Integration of Multimedia Content and E-Learning Resources in a Digital Library

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ABSTRACT

In this paper we describe a proposal for multimedia and e-learning content description based on standards interoperability within a digital library environment integrated in a virtual campus. In any virtual e-learning environment, a complex scenario which usually includes a digital library or, at least, a repository of learning resources, different levels of description are needed for all the elements: learning resources, multimedia content, activities, roles, etc. These elements can be described using library, e-learning and multimedia standards, depending on the specific needs of each particular scenario of use, but this might lead to an undesirable duplication of metadata, and to inefficient content queries and maintenance. Furthermore, there is a lack of semantic descriptions which makes all these contents merely become digital objects in the digital library, without exploiting all the possibilities in an e-learning virtual environment. Due to its flexibility and completeness, we propose to use the MPEG-7 standard for describing all the learning resources in the digital library, combined with the use of an ontology for a formal description of the learning process. The equivalences of Dublin Core, LOM and MPEG-7 standards are outlined, and the requirements of a proposal for a MPEG-7 based representation for all the contents in the digital library and the virtual classroom are described. The intellectual property policies for content sharing both within and among organizations are also addressed. With such proposal, it would be possible to build complex multimedia courses from a repository of learning objects using the digital library as the core repository.

Keywords: e-learning, digital library, standards integration, metadata, MPEG-7, LOM, Dublin Core

1. INTRODUCTION

Distance education in virtual e-learning environments (such a virtual campus, for example) permits an intensive use of new technologies, especially in the field of design, creation and management of multimedia contents. The use of multimedia resources, either as learning tools in virtual environments or as basic pieces of multimedia repositories, allows us an improvement in the process of learning contents of audiovisual nature. In this sense, teaching contents with a clear multimedia structure, such as several subjects in Information and Communication Studies, for example, requires learning tools with two desired characteristics: first, each course follows an activity oriented structure using a temporal framework and, second, content personalization capabilities are needed to create adaptive courses but also to minimize course obsolescence. Therefore, content reusability within a course is an important issue related to course quality and management.

This paper addresses the integration between documents according to standards for multimedia content distribution such as MPEG-7, and other learning resources designed using e-learning standards such as LOM, within the context of a virtual e-learning environment that includes a digital library, which uses the Dublin Core standard for metadata. The need for metadata integration across multimedia, e-learning and library standards becomes a key factor for ensuring a proper content management and retrieval by teachers, researchers and students, the users of the digital library. All the resources in the digital library can be browsed and searched

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as a large repository of multimedia contents which uses structured metadata for the syntactic and semantic description of all the resources.

The use of standards for content description based on XML ensures the possibility of describing thoroughly all the elements in the virtual campus. Integration of standards for content tagging and indexation from different approaches (from the pedagogic field such as LOM, or the multimedia field such as MPEG-7) is a first step to ensure coherence and the reuse of such contents in the future. In this paper we describe a proposal for promoting the integration of such standards in order to improve the indexation, classification and searching and browsing capabilities of multimedia and e-learning contents, therefore enhancing the retrieval of both such contents. This is accomplished by means of metadata standardization, which allows us to create a hierarchy of multimedia learning objects ranging from single text, audio or video clips to complex multimedia courses.

This paper is organized as follows: Section 2 describes the basic services of an e-learning environment, the different kinds of resources used in the learning process and the particular case of the virtual campus at the Universitat Oberta de Catalunya and its digital library. In Section 3, the equivalences and intersection of library, e-learning and multimedia content description standards are presented, and a proposal to use the MPEG-7 standard as the basis for a scenario formalization through ontologies is presented. Finally, in Section 4, the conclusions and several current and future research lines are outlined.

2. E-LEARNING ENVIRONMENTS

The intensive use of Information and Communication Technologies such as Internet, for example, increases the possibilities for both content searching and delivery but also for interface design and implementation has completely changed the visions in the open distance education field. E-learning is one of the most promising and growing issues in the information society nowadays. The growth of the Internet is bringing online education to people in corporations, institutes of higher education, the government and other sectors.\(^1\) The growing need of continuous education and the inclusion of new multimedia technologies become crucial factors for this expansion.

