Advanced Repositories for Science Teaching and Learning (the COSMOS Project): Main Operations and Technologies Used

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Abstract:

This paper presents the main operations and technologies implemented in the framework of the EU funded COSMOS project. COSMOS introduces an advanced web repository which allows teachers and students to search, retrieve, access educational content and re-use educational material for creating earning activities through a specifically designed web interface incorporating innovative technological solutions. Four main activities are supported in COSMOS, each of which is associated with a specific innovative technological solution. For each activity, we describe the technologies and operations used.

1 Introduction

At the European Council in Lisbon in March 2000, the European Union set itself the ambitious objective of becoming “the most competitive and dynamic knowledge-based economy in the world”. In this perspective, the European Council underlined that there is an augmented need for Europe’s education and training systems to adjust to the needs of the knowledge-based society. The penetration of innovative technological applications with Internet access in education may facilitate the accomplishment of this goal. Today, the recent advanced on Web and computer technology can transform student’s classrooms to research laboratories [1].

As reflected in the eEurope 2005 Action plan “Developing a better understanding of the role of science in society and bringing science and scientific subjects closer to the citizen is expected to help increasing young people’s interest in science and scientific careers”. Furthermore the “i2010” has among others as main objective to “Create a "borderless European information space" including an "internal market for electronic communication and digital services". The development of Portal and Repositories aim to offer to young people the opportunity to use scientific content from a wide range of resources and also access to digital services such that will be proposed to be the future in the respective field. Moreover, these tools contribute to the access and sharing of advanced tools, services and scientific learning resources between schools and universities. Finally it supports the provision of key skills to the future citizens and scientists (collaborative work, creativity, adaptability, intercultural communication).
The aim of this paper is to present the initiatives that have already started to be developed and realized in order to create a common access point to different tools and digital content. The user-interface will be multi-lingual by design and will support web access mode. The proposed approach will create fascinating opportunities to interact with the science digital content in novel ways. The research team will validate the system through the activities of the COSMOS project (www.cosmos-project.eu).

In this paper, we present the main operations and technologies used in COSMOS portal, i.e., the main web interface of the COSMOS project. The user, either simple or expert, can be endowed with search, retrieval, access and re-use functionalities regarding educational content and/or structured learning activities. To fulfill these objectives, COSMOS portal integrates state of the art World Wide Web technologies through the open source content management system (CMS) of Drupal (http://drupal.org). The functionalities of the COSMOS project have been presented in [2].

Content is described using existing metadata representation tools through XML-based schemas. The description is encoded using the IEEE Learning Object Metadata framework [3]. The description is based to domain specific vocabularies while multi-lingually curriculum related vocabularies are developed and supported in order to associate educational metadata with formal European Science Educational Programs (for more details see [2]). The scope of this architecture is to ensure interoperability and content exchangeability among distributed and heterogeneous repositories.

Furthermore, tools for describing digital intellectual property rights (IPR) are supported. IPR are formulated based on the publishers’ needs. This means that the user is able to select the license under which he or she would like to publish new content. The possible selections range within the Creative Commons family of licenses [4]. The specific license is represented interoperably using the Right Expression Language of the MPEG-21 [5]. In particular, in the framework of the project, we support the ccREL (Creative Commons REL) specification [6]. ccREL is based on an RDFa expression of triplets and it is embedded into the HTML of the content or into the content itself using XMP (Extensible metadata Platform) technology. More details regarding the rights management technologies used in the framework of COSMOS, one can found in [7].

Finally, all of the above allow for an intelligent search and retrieval of the educational content. Search is performed through a number of interfaces from the classic free text search to the more illustrative “tag cloud”. The search functionalities as well as all the other components of the portal will be thoroughly tested and validated by members of the COSMOS consortium and their ideas and recommendation will be implemented to newer versions of the portal. This procedure aims in the development of the COSMOS portal by the users and for the users.

2 COSMOS Technologies

The context of the COSMOS repository is not transmitted in a theoretical way but rather in a biomatic way in the form of a real life experience. Observing the sky by using a network of robotic telescopes across the world and integrate the astronomical images from their databases in everyday science teaching is a highly interdisciplinary subject and its implications give topics for discussion in Astronomy, Cosmology, Physics, Chemistry, Mathematics, Mechanics and clearly expanding the learning resources for students and teachers.
The aims of this paper is to demonstrate the way for the unification of the existing tools and on-line materials of a network of observatories and research institutions and at offering students and teachers unique educational resources to as the sky is a vast and unique laboratory of science, always in operation, accessible at all times from everybody from everywhere, where all sorts of interesting physical phenomena take place most of which is impossible to reproduce in any scientific laboratory. The COSMOS educational repository contains materials and information connected to the science curriculum. It provides access to data and tools (e.g. simulations of physical phenomena), teacher resources (e.g. learning scenarios and lesson plans, professional development materials, exams), student-centered materials (e.g. data library, communication area, students’ worksheets), applications for observations and collaborative activities.

The COSMOS repository includes numerous astronomical images, scientific data and associated educational projects, lesson plans, simulations, videos and animations which have been developed in the framework of international initiatives in the recent years, like the Discovery Space, www.discoveryspace.net and the Schools Observatory, www.schoolsobservatory.org.uk.

