Learning objects management and evaluation in an e-learning enviroment.

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Introduction

One of the problems that have emerged with e-learning systems was how to represent information and knowledge in a standardized form. So, in the year 2000 the Learning Objects Metadata Working Group (a working group of the Learning Technology Standards Committee), in order to represent information, developed the IEEE (Institute of Electrical Electronics Engineers) LOM (Learning Object Metadata) standard, which referring to them "enables computer agents to automatically and dynamically compose personalized lessons for an individual learner" (IEEE LOM, 2002). This standard proposed a representation through metadata (data about data) that has descriptive information about a resource so it can be easily retrieved and reused. Metadata has very well known advantages such as simplicity, compactness, robustness, verifiability and many others. IEEE LOM provides a semantic representation of information providing an ontology in which concepts are clearly an d unambiguously identified, also providing a set of semantic relation types which allow representing meaning by linking concepts together (Mendes, Sacks, 2004). The IEEE LOM standard also introduced the concept of learning objects that can be defined as "any digital or non digital entity that can be used, reused and referenced during technology supported learning" (IEEE LOM, 2002), in order to divide information in independent meaningful chunks of information, so it can easily be manipulated and accessed regarding users' necessities.

The standard presented before defines a conceptual model for metadata definition with a hierarchical structure, composed by several elements and sub-elements, but it had no specific format to allow the interaction with computers, to promote metadata interchange and to aid programmers in the implementation of the standard. To solve this problem IMS (IMS Specifications, 2004), based on the IEEE LOM standard, developed the IMS *Learning Resource Meta-Data Best Practice and Implementation Guide* (IMS LRM) specification, defining a way to represent metadata through XML (*eXtensible Markup Language*), giving general guidelines of how an application can use IEEE LOM elements, through the use of XML (IMS LRM, 2001).

With the use of XML we have an easier way to read and exchange information, allowing the reusability of the information presented in the files in order to present it in different formats and to different audiences without the necessity of reprogramming (Bray, Alpaoli, Sperberg-Macqueen, 2004).

So, to develop our platform we had to choose the most adequate technological standards and specifications in order to reach our objectives of multipurpose, independence of the learning domain, reusability and interoperability of resources and courses, since several standards and specifications have been developed to structure pedagogical contents and to allow the characterization of a wide variety of

learning environments (Wiley, 2003).

Here we present AKHME (*Adaptive Hypermedia Knowledge Management E-learning Platform*), a platform that supports features of knowledge representation and knowledge management based on metadata described by the specifications. In this platform teachers have at their disposal tools to create didactic materials and to evaluate, import and retrieve quality educational resources, and students can acquire knowledge through quality learning objects, as well as through the more appropriate learning technique based on their characteristics, the learning activities available, the instructional design, their learning style and the learning objects characteristics.

In this paper we will initially present the analysis of current approaches to e-learning and a comparative analysis of standards and specifications in order to find the best to develop our system and then we will describe the platform in order to give an overview and to context the system and we will analyze the learning object management and evaluation in this system. Finally we will present some conclusions and future work.

2.Current Approaches

Nowadays, there are several solutions to support e-learning, where most of them are content-centred neglecting some important educational issues. Before we started to develop our platform we have done an analysis of well-known current approaches to e-learning platforms/systems, like WebCT (WebCT web site, 2005), Blackboard (BlackBoard, 2005) and EduStance (Edustance, 2005). Our goal in studying these platforms was to identify strong points and weaknesses, so we could try to correct them with our platform. We have done an analysis of several tools in these platforms where we have considered several aspects, from which we have extracted strong points and weaknesses like shown on table 1.

Table 1. Strong Points and weaknesses of e-learning current approaches

Strong Points	Weaknesses
Communication Tools	Resource management & portability
Administrative & Management Tools	Adaptability and personalization
Compliance with standards	Quality of resources
Implementation Level	Development of new components
Documentation	Diversity of pedagogies and applications
Possibility of hierarchical organization	Costs

These weaknesses are traduced in problems in terms of interoperability of resources, reusability of the resources, learning domain independence, quality of learning resources and extensibility of the platforms, what meets some of our goals already presented before.

