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Web-based Repositories of Science Education Digital Resources Enhanced with Appropriate Educational Metadata

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ABSTRACT

During the past years a large amount of science education digital content became available worldwide in the form of science museum collections, digital repositories and libraries. To make search and retrieval of science education digital content more efficient it is important to ensure that appropriate (in terms of quality and quantity) educational metadata are attached to them. Thus, in this paper we propose an IEEE LOM Science Education Application Profile that can be used for tagging science education resources with science curriculum related characteristics and we demonstrate an educational metadata authoring toolkit, which supports the proposed IEEE LOM Application Profile.

KEYWORDS: *Science education, Educational metadata, Application profile, Educational metadata authoring*

DEFINITION OF THE PROBLEM

Science Education is a top priority for European policy makers (Rocard et al. 2007). Over the past years the development of technological tools, such as augmented reality, virtual reality, portable devices, wearable computers, simulations and computer modeling of physical phenomena in science classrooms, has allowed the enhancement and enrichment of their current curriculum. Within this context, teachers are recognized as key players in the renewal of science education. Among others, their participation to communities of best science teaching practices, is expected to allow them improve the quality of their teaching and support their motivation (Rocard et al. 2007).

Moreover, a large amount of digital science education content already exists in the form of science museum collections, digital repositories and libraries. This large amount of digital science content has the potential to support technology-enhanced science education. However, science education teachers are lacking the time to investigate the potential educational added-value of the huge amount of digital resources typically returned though web search engines (Mason 2006). An important factor, in order to make search and retrieval of science educational content more efficient is the quality and quantity of educational metadata associated

with these resources. In general, the commonly accepted way to describe educational resources is the IEEE Learning Object Metadata (LOM) Standard (IEEE 2002). Nevertheless, it is beyond the scope of IEEE LOM to directly support the description of science curriculum related characteristics of science education resources.

In this paper we target addressing this issue, that is, we propose an IEEE LOM Science Education Application Profile that can be used for tagging science education resources and we demonstrate an educational metadata authoring toolkit, which supports the proposed Application Profile.

METHODOLOGY

In this section, we present the adopted methodology for building an IEEE LOM Science Education Application Profile. Figure 1 outlines the methodology adopted. More specifically, we apply the Guidelines for building application profiles in e-Learning provided by CEN/ISSS-LTW (Smith 2006) and based on the characteristics of the science curriculum; we have identified controlled vocabularies that can indicate possible extensions to the IEEE LOM Standard concerning science curriculum properties (Sampson and Zervas, 2008).

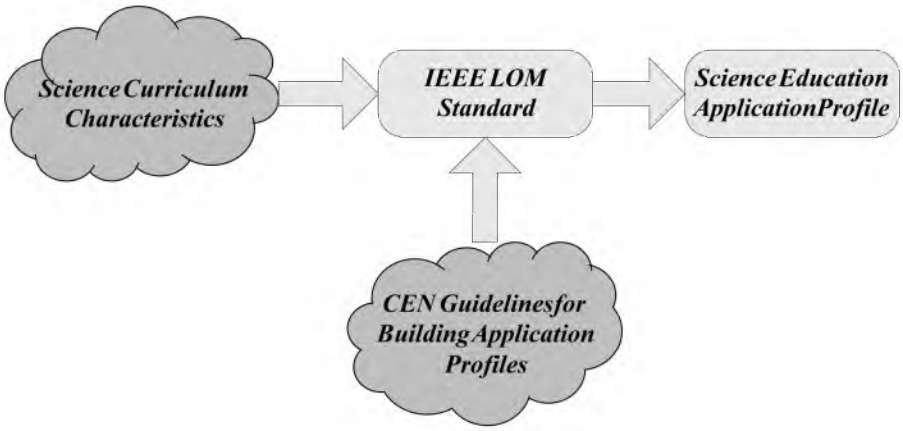

Figure 1: *Methodology for Defining an IEEE LOM Science Education Application Profile*

The process of deriving science education metadata from the identified guideline categories consist of the following key steps:

- *Step 1 - Identifying a Science Curriculum Classification System:* This step aims at the exploration and identification of a Science Curriculum Classification System for the classification of Science Education Resources.
- *Step 2 - Identifying IEEE LOM Elements related with Science Curriculum Classification:* This step aims at the identification of the IEEE LOM Elements that can host the classification system of Step 1.

