Managing Learning Objects Metadata

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Abstract. Our aim is to provide a system with adaptive and knowledge management abilities for students and teachers using the IMS specifications to represent information through metadata, granting semantics and meaning to all contents in the system. The tools of our system along with metadata are used to satisfy requirements like reusability, interoperability and multipurpose. The system provides tools to define learning methods with adaptive characteristics, and tools to create courses allowing users with different roles, promoting several types of collaborative and group learning. It includes tools to retrieve, import and evaluate learning objects based on metadata, allowing students to use quality educational contents fitting their characteristics, and teachers may use quality educational contents to structure their courses. In this paper we will present the metadata management and quality evaluation components of the system since they play an important role in order to get the best results in the teaching/learning process.

Keywords: e-Learning, IMS Specifications, Learning Object, Knowledge Management, Metadata.

1 Introduction

In learning environments, information has to be perceived and processed into knowledge but one problem that emerged was its representation. Thus, standardization was indispensable to provide knowledge semantic representation through ontologies where concepts are clearly and unambiguously identified, providing a set of semantic relations allowing meaning representation by linking concepts together, the characterization of learning environments and structuring of pedagogical contents [4][11].

Through the usage of standards, systems can interact, import, interpret, understand and represent information in a uniform way. These standards usually specify a structured format for information, providing its semantic representation clearly identifying its description, characteristics and meaning. In e-Learning environments the interoperability between systems is very important because with the exchange of knowledge and information, we can drastically decrease the resources and courses development time, through the reusability of this information and knowledge. Associated with time saving is always the cost of developing courses and resources that also decreases.

So the choice of which standard to use in e-learning systems is very important because it should reflect most widely the learning/teaching process. Among these standards and specifications there are some more focused on the design and structuring of courses and others that try to enclose, in a general way, all the process of teaching/learning. Among the existing specifications we have Sharable Content Object Reference Model (SCORM) [1], a project from Advanced Distributed Learning (ADL), and the specification Educational Modeling Language (EML) [9]. However these have some problems. SCORM becomes more a standard integrator than a standard by itself, what makes it dependent of the other standards it integrates, besides it doesn't consider the evaluation and characterization of students. EML is a specification that became obsolete when the Instructional Management Systems (IMS) Learning Design (LD) [10] emerged, however it allows the building of the learning experience based on learning activities, being open to any other learning theories, including aspects such as sequence of activities, users' roles and students' characterization and evaluation. An example of an EML application is HyCo - Hypertext Composer, which is an authoring tool to create contents [7]. Finally we have the IMS specifications that are used as a guide for structuring contents, developed by the IMS consortium [6] that began its activity with the definition of specifications for instructional structure, to become the standard it is today. It includes specifications to structure the learning process, the learning objects and their metadata, to design units of learning and courses, to evaluate and characterize the users, among others. The main objective of these specifications is to be as general as possible, so they can be applied to any process of teaching/learning.

Here we present Adaptive Hypermedia Knowledge Management E-learning (AKHME) System which goals and main contributions are: LO management and quality evaluation, where we tried to introduce some intelligence through the usage of intelligent agents; Usage of the IMS specifications to standardize all the resources of the platform; And the interaction between all subsystems through feedback allowing the platform to adapt to students and teachers characteristics and to new contexts.

Through the usage of the IMS specifications it's possible to guarantee the reusability and interoperability of the educational elements. To guarantee this, IMS uses XML (eXtensible Markup Language) to store the information in packages and schemas [5], using some mechanisms that Web Semantics allows, such as granting meaning to Web contents and providing a form of structured storage to guarantee easy access and integration of information.

We will give an overview and context the system and we will focus on tools that provide management and quality evaluation of LOs through metadata. Finally we will present how it can be integrated with other systems, take conclusions.