So, in order to solve these problems we are developing an e-learning platform with several tools, not to compete with the platforms presented before, but to be an extension of them

3. Standards and Specifications Comparative Analysis

As we know the use of standards as become very useful not just for the sake of saying that you use a standard but because the use of a standard or standards automaticaly makes everything you make cross systems providing this way common knowledge. The use of a standard helps to achieve more stable systems, reduces the development and maintenance time, allows backward compatilibity and validation, increases search engine success, among many other know advantages.

Having detected the main problems of current e-learning approaches, we have started to analyse several aspects of several standards and specifications to choose the one(s) that would best fit our needs, like described on table 2.

From this analysis we have chosen the IMS specifications, since they allow most of the aspects we have analyzed and that we considered important to reach our goals.

Table 2. Standards and Specifications Comparative Analysis

Features		IMS	AICC	SCORM	Dublin Core
Metadata		X		X	X
Learner Profile		X			
Content Packaging		X	X	X	
Q&T Interoperability		X			
DR Interoperability		X			X
Content structure		X	X	X	
Content Communication			X	X	
Learning Design		X			
Simple Sequencing		X		X	
Accessibility		X			
Bindings	XML	X		X	X
	RDF	X			X
Implementation handbooks		X		X	X
Learner registration		X			

4. AHKME Description

AHKME is an e-learning platform that is divided in different subsystems: Learning Object Manager and Learning Design subsystem, Knowledge Management subsystem, Adaptive subsystem and Visualization and Presentation subsystem. These subsystems were structured this way taking into account a certain line of reasoning, where first we have the process of creation and management of learning objects (LO), which is 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. Then they pass through an adaptive process based on the students' characteristics to be presented to them, as we can see on figure 1.

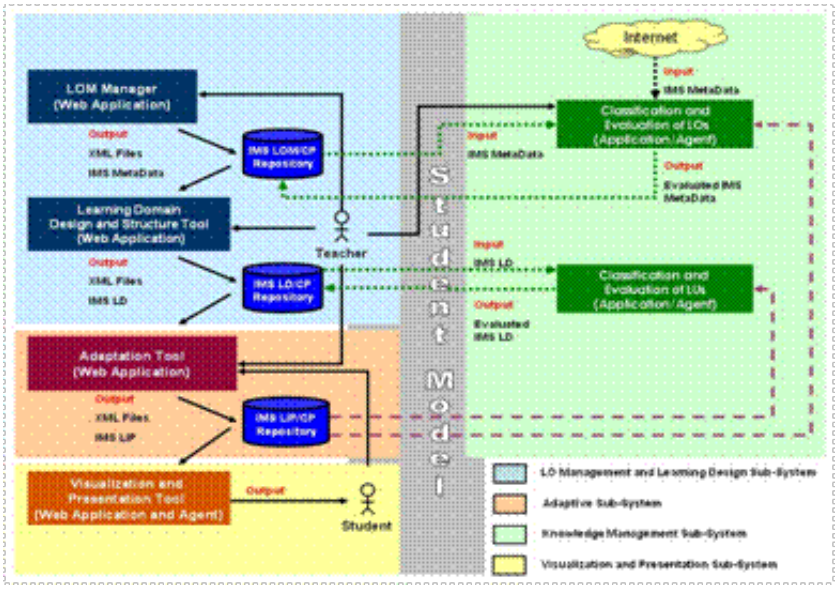

Fig. 1. AHKME's structure

To implement the subsystems mentioned before we have been developing Web applications using HTML (*Hypertext Markup Language*) and CSS (*Cascade Style Sheets*) for the Web pages' design, PHP *(PHP: Hypertext Preprocessor)* to run on server side to make the manipulation of XML files, Javascript to run on client side to implement mechanisms in Web forms, pop-up windows and .NET and C to implement several software agents.

These subsystems use XML as standard for file storage. This standard has been widely used because it allows the interchange of contents between different applications and platforms, facilitating the publishing of contents.

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 in the Learning object management and Learning Design sub-system and in the Knowledge Management sub-system and explain the packaging of information feature.

4.1 LOM and Learning Design Sub-System

The Learning Object Management and Learning Design Sub-system is mostly used by teachers. With this sub-system we provide several features where teachers can develop, search, retrieve, import and analyze resources and also create courses.

We will now describe the tools and features of this sub-system and how they are related with the IMS specifications.