- *Step3 - Extending value space or datatype:* This step includes the identification of possible extensions required in the value space or datatype of the IEEE LOM elements identified in Step 2

THE PROPOSED IEEE LOM SCIENCE EDUCATION APPLICATION PROFILE

In this section, we propose an IEEE LOM Science Education Application Profile that can be used for tagging Science Education resources. The first step in this process is the identification of a Science Curriculum Classification System. For this purpose, we have adopted the Science Curriculum Classification System of Curriculum Online (Curriculum Online 2003).

The next step is the identification of IEEE LOM elements that can host the selected classification system of the Science Curriculum. As it can be seen in Figure 2, these elements are located under the [*9. Classification*] category of the IEEE LOM Standard IEEE (2002).

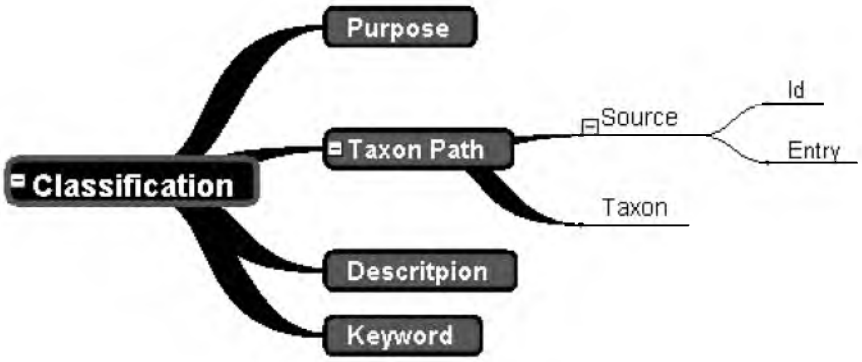

Figure 2: *IEEE LOM Classification Element (IEEE 2002)*

The IEEE LOM Classification category describes a learning object in relation to a particular classification system (IEEE 2002). In the sub-element [*9.1 Purpose*], we can use the "*Discipline*" value to state that the purpose of the classification is to describe the discipline characteristics of the learning object and in the sub-element [*9.2.1 TaxonPath.Source*] we can use the "*Science*" value to state that the name of the classification system is the Science Curriculum. Finally, we introduce a controlled vocabulary for the sub-element [*9.2.2.2 TaxonPath.Source.Taxon.Entry*] of the [9. Classification] Element, which derives from the adopted classification system of the Science Curriculum. This controlled vocabulary is presented in the Table 1. The controlled vocabulary of sub-element [*9.2.2.2 TaxonPath.Source.Taxon.Entry*] includes a further elaboration in more detailed terms as presented in (Curriculum Online 2003) (totally 272 terms), however, this paper presents only the basic terms for simplicity reasons.

Table 1: *Controlled Vocabularies for Science Educationof IEEE LOM Classification Element*

9.1 Purpose	9.2.1 TaxonPath.Source	9.2.2.2 TaxonPath.Source.Taxon.Entry
Discipline	Science	Scientific enquiry
		Life processes
		Humans & other animals
		Green plants
		Variation, inheritance and evolution
		Energy and nutrient transfer
		Environment
		Solids, liquids and gases
		Atoms and molecules
		Elements, compounds and mixtures
		Changing materials
		Useful materials and products
		Obtaining and using materials
		Earth science
		Chemical reactions
		Electricity and magnetism
		Waves
		Radioactivity
		Forces and motion
		Light
		Sound
		The earth and beyond
		Energy
		Tools for Science