2 AHKME description

AHKME is an e-learning system that is divided in four different subsystems: Learning Object Manager and Learning Design subsystem, Knowledge Management subsystem, Adaptive subsystem and Visualization and Presentation subsystem. The four subsys-

tems were structured taking into account the following: First we have the process of creation and management of learning objects, followed by the process of course creation through the learning design (LD). In parallel with these two processes the Knowledge Management subsystem makes an evaluation of the quality of the available learning objects and courses that then pass through an adaptive process based on the students' characteristics to be presented to them, as we can see on Figure 1.

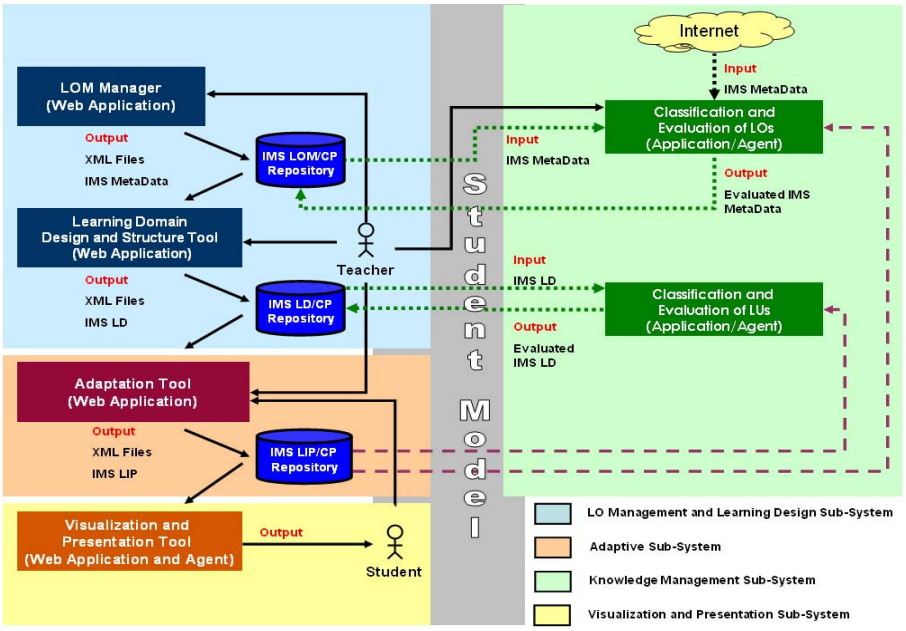

Fig. 1. AHKME's structure

These subsystems are web applications that were developed using Asynchronous JavaScript And XML (AJAX) to create interactive web applications, permitting through JavaScript the communication directly with the server without reloading pages making the internet applications smaller and faster, being browser and platform independent since it is based on well know standards like Hypertext Markup Language (HTML), Javascript, Cascade Style Sheets (CSS) and eXtended Markup Language (XML) [2]. We use HTML and CSS for the Web pages' design, PHP (PHP: Hypertext Preprocessor) to run on server side to make the manipulation of XML files, Javascript to implement mechanisms in Web forms, pop-up windows and .NET and C to implement several software agents. All of these subsystems use XML as standard for file storage and knowledge representation. This standard allows the interchange of contents between different applications and platforms, facilitating the publishing of contents [5]. All the tools of the Learning Object management and Learning Design subsystem include a mechanism that packages the generated information, at the level of learning objects, courses as well as at the level of the adapted courses. We will now

focus on the subsystems that provide the management and evaluation of learning objects through their metadata.

2.1 LOM and Learning Design Subsystem

The LO Management and Learning Design subsystem is mostly used by teachers, providing several features to develop, search, retrieve, import and analyze resources and also create courses. We will now describe the tools and features of this subsystem.

2.1.1 LO Manager

The Learning Objects Manager tool, allows teachers to define/create/edit metadata to describe LOs following the IMS Learning Resource Metadata (IMSLRM) specification [3] which is based on the IEEE Learning Object Metadata (IEEE LOM) [8] standard that allows the management and representation of knowledge through LOs. The architecture of this tool is described on Figure 2.

