The impact of metadata on AHKME e-learning platform

Hugo Rego, Tiago Moreira & Francisco José Garcia
University Of Salamanca, Plaza de la Merced s/n, 37008, Salamanca, Spain
hugo_rego04@sapo.pt, thm@mail.pt, fgarcia@usal.es

Abstract
AHKME’s aim is to provide a system with adaptive characteristics and knowledge management abilities for students and teachers. The development of this system is based on metadata, since the knowledge representation is made through it, and knowledge management of all the information in the platform is done using the descriptive metadata. In this system metadata is used to satisfy the requirements of reusability, interoperability and multipurpose. The system provides authoring tools for teachers to define learning methods with adaptive characteristics, as well as tools to create units of learning allowing users with different roles, promoting both collaborative and group learning of several types. To support knowledge management, the system is endowed with tools to retrieve, import and evaluate learning objects, enabling the possibility of students to use quality educational contents that fit their characteristics. And teachers have the possibility of using and retrieving quality educational contents to structure their courses.

1. Introduction
In the learning environments, information has to be perceived and processed into knowledge. One of the problems that have emerged from this transformation was how to represent this knowledge. So standardization was indispensable. In the year 2000 the Learning Objects (LOs) Metadata Working Group’s (a working group of the Learning Technology Standards Committee), in order to represent knowledge developed the Institute of Electrical Electronics Engineers (IEEE) Learning Object Metadata (LOM) standard, which referring to them “enables computer agents to automatically and dynamically compose personalized lessons for an individual learner”[1]. This standard proposed the knowledge representation as metadata (data about data) that has descriptive information about a resource (learning object) in a way that it can be easily retrieved and reused. Metadata has very well known advantages such as simplicity, compactness, robustness, verifiability and many others. That’s why a semantic representation, defined by a standard, is important to represent knowledge because it provides an ontology in which concepts are clearly and unambiguously identified, also providing a set of semantic relation types which allow representing meaning by linking concepts together [2].

Many theoretical persons have approached different ideas for the construction of Web sites, where the texts or formative contents should be divided into chunks or modules that refer only to one matter or theme, being completely independent between them. With this necessity of chunks of information the standard IEEE LOM also defines learning objects, that can be defined as “any digital or non digital entity that can be used, reused and referenced during technology supported learning” [3]. This way the information, through LOs, can easily be manipulated and accessed regarding users’ necessities. So the development of this standard was very important to archive knowledge representation.

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 [4], based on the IEEE LOM standard, developed the IMS Learning Resource Meta-Data Best Practice and Implementation Guide (IMSLRM) specification, defining a way to represent metadata through XML (eXtensible Markup Language) [5]. The main goal of this IMS specification is to give general guidelines of how an application can use IEEE LOM elements, through the use of XML, which is perfect for hierarchical representation.

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, from which we have decided to use the IMS specifications, because it described most of the learning process through metadata.

Here we present AHKME (Adaptive Hypermedia Knowledge Management E-learning Platform), a platform that supports both 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 description of the platform to give an overview and to context the system, and then we will analyze the importance metadata 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 a comparative analysis of tools of some well-known current approaches to e-learning platforms/systems, like WebCT, Blackboard and EduStance, in order to identify strong points and weaknesses, so we could try to correct them with our platform, like shown on Table 1.

<table>
<thead>
<tr>
<th>Features</th>
<th>IMS</th>
<th>AICC</th>
<th>SCORM</th>
<th>Dublin Core</th>
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<tbody>
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<td>Metadata</td>
<td>X</td>
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<td>Learner Profile</td>
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<td>Content Packaging</td>
<td>X</td>
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<td>Q&amp;T Interoperability</td>
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<td>DR Interoperability</td>
<td>X</td>
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<td>Content structure</td>
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<td>Content</td>
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<td>Simple Sequencing</td>
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<td>Accessibility</td>
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<tr>
<td>Bindings</td>
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<td>Implementation</td>
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<td>Learner registration</td>
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From this analysis we’ve chosen the IMS specifications, since they allow most of the features we’ve analyzed and that we have considered important to reach our goals.

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 automatically 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 compatibility and validation, increases search engine success, among many other know advantages.