THE INLOT SCIENCE EDUCATION LEARNING OBJECTS METADATA AUTHORING TOOLKIT

The InLOT Science Education Learning Objects Metadata Authoring Toolkit (InLOT LOM-AT) is a software tool, which was developed within the context of the InLOT Project. The InLOT Project (InLOT Project 2007) aims to investigate the feasibility of technology-enhanced educational services for science teaching and learning. These services are built around the inLOT infrastructure which consists of: (a) wearable computers and intelligent sensors, which are embedded in everyday objects (t-shirt, ball, vest) and can be used by students for experimentation, data collection and storage, (b) a specially designed software tool, which is used to produce graph trends and patterns based on the recorded data from the inLOT hardware components, (c) *the InLOT LOM-AT*, a software tool which facilitates the authoring and management of science education metadata for the InLOT Learning Objects, and (d) *the InLOT Learning Objects Web-based Repository* which facilitates storage, search and retrieval of InLOT Learning Objects

The InLOT LOM-AT is designed to meet the requirements of the following user groups:

- *Science Education Digital Content Suppliers* and/or *Science Education Digital Courses Suppliers*, who store and deliver Science Education Digital Content and/or Science Education Digital Courses as learning objects.
- Science Education Organizations, which provide and administrate Science Education Digital Content though Web-based Learning Objects Repositories.

The main functionalities of InLOT LOM-AT can be summarized as follows:

- *Educational Metadata Authoring:* allow to characterize science education learning objects with educational metadata in general and, more specifically with appropriate metadata related with the science curriculum characteristics following the IEEE LOM Science Education Application Profile presented above. The educational metadata authoring process is facilitated though the use of a step by step authoring wizard (Figure 3).

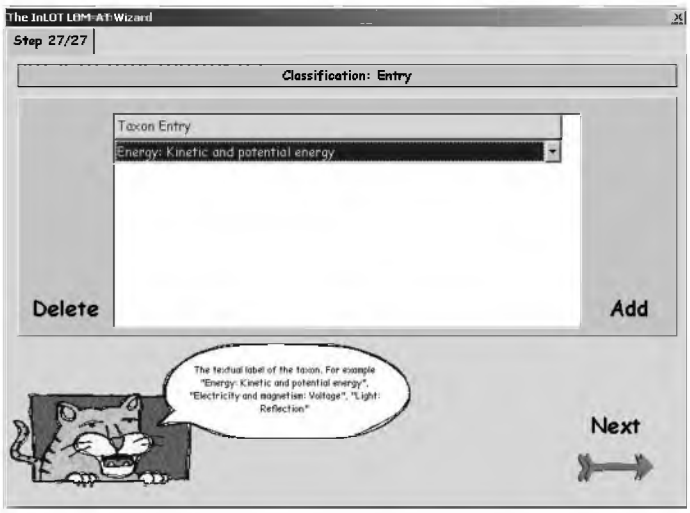

Figure 3: *Educational Metadata Authoring Wizard*

- *Educational Metadata Records Management:* allows the administration of educational metadata records within the local learning objects metadata repository (as illustrated in Figure 4).
- *Export of Educational Metadata Records:* allows to export educational metadata records in XML format following the IEEE LOM standard (Figure 5) and share them through the InLOT Learning Objects Repository (Figure 6).