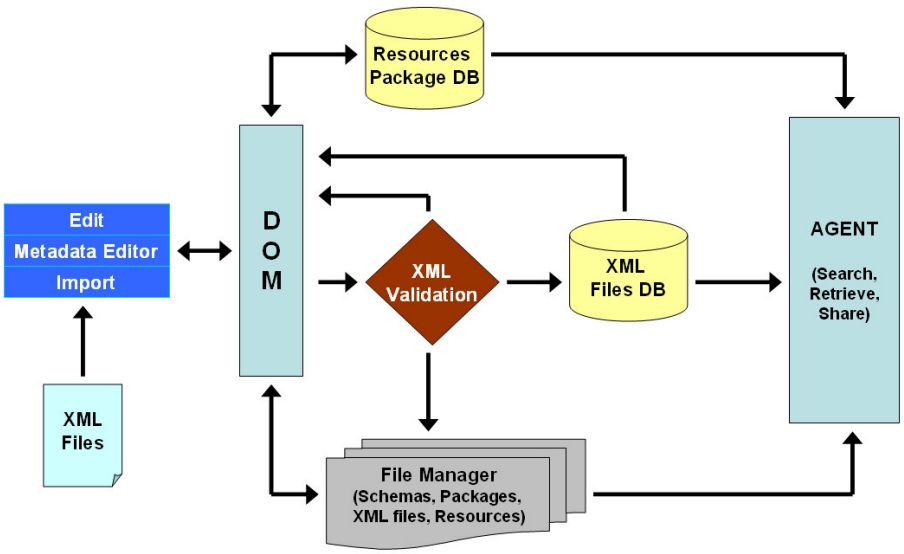

Fig. 2. LOM tool architecture

This tool structures all information into a XML manifest, that gathers all the XML files with their metadata and all the resources used by a LO, making easier the management learning contents, facilitating the portability of information. It also gives the possibility for the user to create general metadata that can be associated with any LO. Besides that, it still allows the creation of packages with their manifests and LOs and

their storage in a MySQL database, enabling the management of these packages that will be used in the design of courses, in a form that they can easily be transported and reused in other systems, going towards reusability and interoperability through IMS CP [13]. All these files and packages pass through a validation process to check if they're in conformance with the IMS specifications, and all the communication between tools and databases is done based on the XML Document Object Model. We can see a screenshot of this tool on figure 3.