These educational materials offer a “feel and interact” user experience, allowing for learning “anytime, anywhere” by employing advanced and highly interactive visualization technologies and also personalised ubiquitous learning paradigms in order to enhance the effectiveness and quality of the teaching and learning process.

Figure 1 presents the main architecture of the developed COSMOS portal. As we observed the COSMOS repository includes four different functionalities which are framed with four innovative technologies.

1. **Upload Activity**: This functionality allows for registered users of the COSMOS portal to upload to the repository either tagged educational content and/or learning activities. We define as learning activity an educationally structured content organized to fulfill a particular teaching objective. In the upload activity, COSMOS architecture supports two innovative technologies. A) The IEEE Learning Objective Metadata (IEEE LOM) standard which is a format able to enrich raw educational content with teaching metadata information [3] and B) the IMS IMS Learning Design (IMS LD) which is a specification for a metalanguage that enables modelling of learning processes [8]. The specification is maintained by IMS Global Learning Consortium. These two innovative technologies of COSMOS allow the stored content to be easily exchangeable, portable and accessible by other educational repositories.

2. **Search Activity**: This functionality allows simple or registered users to semantically search for either educational content or learning activities. Semantic searching exploits the educational /learning activities metadata as being interoperably described using the IEEE LOM and the IMS learning design [3], [8]. Multilingual technologies are supported in the framework of COSMOS. This means that educational semantics are automatically translated in a series of European Languages through the exploitation of Science Educational Vocabularies which are related with the formal European Science Curricula [2].
3. **Intellectual Property Right Activity**: This functionality is responsible for enriching COSMOS educational content and learning activities with rights metadata. The structure of the ccREL (Creative Commons Right Expression Language) is used in the framework of COSMOS project [6]. Creative Commons [4] defines the spectrum of possibilities between full copyright — all rights reserved — and the public domain — no rights reserved. Creative Commons is actually “some rights reserved” copyright policy. In the framework of COSMOS, we have developed the ccREL framework, which is a specification that describes how license information may be described using RDF [9]. ccREL is an RDFa for HTML Web pages and resources referenced therein, and XMP for standalone media. This way, the uploaded content is enriched, apart from educational metadata, with rights metadata that describe the license of the content itself.

4. **Download Activity**: This functionality allows for interested users to download educational content as well as learning activities according to their information needs. We have implemented semantic search functionality, since educational content and learning activities are retrieved according to high level educational semantics. Special emphasis is given in the framework of COSMOS architecture for interoperability issues between the portal and other educational repositories. For this reason, the COSMOS exploits Web/XML technologies, to permit easy, heterogeneous and remote access and download of the content.

3 **COSMOS Operations**

In this section, we describe the main operations of the COSMOS architecture for each of the aforementioned described activities. Figure 2 presents the main operations as far as the upload activity is concerned. Initially, a user (educational content provider) uses educational and learning activities metadata software tools for enriching his/her content with teaching metadata. These toolkits should satisfy either the IEEE LOM standard and/or the IMS specification. Then, the raw content material along with its respective metadata (described
through the XML based IEEE LOM schema) are submitted to the portal. At this point DOM based XML parsers [10] are activated with the purpose of a) checking the validity of the metadata files and b) parsing the respective educational and learning activity metadata. In case that an error in the XML files occurred, a message appears to the user and a feedback is established which urges the user to submit content compatible with the IEEE LOM standard and IMS specification. Otherwise, the raw educational content along with its respective metadata are stored in COSMOS repository.

Figure 2: The main operations regarding the upload Activity.

Figure 3 presents the main operations regarding the search activity of the COSMOS interface. As set of different search interfaces is used in COSMOS; i) free text interface that enables user to look for content of interest using free text keywords, ii) tag cloud which visually depicts the most used semantics tags, iii) simple filter search which contains the most basic educational and learning activity metadata and finally iv) advanced filter search which expands simple filter search with additional metadata. All the four supported interfaces allow for the users to perform their search using either educational and/or learning activity semantics. In addition, COSMOS supports the use of curriculum based searching which is implemented through Science curriculum vocabularies. All the search functionalities of COSMOS are developed in a multilingual framework.

Figure 3: The main operations regarding the search Activity.

Figure 4 presents the main operations as far as the activity of the intellectual right property is concerned. In this activity, the educational content providers are able to introduce licenses to their submitted content. In the framework of COSMOS the Creative Commons family of licenses is supported. The licenses are encoded using the ccREL specification. Initially, a rights interface appears to the user over which he/she can define work/license properties. Example of the work properties are the attribution name, content description and title. License properties include work permissions, jurisdiction and the conditions under which the permissions are granted.
All these activities are implemented in a Web/XML framework to allow interoperability of the proposed architecture with other educational repositories. The interface is implemented in a Web/database framework and thus it is permitted remote and heterogeneous access to other educational content and learning activities (see figure 5).

4 Conclusions
In this paper, we present the main operations and technologies implemented in the framework of COSMOS. More specifically the main conclusions are the following

1. COSMOS supports standardized ways for enriching educational content with semantic metadata through the IEEE LOM and IMS technologies.

2. COSMOS permits a series of different semantically enriched search interfaces which help users to search, retrieve and access educational content and learning activities.

3. COSMOS provides a framework for incorporating licenses on the submitted content, innovating in the area of educational intellectual rights description.

4. COSMOS is based on Web/XML technologies to address easy content portability, accessibility and exchangeability.

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6 References

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