2.1. UOC virtual campus

The Universitat Oberta de Catalunya\(^2\) (UOC\(^*\), in English known as Open University of Catalonia) is a completely virtual campus which offers 19 official degrees, several graduate programs and post-graduate studies, and a doctoral degree, with more than 35000 students and more than 1500 people including instructional designers, teachers, tutors, academic and technical staff. The UOC virtual campus is an integrated e-learning environment which allows users to communicate with other users using a mail system, and includes an agenda, a news service, virtual classrooms, a digital library and other e-learning related tools. Although the use of classical text printed books is still massive, there is also a growing use of web based e-books and other online learning resources, so the introduction of new e-learning standards and application profiles such as SCORM\(^3\) and IMS-LD\(^4\) is becoming a necessity for maintaining the constant evolution of the virtual campus. The increasing amount of multimedia content and standard based learning resources is revealing the need of new functionalities and capabilities provided by the digital library.

2.2. The virtual classroom

Each subject has a classroom with all the needed elements for the development of the learning/teaching process: e-mails, access to documentation, the activity based teaching planning model, access to evaluation results, access to the teacher board, forums, debates, etc.

The classrooms at the virtual campus are the meeting points of the learning activities. Every subject has its own group of virtual classrooms with a maximum of eighty students and one consultant professor per classroom (although depending on the subject these figures may be very different). From the very beginning, students receive support from their tutoring counsellor, who guides them through the complete process of enrolment, learning and being part of the UOC community. On the other hand, the teaching counsellor offers academic advice on all matters related to the fulfillment of educational challenges, the process of integration within the university community and professional orientation on completion of a student’s studies.

\(^{*}\)http://www.uoc.edu
Figure 1. Example of the resources area in a virtual classroom.

The virtual classroom has four access zones where all the activities related to the learning process are performed, namely Planning, Communication, Information resources and Evaluation:

- Planning: shows a calendar with all the activities of the learning process, and also the teaching curriculum for the subject.

- Communication: provides access to the public e-mail system of the classroom, the list of the classmates from where anyone can e-mail the other students or chat with them, and access to the tutoring and teaching counsellor e-mails.

- Resources: shows a list of all the educational material, information sources and resources related with the subject. Figure 1 shows an example of a list of available learning resources for one subject, “Data Mining” (in Catalan).

- Evaluation: it offers a direct access to the mailbox for submitting the evaluation activities and access to the marks and final results of all the parts of the course.

The resources area provides access to four basic kinds of resources, two of them optional. The first, named “Subject material”, contains the learning materials which are edited under the UOC format and that are directly related with the course and subject objectives. Although most educational material is available in form of printed books, this area also includes access to the web and the PDF versions for printing, and other kinds of resources such as reading materials, study cases, etc. This kind of resource is mandatory for all subjects.

While this area is a more permanent content, which undergoes a publishing plan and an editing process, at the “Information Sources” area there is the content which is easier to change, under a dynamic management process, which allows content modification each semester under the particular needs of each subject.

Under “Information sources”, at the moment the sources being used are: full text articles scanned from paper publications or with direct link to the electronic version; recommended bibliography with direct access to the online circulation service; academic and professional databases that the library subscribes for the UOC community; encyclopedias and dictionaries also exclusive to UOC users; law content and standards; and a selection of free web sites coming from the bookmarks of the teachers. This kind of resource is also mandatory.

“Tools and support elements” comprises those features that give support to the students for their homework. It provides tools such as software, exams and exercises from other semesters that can be used as samples of the evaluation process, etc., all them related with the methodology, but not directly with the basic course content.
Finally, there is also the option of providing access to a "Shared Server", a public space available to all the users of the virtual classroom which is used for updating information and adding new contents in an easy manner.

It is worth to remark that most of the information resources come from the digital library integrated in the virtual campus, which uses an ad hoc database with Dublin Core, IMS and SCORM standards and application profiles for managing the electronic resources, and a commercial OPAC with MARC 21 for the recommended bibliography. For visualizing these resources at the virtual classroom, at the digital library or elsewhere at the virtual campus, both XML and a set of XSL transformations are used, in order to separate both content and presentation.

When using these tools, teachers have an easy manner to maintain and update the resources, and it is also possible to work with different languages (Catalan, Spanish and English). This also increases reutilization because the same resource can be accessible from different virtual classrooms without need to maintaining several copies into the resource manager.