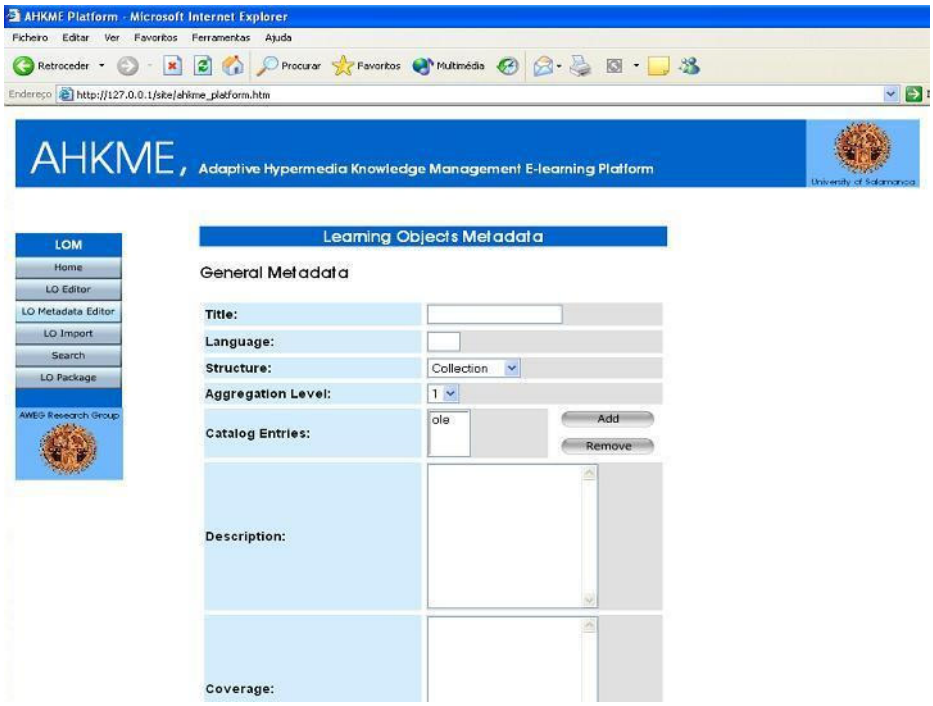

Fig. 3. LOM tool screenshot

The LOs are not static in the repositories, but they're in constant evaluation by the knowledge management subsystem. After the evaluation it may be needed to change the LO cataloguing or the way that a LO is related with other LOs, to get better LOs' associations, to obtain courses in a easier way taking into account the content models that were more efficient, letting these changes to be reflected until the creation of the content package, taking into account the user's wishes, granting a higher level of flexibility.

2.1.2 LD Editor

The subsystem's feature referring to LD allows teachers to define LD components, create and structure courses using the level A of the IMS LD specifications, defining

activities, sequences, roles and the courses' metadata [6]. The architecture of this tool is presented on figure 4.

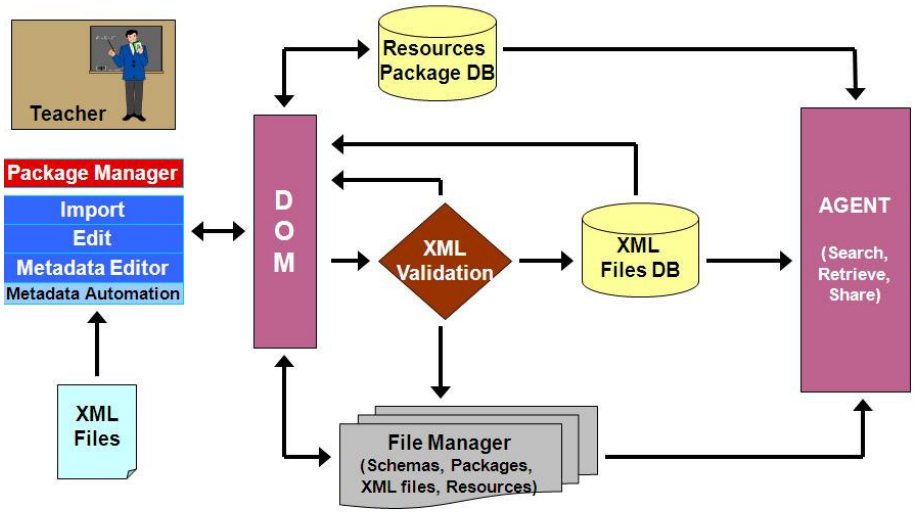

Fig. 4. LD tool architecture

The process of course creation generates a XML manifest that gathers all the XML files, LOs, metadata and resource files associated with the course. The usage of the IMS LD allows the users to structure courses with metadata in XML files that can be reused in the construction of other courses making easier the portability of learning information to interact with *Learning Management Systems* (LMS).

The platform, through this tool allows the design of courses where the participants can assume different roles. These roles can be student or staff, what makes possible collaborative and group learning, which importance is recognized at the training and educational levels [10]. We can see a screenshot of this toll on figure 5.

This tool also provides the creation of packages with the courses integrating them in a data repository, to reach a more efficient management and, also, communicates with the knowledge management subsystem in order to evaluate the courses that were created. After the evaluation this tool allows the restructuring of the courses always allowing the user to interact with the learning design process.

