a so-called "ecological approach" in which it is by analysis of the user profile that is possible to derive information useful for the categorization of the resource. The central role of users is emphasized also in those works that analyze the mechanisms of collaborative filtering and recommendation for the retrieval and the evaluation of educational resources. These works exploit social relationships between users trying to first locate people who might "…share a great deal of interests with the searching person" (Freyne et al, 2004).

5. **Towards the Learning Object Management System**

(Fulantelli et al, 2007) highlights how the functionalities offered by Learning Object repository (LOR) are not enough to manage learning resources with a dynamic life cycle as in the case of the OpenLO model. In fact, in general the LOR uses the metadata exclusively to improve the management of categorization and retrieval of learning materials. Only in recent years, some LOR have been improved with tools that allow users to annotate and comment the resources in order to promote a collaborative process of evaluation of educational resources.

Some experiences promote a close integration between LOR and learning management system (LMS) (Fulantelli et al, 2007; Han et al, 2008); in particular, these integrated environments facilitate/allow users to find learning resources from LOR and integrate it into the learning context directly from the LMS. Few LORs use data from the context of the use of resources, in order to complete the description of educational resources (Broisin et al, 2005), and perhaps no experience plan on using the information on the model user present in LMS to encourage the ecological approach suggested by (Brooks and Mccalla, 2006).

The dynamic life cycle of OpenLO model requires the transition towards a new kind of system called Learning Object Management System (LOMS). LOMS are environments that facilitate the management of learning resources throughout their life cycle. Within the framework of the EU-funded sloop project, sharing learning objects in an open perspective, we have developed FreeLOms (Gentile et al, 2006), a learning object management system aimed to managing learning objects according to the OpenLO model. The main objective of FreeLOms is to provide a community of teachers with an on-line platform to share and produce learning resources collaboratively.

Two different approaches can be used to implement such kind of systems: the close integration of a LOR with other tools like authoring system, LMS to build a unique global environment; the creation of a network of services, according to a service oriented architecture (SOA) approach, to facilitate a light integration with existing systems.

In comparison to the first the second approach seems more suitable in order to create a Web 2.0 environment. Moreover, some works as (Ochoa et al, 2006; cam, 2007) move already in the direction of encouraging the creation of networks of services. In our vision, a LOMS is both a rich Internet application and, at the same time, a set of services accessible through the web from different applications. The goal is to make it easy to use the services provided by a LOMS, and not to impose specific software, but rather to propose a philosophy that makes the creation, management and reuse of digital educational resources efficient and effective.

For these reasons, the platform FreeLOms, in addition to providing an online collaborative environment with the features typical of a LOR, offers a series of services to facilitate the management of their life cycle of the learning resources. For example FreeLOms allows end users to access the repository as though they were accessing a shared drive in different ways through mechanisms like WebDAV, CIFS or SharePoint protocols. FreeLOms also makes use of mechanisms of sequencing that allow you to analyze content in different formats and extract the parties and relations in order to allow a navigation of the content through different views.

6. **Conclusions and future proposals**

In this paper we have illustrated how a dynamic vision of the metadata should be integrated in the design of a LOMS in order to improve the management of Learning Objects. Currently our research is concentrated on the improvement of usability of the user interface of the FreeLOms platform; moreover, we have been developing a set of web services that can facilitate the management and reuse of digital educational resources in efficient and effective way. For example, in relation to integration with the LMS currently we have been developing the integration between FreeLOms and the Moodle platform. The goal is to create a set of services that allow LMS not only to use the content stored in FreeLOms, but also allow LOMS to exchange information about the context of use of the learning resources according to the dynamic metadata approach previously analyzed.

Finally, in our vision we have to explore how the informal learning opportunities created by the Web 2.0 applications can make use of learning resources. The increasingly use of social networks, allow users to interact and collaborate in new ways, and in this sense a LOMS must allows teachers and experts to create a network where they can participate collaboratively in the processes of design, development, sharing, reusing and evaluation of open learning resources.

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