4.1.1 LO Manager

The Learning Objects Manager is a tool that allows teachers to create and edit metadata to LOs, associating descriptive metadata to them and storing the information in a database and in XML files, making easier the management and structuring of all the learning contents. The architecture of this tool is described on figure 2.

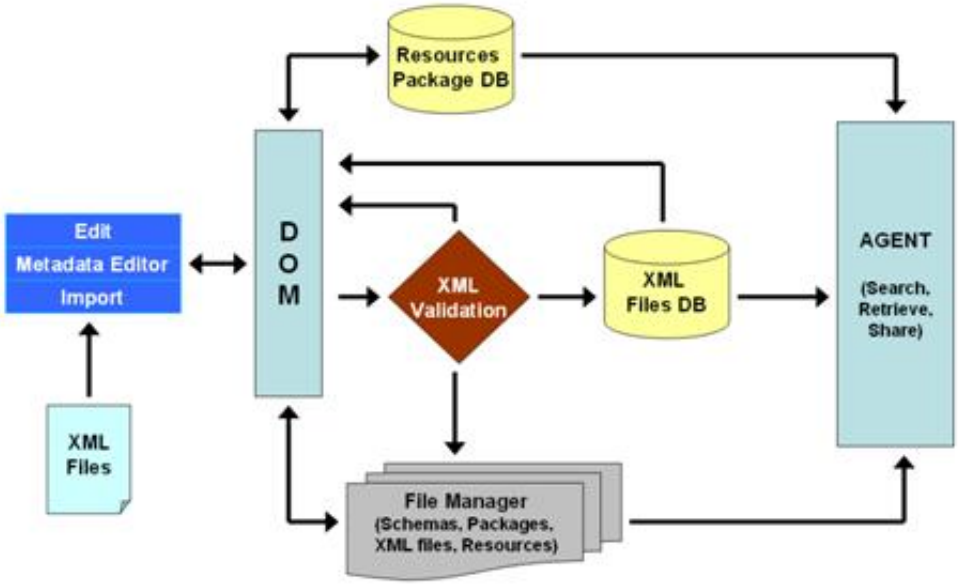

Fig. 2. LO Manager architecture

It follows the IMS *Learning Resource Metadata* specification, which is based on the IEEE LOM standard that allows the management and representation of knowledge through LOs and their metadata and all the communication between tools and databases is done through XML Document Object Model (DOM).

All the files and packages that are imported or created in the platform pass through a validation process with the schemas to check if they're in conformance with the IMS specifications. This tool also gives the possibility to the user to import LOs and to create general metadata that can be associated with any LO, reducing the time of development. Besides that, it still allows the creation of packages of LOs and their storage in a database, so they can easily be transported and integrated with other systems, providing also the management of these packages that will be used in the design of courses (The process of package creation is presented in the point 4.5).

The LOs are not static in the repositories, but they're in constant evaluation made by the knowledge management sub-system that is in constant communication with this tool. After the LOs' evaluation, it may be needed to change the LO cataloguing or the way that a LO is related with other LOs, so we can get better associations, to obtain courses in a easier way taking into account the content models that were more efficient. This tool allows these changes that are reflected until the creation of the content package, taking into account the user's wishes, granting a higher level of flexibility. In figure 3 we can see the part of this tool, which refers to the introduction of metadata of a LO.