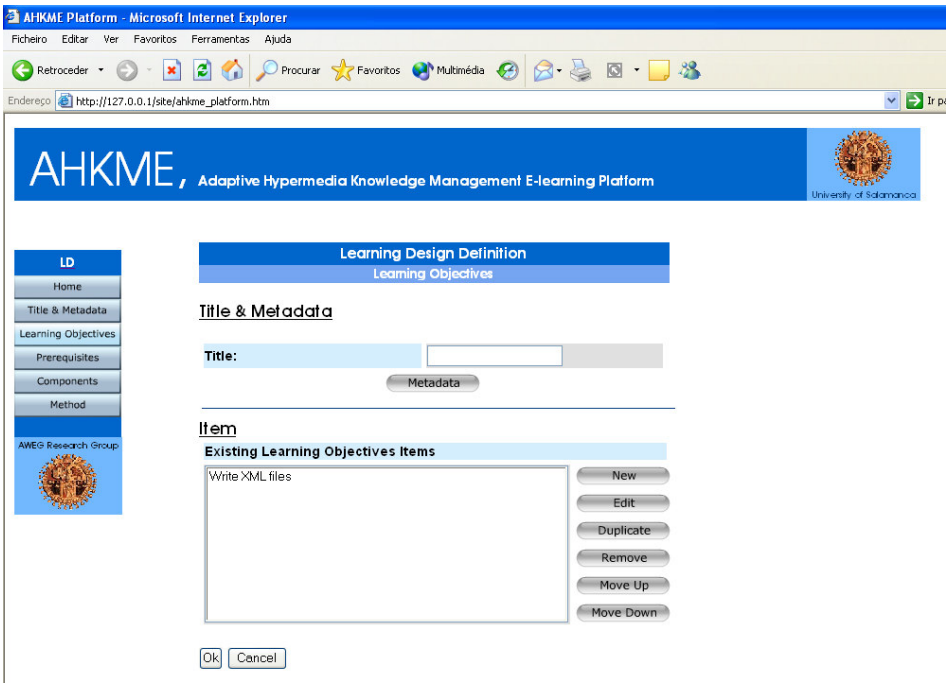

Fig. 5. LD tool screenshot

2.2 Knowledge Management Subsystem

Knowledge management and e-learning are two concepts that are strictly related, as e-learning needs an adequate educational resources management to promote quality learning. The quality of the learning resources is becoming an aspect with great importance on e-learning environments, since when e-learning systems first emerged there was a massive production of resources without taking into account their quality. Vargo, et. al states that a systematic evaluation of learning objects must become a valued practice if the promise of ubiquitous, high quality Web-based education is to become a reality [14]. Thus, we've been developing a subsystem to evaluate LOs quality through metadata

2.2.1 LO Evaluation

To archive an optimal evaluation of LOs, it's necessary to consider quality criteria from different kind of categories, so we proposed the criteria with respective weights described on table 3. Then we have made a match between the IMSLRM educational category elements and these criteria in order to make the quality evaluation that is

expressed on the following rating scale: 0=not present;1=Very low; 2=Low;3=Medium;4=High;5=Very High

Table 3. Evaluation criteria categories and matching with the IMSLRM educational category

Eval. criteria categories	Weight	IMSLRM Ed. Elements	Description
Psychopedagogical	30%	intended end user role; typical age range; difficulty	Evaluates if the LO has the capacity to motivate the student for learning;
Didactic-curricular	30%	learning-resource type; context; typical learning time; description	Evaluates if the LO helps to archive the unit of learning objectives, etc;
Technical-aesthetic	20%	semantic density; language	Eevaluates the legibility of the LO, the colors used, etc;
Functional	20%	interactivity type; interactivity level	Evaluates LOs accessibility among other aspects to guarantee that it doesn't obstruct the learning process;

With the definition of these quality evaluation criteria, we are developing two different tools to evaluate the quality of the LOs. One of the tools is a collaborative tool that allows teachers and experts to import, analyze, change and evaluate LOs through a Web application, where they give them an individual evaluation to the LO. After this individual evaluation, all the persons that classified and evaluated the LO gather around in a sort of forum to reach to the final evaluation of the LO. It has also been projected a search engine to search for LOs, being the results presented in order of quality evaluation. This tool is being developed in JAVA [12].