2.3. Subject planning

Figure 2 shows a typical scheduling which includes all the activities the students need to perform in order to successfully achieve the desired learning plan goals for one subject. This scheduling, altogether with all the available learning resources form what is known as the “Teaching Plan”, a document which explains all the course methodology, goals, resources, and so.

Currently, the scheduling, which is activity oriented, is not directly related to the learning resources but for a simple enumeration of the resources needed for each activity. This lack of structure makes very difficult the continuous actualization of contents, for example, or the inclusion of any new learning resource on-the-fly. By the moment, the digital library is used as a simple repository for all the learning resources, but without a real semantic tagging or including any formal description of the learning process. The teaching plan is the first step towards a complete formalization of the learning process, as described in Section 3.6, with the help of the appropriate standard extensions. The use of e-learning standards for both content description and structuring will allow the inclusion of complex learning strategies such as personalization, for example.

2.4. The Digital Library

As mentioned above, the UOC’s digital library is the center for resources of information provided by the university so that students, teachers, researchers and staff can access all the contents and services they need to carry out
their basic tasks: learning, teaching, research, continuing studies and management. These resources include, among others:

- Exclusive electronic content, both academic and professional, from e-journals, databases and e-books, among other sources. These contents are accessed remotely using the Library on the UOC’s Virtual Campus and, thus, can be accessed from any computer. These resources from the library are only available to UOC users (students, teachers and academic staff) and, therefore, cannot be accessed freely from the internet.

- Free and carefully selected resources which complement the exclusive archive and which are of particular interest to the community due to their academic value and the information they provide. Amongst these electronic resources, are bookmarks selected by UOC teaching staff. All the resources in this section, namely “Digital Collection”, are described in detail to provide users with an assessment of their contents and usefulness.

The resources in the classrooms are created upon this range of digital content and also from new additions. Both selection and new proposals for content to be placed at the classrooms are managed through and e-mail service based, posted by teaching staff to librarians, so content updating it is not immediate. Furthermore, all content is revised and tagged before it becomes available in the virtual classroom, so the possibilities of updating content in an on-the-fly manner are dramatically reduced.

The content which is also available from the digital library at the virtual campus, is usually described through MARC21 or, for the electronic resources, through the Dublin Core standard. But, as mentioned before, the semantic description generated by the library is not used at the virtual classroom, the place where these content is still not semantically organized but through the teaching plan. This is a clear example of metadata redundancy, as the same information (but from two different points of view, library or e-learning) must be specified twice in different formats. From the e-learning perspective, there is also the need of adding new types of content at the virtual classroom resources area, which at the moment are mostly text base material:

- Teaching materials: created ad hoc for the UOC’s educational methodology, which develop the basic contents for all the subjects.

- Basic digitized articles or from the database.

- Exclusive electronic information resources: e-books, databases, e-journals, etc.

- Access to the latest newsletters specializing in the subject matter.

- Recommended bibliography: a reading list with the basic bibliography for the subject, with the option of requesting their borrowing from the classroom.

- Exams and answers to the exercises from previous semesters.

- Frequently asked questions (FAQ). With the help of the appropriate tools, threads in the forum of the virtual classroom can be converted into useful FAQ documents.

All these resources are currently tagged using a minimum set of metadata for library maintenance purposes only using MARC 21 or Dublin Core. In a few subjects, these resources are also tagged using a subset of the LOM standard for educational purposes (for example, allowing students to create their own evaluation activities by selecting the appropriate exercises from a large repository), but this tagging is not integrated with the MARC 21 yet. One of the goals of the work presented in this paper is to establish the requirements of such integration using the paradigm of interoperability among content distribution standards.
3. STANDARDS INTEROPERABILITY

Metadata provide controlled and structured descriptions of learning resources through searchable access points such as title, author, date, location, description and subject, but can also provide interpretative information on the potential education application of resources or include described information about the relationships with other resources. The learning resources form a hierarchical structure when are combined to create courses using learning objects as the basic pieces. Furthermore, these resources usually are used by learners following the temporal planning described in Section 2.3, so there is a clear need for representing all this knowledge about each subject.

In order to do so, we need to define the appropriate mappings between multimedia, e-learning and library standards in a two-stage approach: first, a set of common metadata is identified in all three standards for supporting basic browsing and searching capabilities and, second, the appropriate extensions using ontologies are created to minimize metadata overlap and inconsistencies, using the MPEG-7 standard as the basic language for content description.