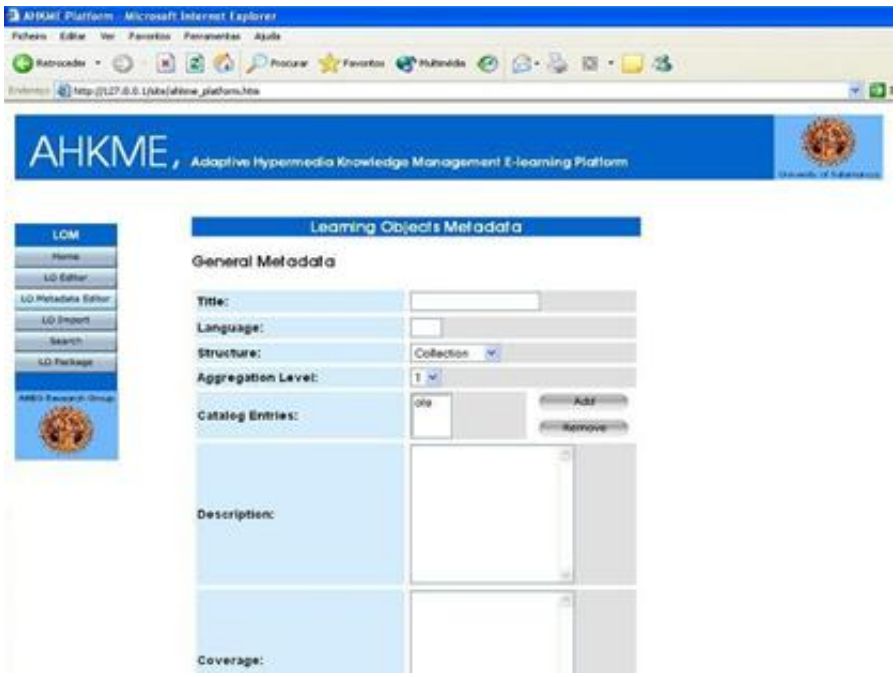

Fig. 3. AHKME platform - Learning Objects Manager tool

The main advantage of using the IMS specification for LOs is that through the association of descriptive tags, we can better index them, find them, use and reuse them.

We will now describe the two features of the LO Manager that contribute to the automation of processes on this tool.

4.1.1.1 LO Search Engine

The search of learning objects is a very important task in order to reach reusability. The descriptive metadata associated to the LOs becomes now more important than ever, since the search is based on it. The learning object's search engine is based on an intelligent agent that receives as inputs the metadata elements from IMS LRM for the search and retrieval of the LO. When the teacher accesses the LO search engine, he can choose from two different types of search - simple or advanced. If the teacher chooses a simple search the agent automatically presents the metadata elements mostly used in searches for him to fill. Otherwise if the teacher chooses an advanced search, the search engine allows the selection of whatever elements he wants to search for.

Finally, the search engine, as result of the elements selected, presents the LOs according to the teacher's search query with the respective quality evaluation, attained by the LOs evaluation. From this search results the teacher can choose the LOs with more quality to integrate the courses he is creating.

4.1.1.2 Metadata Automation Process

The insertion of metadata can be a complex and time-wasting process, because it has several categories and in them several elements and items. So, in our platform we provide an automation of this process, to facilitate the insertion of metadata, and to describe the LO's through the most adequate metadata elements. This way we can optimize the LO's search, retrieval and reusability and facilitate the user's task reducing the time of development of learning objects.

4.1.2 LD Editor

The part of the sub-system referring to the Learning Design provides a tool where teachers can define learning design components, create and structure courses using the level A of the IMS LD specification to

define activities, sequences, users' roles and to define metadata to describe the courses.

In the process of course creation it is generated an XML file with the information of the course, and information about the LOs and resource files that it uses.

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 (IMS LD, 2003).

The use 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).

This tool also provides the creation of packages through the creations of an XML manifest that gathers all the XML files associated with the course, as well as all the LOs, metadata and resource files needed. All these packaged courses are integrated in a data repository, to reach a more efficient management. This tool also communicates with the knowledge management sub-system 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.

4.2 Knowledge Management Sub-System

The quality of the learning resources is becoming an aspect with great importance on e-learning environments, since e-learning systems first emerged there was a massive production of resources without taking into account their quality. Nowadays the scenery is changing, as 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 (Vargo, Nesbit, Belfer, Archambault, 2003).

So, here we present a sub-system which main objective is to assure quality to the information in the platform through the evaluation of LOs and courses, in order to get the best courses and the best resources to reach to the best learning/teaching process.

To evaluate LOs we are developing two different tools. One of the tools allows a collaborative evaluation of LOs and the other does an automatic evaluation of the LOs based on criteria that were defined.

We will now describe the criteria and the tools to evaluate learning objects.