The other tool is an intelligent agent that automatically evaluates LOs basing its final evaluation on previous evaluations of other learning objects. A schematic representation of the agent is presented on figure 6.

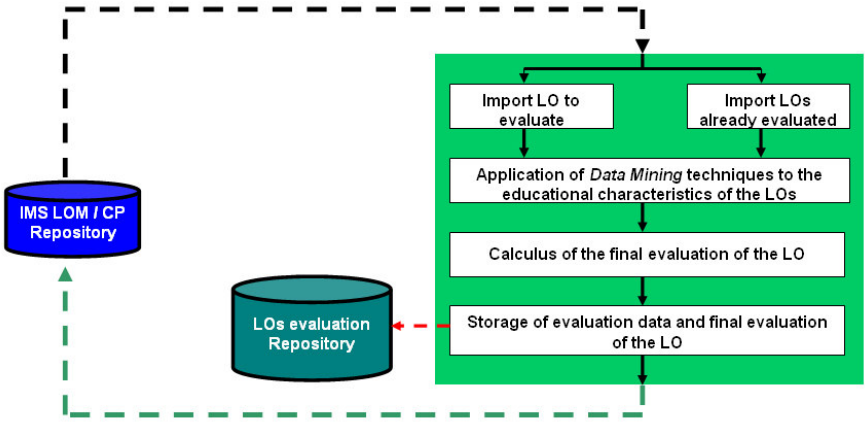

Fig. 6. Schematic representation of the agent

The agent starts to import the LO to evaluate and other LOs already evaluated, then it applies data mining techniques (decision trees) to the educational characteristics of the LO defined in the IMS LRM specification to reach to the final evaluation. After the calculus of the final evaluation of the LO, the agent stores this information in an auxiliary database and also inserts it in the annotation element described by the IMSLRM specification.

For now we have just considered the educational category because it has almost all the information about the technical and educational aspects of LOs we consider important to evaluate LOs. With these two tools learning objects are constantly being availed of their quality, playing an important role in the reusability of the learning objects for different contexts.

3 Conclusions

In this article we've presented how the AHKME system uses metadata for learning resource management and evaluation. The IMS specifications, which use the combination of potentialities of metadata and XML, are excellent to represent knowledge providing the description of learning objects through metadata therefore permitting their cataloguing, localization, indexation, reusability and interoperability. Through knowledge management the platform allows a continuous evaluation of contents, granting quality to all the existing resources in the platform for teachers and students to use. The presented platform uses knowledge representation and knowledge management as two processes that work simultaneously to grant success to the process of teaching/learning.

The main contributions of AHKME are the learning object management and evaluation of quality, where we tried to introduce some intelligence to these processes through intelligent agents; the usage of the IMS specifications to standardize all the resources of the platform in order to reach interoperability and compatibility of its learning components, and the interaction of all subsystems through the feed-back between them allowing the platform to adapt to the students and teachers characteristics and to new contexts. So, it's very important to have the resources well catalogued, available, and with quality so we can create quality courses. Meanwhile, we should take into account that quality courses don't just depend on quality re-sources, but mainly in the design of activities to reach determined learning objectives. Being a multi-purpose platform it can be applied to several kinds of matters, students, and learning strategies, in both training and educational environments. Being a modular and open source system allows developers to add/develop new modules and extend the system or integrate it with already develop e-learning systems and tools.

In terms of future work, we will include in the learning design tool, the level B of the IMS LD specification that allows the inclusion of properties and general conditions. In the adaptive sub-system we will add some functionality according to the IMS Question and Test Interoperability and Enterprise specification. In the knowledge management subsystem we will add the feature of analysis of quality of the courses,

through the development of a standardization knowledge model to import external courses and evaluation tools made for this purpose.

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