3.1. The MPEG-7 standard

The MPEG-7 standard\(^8\) is a recent standard (the version of the final work was produced in 2003) for distribution of multimedia contents, which allows users a complete syntax of contents as well as a semantic level of code. Previous standards of the MPEG family, such as MPEG-1, MPEG-2 and MPEG-4, were focused on compression and digitalization of video and audio signals. MPEG-7 complements them since it aims to standardize the description based on contents of different types of audiovisual information. Search, recovery and indexation of such multimedia contents require a tool for describing documents and let them use in an efficient manner. The aim of MPEG-7 is to provide interoperability amongst systems and applications employed in the generation, management, distribution and consume of audiovisual contents.

The main feature of MPEG-7 standard is its flexibility: the use of XML (eXtensible Markup Language)\(^9\) as content description language and the possibility to define a pack of descriptors adapted to requirements of tagging and indexation according to the application desired. They provide the extension of the standard MPEG-7 to be used in diverse environments and be adapted in each case to the particular use requirements. The use of XML allows users to have a structured access towards the information contained in the MPEG-7 document in an efficient manner, and ensures a connection with other standards of description through the use of transformations XSLT.
MPEG-7 uses a Description Definition Language (DDL) to allow the creation of Description Schemes (DSs) and Descriptors (Ds) when new extensions are needed. An example of the relationship between these elements is shown in Figure 3. These descriptions are based on catalog (i.e., title, creator, rights), semantic (i.e., the who, what, when, and where information about objects and events), and structural (i.e., the color histogram of an image or the timbre of a recorded instrument) features of the multimedia content. The DDL defines the syntactic rules to express and combine Description Schemes and Descriptors. A DDL file is encoded in XML and more specifically uses the constructs defined in the W3C’s XML Schema Language. The XML Schema Language defines a language for defining the structure, content, and semantics of XML documents. XML Schemas express shared vocabularies and allow machines to carry out rules made by people, expressed in the schema language. An XML Schema is, itself, an XML document. The importance of XML Schema language to the MPEG-7 DDL is because of the stability of the XML Schema language, its potential wide-spread adoption, availability of tools and parsers, and its ability to satisfy the majority of MPEG-7’s requirements led to the decision to adopt XML Schema as the basis for the DDL.

Regarding efficiency issues, the use of BiM (Binary Format for MPEG-7) ensures a fast access because it enables the streaming and the compression of any XML documents, enabling also a parametrized transmission of any XML document and, therefore, the same contents can be accessed in many different ways, as shown in Figure 4. This is a clear sign of the large flexibility offered by the MPEG-7 standard which can be used to build complex multimedia courses following a hierarchical structure.

3.2. E-Learning standards

As a very complex scenario in nature, the description of the e-learning process and the interactions between all its elements is not a simple question. Two basic levels of description can be identified: the first level, pointed towards learning objects, describes the aspects directly related to the educational content. The second level describes the interactions between such learning objects and the users within the framework defined by the learning process.

For the first level, the LOM standard defines a structure for interoperable descriptions of learning objects. In this case, a learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training. Notice that we do not use the definition of learning object from Wiley because it does not include non-digital resources. Nevertheless, although there are several other definitions for learning objects, all of them coincide in a single desired behavior: reusability.

Metadata for a learning object describes relevant characteristics of such learning object to which applies, pursuing reusability. Regarding the LOM standard, such characteristics may be grouped in general, life cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories. Nevertheless, the LOM standard has been criticized because of the lack of specific metadata for educational purposes (the current educational category is very limited) and several authors have proposed extensions for covering such limitations (see for example).

On the other hand, application profiles such as SCORM or the IMS-LD standard, which is based on EML, try to describe the aspects more related to the learning process in itself, such as sequencing or role playing. It seems clear that this information cannot be stored in the learning objects, but in a higher semantic level. The use of ontologies for representing all the richness of the learning process scenario is a clear example of separating the concepts of resource, activity and role. Although the IMS-LD standard may seem too complex,
its flexibility and multilevel description capabilities allow the specification of any learning process ranging from simple educational itineraries to complex learning processes including personalization and collaborative working capabilities. Furthermore, in the simplest level, it is easy to convert any IMS-LD schema into a SCORM compatible course, which is already in development in the UOC virtual campus, ensuring compatibility.