4.2.1 LO Evaluation

To archive an optimal evaluation of LOs, we have proposed a criteria that fit into four categories with respective weights, where we consider the *Psychopedagogical category* (30%), that contains pedagogical criteria that can evaluate, for example, if the LO has the capacity to motivate the student for learning; *Didactic-curricular category* (30%), this criteria can evaluate if the LO helps to archive the unit of learning objectives, etc; *Technical-aesthetic category* (20%) tries to evaluate the legibility of the LO, the colors used, etc.; *Functional Category* (20%), tries to evaluate its accessibility among other aspects to guarantee that the LO does not obstruct the learning process. The final evaluation value is the sum of all the classifications attributed to each category multiplied by their weight. The classification of the categories has the following rating scale: 0 = not present; 1 = Very low; 2 = Low; 3 = Medium; 4= High; 5 =Very High (Morales, García, Barrón, 2004).

With these quality evaluation criteria defined, we are developing two different tools to evaluate the quality of LOs. One of the tools is a collaborative tool in which experts and teachers analyze the LOs and give an individual evaluation to the LO. After this individual evaluation, all the persons involved in the evaluation of the LO gather in an on-line forum to reach to the final evaluation of the LO (Morales, García, Barrón, 2004).

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 4.

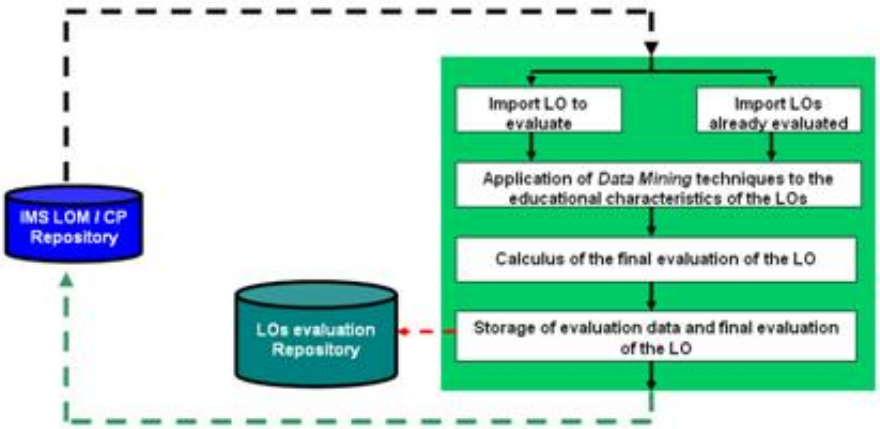

Fig. 4. Schematic representation of the agent

In order to evaluate the LO, the agent starts to import the LO to evaluate and other LOs already evaluated. Then he applies data mining techniques to the educational characteristics of the LO defined in the IMS LRM specification in order to calculus the final evaluation of the LO.

In order to use the learning objects criteria mentioned before we have made a correspondence between the educational characteristics defined on the IEEE LOM standard and the aspects described in the evaluation model. After the calculus of the final evaluation of the object, the agent stores this information in an auxiliary database made for this purpose and also inserts it in the annotation element described by the IMS LRM specification.

4.3 Information Packaging

The tools presented on the Learning Object Management and Learning Design sub-system and in the Adaptive sub-system, use the IMS *Content Packaging* (CP) specification, which allows the creation of packages (*content interchange package*) with the information related with the learning process, manifests, XML files and their schemas. By this, the packaging of information represents knowledge in a compact form, through structured manifests, to facilitate its indexation, reusability and interoperability. It structures knowledge in a form where the resources are completely integrated, referenced and related what enables a better course organization and structure.

With this specification authors can build learning contents on-line, administrators can manage and distribute content and the students con interact and learn with these contents, providing an efficient way of aggregation, distribution, management and availability of this contents.

This specification distinguishes between 3 different types of user profiles: teacher (author) that creates the packages for distribution, the administrator that interacts with the LMS, by storing and managing data, and student that interacts and learns with the systems (IMS CP, 2003). To store packages and files we have repositories like show on figure 5.