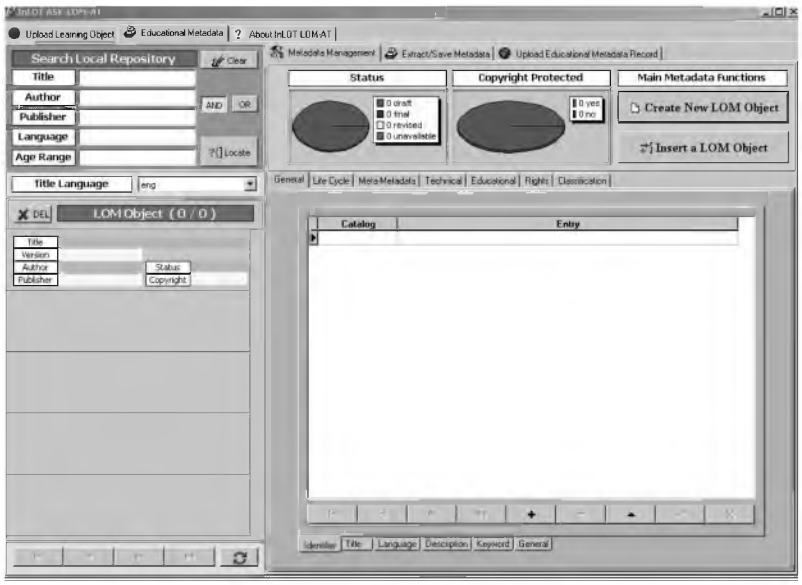

Figure 4: *Educational Metadata Records Management*

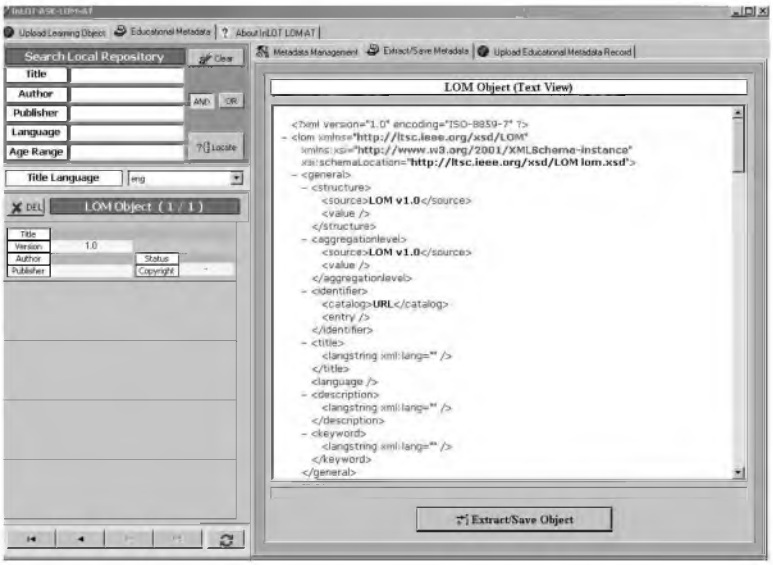

Figure 5: *Export Educational Metadata Record in XML Format*

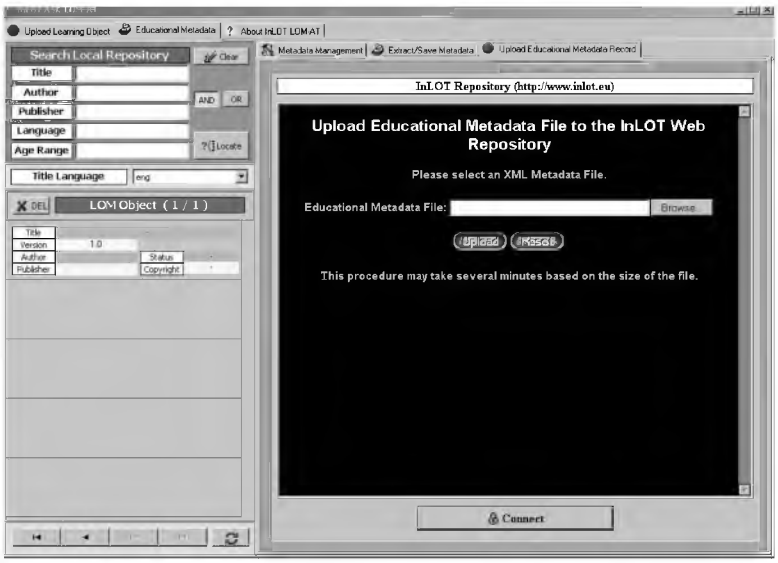

Figure 6: *Share Educational Metadata Records with InLOT Learning Objects Repository*

CONCLUSIONS

As the demand for science education digital content increases, an important factor towards their effective searching and retrieval is the quantity and the quality of educational metadata. Although, the IEEE LOM Standard is used for describing educational resources with metadata, it is beyond its scope to directly support the description of science curriculum related characteristics.

In this paper it was argued that it is reasonable to attempt synchronizing these two dimensions. To this end, we claim that an IEEE LOM Science Education Profile is needed for tagging science educational resources and we demonstrate the InLOT LOM-AT, a software tool, which facilitates educational metadata authoring and science curriculum related characteristics using the proposed IEEE LOM Application Profile.

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