3.3. Digital Library standards

Finally, regarding the Dublin Core and MARC 21 standards, both of them have been typically used for content tagging in digital libraries.

On the one hand, the Dublin Core is a metadata element set. It includes all Dublin Core Metadata Initiative terms (that is, refinements, encoding schemes, and controlled vocabulary terms) intended to facilitate discovery of resources. The Dublin Core has been in development since 1995 through a series of focused invitational workshops that gather experts from the library world, the networking and digital library research communities, and a variety of content specialties. The Dublin Core is a content description metadata model for the recovery of electronic resources. It is being used by formal resource description communities such as museums, libraries, government agencies, and commercial organizations. The Dublin Core is based on XML language. It is possible to use different syntactical forms for a DC document: resource description framework (RDF), DTD and XML schemas.

On the other hand, Machine Readable Catalog (MARC) is used for coding, storing and exchanging bibliographic data since 1968. MARC was born at the Library of Congress for interchanging bibliographic machine readable references between libraries. MARC 21 is a result of the evolution of the MARC with the main difference that is enhanced for cataloguing electronic resources. Both standards are in fact interoperable as it is possible to convert the metadata in one format to the other using the appropriate mapping.

3.4. Equivalences and interoperability among standards

Interoperability can be defined as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged". Interoperability ensures that the data is entered only once in one application and that can be automatically propagated or queried to/from other applications. Such a scenario requires a common semantic model, in order that metadata from one repository can also be interpreted by any other repository.

As all the three standards described above share the same basic goal (content tagging), it is possible to establish a common set of functionalities covered by all of them, as described in. Table 1 shows a basic subset of common descriptors for the three standards. For each field in the Dublin Core standard, the equivalent field in the LOM standard (category and element name) and the path and the equivalent field in the MPEG-7 hierarchy structure is shown. Notice that the MPEG-7 standard is much richier than the other two standards, and that it can be even extended through the DDL. Nevertheless, although the MPEG-7 standard could be extended to represent all the descriptors and the description schemes to include all the metadata available in both LOM and Dublin Core, only a basic subset of both standards is really necessary for basic content tagging. We are currently working in the definition of such basic subset (for the LOM standard) which will become the new set of Ds and DSs elements in the MPEG-7 proposal.

Following the ideas described in, the MPEG-7 standard needs to be represented through an ontology, in order to ensure both interoperability and scalability with other systems. In fact, any extension of the MPEG-7 standard (or any other standard) is better defined by means of the equivalent ontology, as stated in. Therefore, once the basic set of Ds and DSs had been defined, we will extend such ontology to incorporate these new elements.

3.5. External resources and intellectual property

Usually, digital libraries are not only structured repositories of contents, but also gateways to external databases and other external information providers. It is important to remark that the use of all the available resources is restricted by the applicable intellectual property rights policies. In the case of internal learning resources, generated within the virtual campus by teachers and students, they are always asked in advance for permission for using their work without changes in other classrooms, without making any dissemination through Internet,
and only for educational reasons and providing always the author of the material. UOC policy ensures that all content generated within the learning process context becomes part of the UOC community and, therefore, it can be shared among all the users of the virtual campus.

But in the external case, there is a clear need for adopting intellectual property licences that allow the modification and redistribution of such content for different purposes. Therefore, there is a need for using a type of licence that lets the teaching staff to distribute and build new content upon the work of other teachers and external resources. UOC is promoting the adoption of content sharing licences such as Creative Commons† or the General Public Licence (GPL)‡, for example, in order to ensure a simple but effective intellectual rights policy. For those contents with more restrictive rights, the system should ensure the proper use through the appropriate standards.

In this sense, the upcoming MPEG-21 standard\textsuperscript{20} is intended to provide a normative open framework for multimedia delivery and consumption for use by all the players in the delivery and consumption chain. This open framework will provide content creators, producers, distributors and service providers with equal opportunities in the MPEG-21 enabled open market. As stated in,\textsuperscript{21} MPEG-21 can play a role in the design and development of digital library applications to ensure proper digital rights management within any organization.