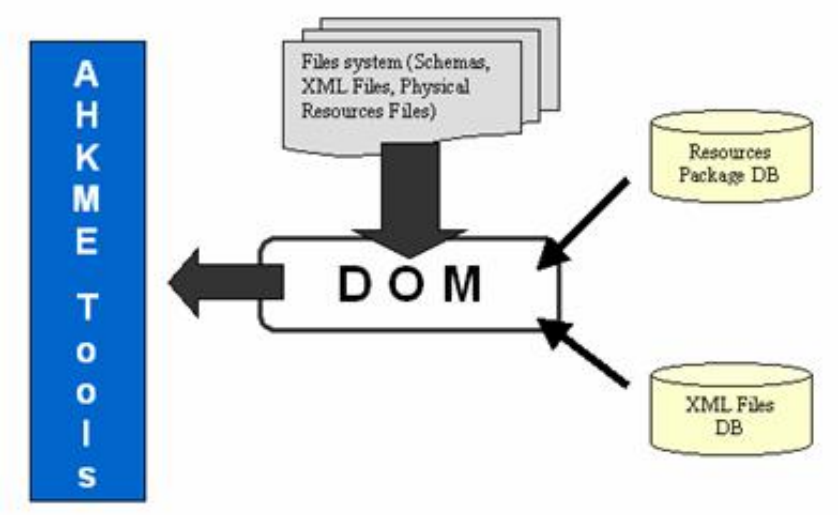

Fig. 5. Interaction of databases and AHKME tools

One repository that stores all the packages generated by the AHKME tools, other that stores all the information about the XML files in the platform and a file system that contains metadata files of XML type, schemas and physical resources files.

All the tools in the system interact with the databases using the XML DOM.

5. AHKME vs Similar Tools

We have also done an analysis of some AHKME's features confronting them with some other similar metadata tools. To make this analysis we have defined a set of tasks like the ones described on table 3.

Table 3. Comparative analysis b

Task	Alfanet	LOM Editor	ADL Scorm	Reggie	AHKME LOM	EUN
Creation of new metadata files	X	X	X	X	X	X
Modification of data in metadata files	X	X			X	
Support any educational metadata standard, specification				X		
Modification of structure of metadata files					X	
Validation in terms of data values	X		X		X	X
Validation of structure of metadata	X				X	
Support of the XML	X	X	ü		ü	
Packaging of LOs metadata					ü	
Evaluation of LOs metadata					ü	
Allow metadata document management					ü	

etween AHKME and similar tools

The Advanced Distributed Learning (ADL) Sharable Content Object Reference Model (SCORM) Metadata Generator (ADL Scorm metadata generator, 2005) is an application for creating XML metadata files based on SCORM specification and provides data validation. The resource description tool of EUN, created by Lund University in Sweden, is an HTML page where the user can fill a number of fields that represent the EUN (EUN, 2005) proposed specification of educational metadata. Reggie metadata editor supports a number of metadata educational specifications where the user has to complete the required

fields and to select the metadata format required from a list of technologies available (Resource Description Format, HTML). The LOM Editor (LOM editor, 2005) is an application for creation and modification of XML metadata files based on a previous version of LOM v1.4. The Alfanet (ALFANET, 2005) is an authoring tool that is based on the standards of the IMS Global Learni ng Consortium. So, AHKME LOM provides some additional features regarding the packaging of LO metadata and their evaluation. Although, AHKME is the only tool that allows these features, Alfanet also packages information but only at the level of courses.

Conclusions and Future Work

In this article we have presented how the platform AHKME contributes to LO management and evaluation in order to get reusability and quality of the resources on an e-learning system.

The IMS specifications, which use the combination of potentialities of metadata and XML, are an excellent way for learning object reusability, dividing information in several meaningful chunks allowing their description through metadata and their storage in XML files, therefore permitting their cataloguing, localization, indexation, reusability and interoperability, that is permitted through the creation of packages of information. These specifications grant to the platform the capacity to design learning units that simultaneously allow users with different roles, promoting both collaborative and group learning of several types. Through the knowledge management tools described, the platform allows a continuous evaluation of contents, granting quality to all the existing resources in the platform for teachers and students to use and reuse.

The main advantages of AHKME platform are the fact of being developed in open source programming languages, its adaptive functionalities based on students' characteristics, the reusability of its objects, as well as the interoperability and compatibility of its learning components that come from the use of the IMS specifications, which provides LOs to be used and reused in various instructional contexts, covering the multipurpose objective. So, it is 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 do not depend just on quality resources, 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.

Compared with similar tools, AHKME provides some features that become important in the metadata management like the packaging and evaluation of LOs through metadata.

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 knowledge management sub-system we will add a quality analysis feature to the learning design, through the development of a standardization knowledge model to import external courses and evaluation tools made for this purpose.

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