3.6. Proposed framework

Therefore, according to the requirements described in the previous sections and the particularities of the learning resources which are used as the basic educational material in the virtual classroom, we propose to use the MPEG-7 as the basic standard for content description in the digital library. Using the appropriate DDL based extensions, the MPEG-7 standard can represent also the required fields of Dublin Core, MARC 21 and LOM standards. In order to do so, we propose a standards integration project development in three stages:

1. Basic metadata identification: once the specific requirements for both librarians and teachers have been identified, a basic subset of the needed metadata for the three standards will be described using the DDL,

<table>
<thead>
<tr>
<th>Dublin Core</th>
<th>LOM</th>
<th>MPEG-7</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Media Information. Media Identification Identifier</td>
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<tr>
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<td>Rights</td>
<td>UsageMetaInformation. Rights RightsID</td>
</tr>
</tbody>
</table>

Table 1. Basic metadata equivalences between Dublin Core, LOM and MPEG-7 standards.

\textsuperscript{1}http://creativecommons.org
\textsuperscript{2}http://www.gnu.org/copyleft/gpl.html
extending the MPEG-7 standard. This stage is currently under development involving both librarians and teachers, but also instructional designers and usability experts, in order to ensure a tagging oriented towards the concept of activity. The resulting MPEG-7 extended standard will be represented through the appropriate ontology, hiding all metadata details from pure content, and simplifying also the access to such content from different scenarios (the virtual classroom or the digital library interface, for example).

2. Ontology extension: starting from the ontology described in, we will define the adequate extensions to incorporate the richness of the learning process, using the IMS-LD standard first level functionalities as the basic requirements of our system.

3. Prototype development: finally, using the new available Ds and DSs, a set of learning resources is tagged accordingly to all the needed criteria: for library purposes, e-learning and multimedia content description. Then, a basic educational itinerary will be described for such learning resources using the ontology described in the previous stage. This prototype will be probably implemented using any available IMS-LD player with the appropriate XSL transformation, using the ontology for representing all the elements in the learning process. In order to test the multimedia capabilities, a subject with audiovisual content will be chosen as the course prototype.

Therefore, all the small fragments of content which are used as learning resources in any subject or course will be tagged according to the extended MPEG-7 standard, including metadata for both pedagogical and library purposes. In fact, using the appropriate transformations (i.e., a subset of the available metadata), it will be possible to generate the Dublin Core or MARC 21, or the LOM record for any learning resource in the digital library, as they are partial descriptions of the complete tagging using the extended MPEG-7 standard. All these resources will be structured and integrated in another MPEG-7 document created from the extended ontology, in order to represent all the possibilities of the learning process, including sequencing and temporal requirements, following the same approach than the IMS-LD standard. Therefore, any subject could be seen as a single MPEG-7 document, and the digital library will become a content producer, and students (but also teachers) will become consumers using both push and pull application paradigms. We expect that the creation of a large repository of learning resources and MPEG-7 documents for the different formative itineraries will follow the prototype course, once the proposed framework has had been validated.

4. CONCLUSIONS

Large e-learning environments such as the UOC virtual campus, for example, usually include the use of content repositories where very different kinds of learning resources can be found, ranging from printed books to multimedia contents. These resources are used by students as the basic educational materials for each subject they are enrolled to, following a predefined teaching plan and a scheduling. Currently now, this information and learning resources are stored in the digital library as isolated documents, without any structuring.

In this paper a proposal for standards integration has been presented. The use of the MPEG-7 standard capabilities for describing all the metadata needed by the learning resources used in the virtual classroom seems to be the most efficient option, integrating all the knowledge managed from three different points of view: the digital library, e-learning resources and multimedia content. Three stages have been identified: first, the identification of a basic subset of metadata for content tagging, and its representation using the MPEG-7 standard by means of the DDL. Second, the extension of the MPEG-7 ontology mapping to incorporate all the aspects related to the learning process, such as activities, roles, and so, as defined by the IMS-LD standard. Finally, as a third step, we will implement a course prototype for a selected subject in order to validate the MPEG-7 standard as the basic language for multimedia and e-learning content description in a digital library. The work presented in this paper is still in the first stage of the proposal, although several aspects related to the second stage are currently under development.

The main lines of present and future research in this project cover the study of the forthcoming MPEG-21 standard, still under development, which includes aspects related to contract and distribution services, or author rights management. The use of complex ontologies for the description of the relationships between producers and consumers of e-learning and multimedia content using the appropriate description standards is also an interesting research subject.
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