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

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

<table>
<thead>
<tr>
<th>Strong Points</th>
<th>Weaknesses</th>
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<tr>
<td>Communication Tools</td>
<td>Resource management &amp; portability</td>
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<td>Administrative &amp; Management Tools</td>
<td>Adaptability and personalization</td>
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<td>Compliance with standards</td>
<td>Quality of resources</td>
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<td>Implementation Level</td>
<td>Development of new components</td>
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<td>Documentation</td>
<td>Diversity of pedagogies and applications</td>
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<td>Possibility of hierarchical organization</td>
<td>Costs</td>
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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’re developing an e-learning platform with several tools, not to compete with the platforms presented before, but to be an extension of them.
4. AHKME description

AHKME is an e-learning platform that is divided in four different subsystems:
- Learning Object Manager and Learning Design subsystem: This subsystem provides tools for teachers to edit, define and create metadata to describe LOs based on the IMSLRM specification, and tools to search, retrieve, and reuse LOs based on their metadata. The part of the sub-system referring to the Learning Design gives us a tool where teachers can define learning design components, create and structure courses using level A of the IMS LD specification, allowing the definition of activities, sequences and users’ roles, that can be student or staff.
- Knowledge Management subsystem: this subsystem has tools to evaluate the quality of learning objects based on the metadata that describe them;
- Adaptive subsystem: This subsystem tries to determine the most adequate learning method according to students’ characteristics, the learning design and the interaction with the student, storing all this information.
- Visualization and Presentation subsystem: this subsystem presents the educational contents to the students taking into account the adaptive meta-model generated for each student.

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, 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 (line through – inputs and outputs; dashes – feedback from the adaptive sub-systems).

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.

5. Metadata and AHKME

Metadata on AHKME plays a very important role since all the knowledge representation is based on it. Several existing and well-known e-learning platforms use metadata just to describe resources and not to give them meaning. Sometimes they even neglect the introduction of metadata, stating that it becomes a very complex process. We use metadata not only to describe resources but also to index, search, retrieve and evaluate their quality.

We will now present how metadata is present in some of the features of the Learning Object Manager and Learning Design subsystem and on the Knowledge Management Subsystem.

5.1. Learning Object Manager and Learning Design Subsystem features

In the Learning Object Manager and Learning Design Sub-system metadata is present in its different features and tools which some will be described next.

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 reducing the time of development of learning objects. This feature automatically fills the fields of metadata with the most common used selections for the fields.

The LO Search engine is a very important tool to reach reusability since it allows the search, retrieval and reuse of LOs based on their metadata.

The information packaging feature enables the creation of packages of LOs and courses with their metadata, so they can easily be transported and reused in other systems, going towards reusability and interoperability, using the IMS CP specification [6].

With the use of repositories we can easily manipulate metadata since we have all the metadata.

Figure 1. AHKME’s structure
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. Nowadays it became a fundamental issue.

5.2. Knowledge Management Subsystem features

The quality of the learning resources is becoming a fundamental issue without taking into account their quality. Nowadays it emerged there was a massive production of resources environments, since when e-learning systems first appeared. High quality Web-based education is to become a reality [7].

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 [7].

Here we present the main feature of the Knowledge Management sub-system that is the evaluation the quality of LOs based on the analysis of LO metadata.

To archive an optimal evaluation of LOs, it’s necessary to consider quality criteria. So we’ve proposed the following categories with respective weights: Psychopedagogical category (30%), contains pedagogical criteria related with learning psychology, allowing to evaluate if, for example, the LO has the capacity to motivate the student for learning, if it considers the characteristics regarding its relevance and fits the receivers characteristics; Didactic-curricular category (30%), this criteria can evaluate if the LO helps to archive the unit of learning objectives, if it promotes the development of metacognitive activities. We also consider the structure of the content and usability of the LO; Technical-aesthetic category (20%) tries to evaluate the legibility of the LO, the colors used, the interface design among others aspects, in order to avoid LOs to be neglected by users and LOs that do not motivate the learning process; Functional Category (20%), tries to evaluate LOs accessibility among other aspects to guarantee that the LO doesn’t obstruct the learning process.

The final evaluation value is the sum of all the classifications attributed to each category multiplied by their weight and is expressed in the following rating scale: 0 = not present; 1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high [8].

To make this evaluation possible we are developing two different tools to evaluate the quality of learning objects. One of the tools is a collaborative evaluation tool, that allows teachers and experts to import, analyze, change, classify and evaluate LOs. They start to analyze LOs and give them an individual evaluation an then gather in an on-line forum to discuss and to reach the final evaluation of the LO [7].

The other tool is an intelligent agent that automatically evaluates LOs. 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 IMSLRM specification in order to calculate the final evaluation of the LO.

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 have considered important to evaluate LOs.

In order to use the learning objects evaluation model defined before we have made a correspondence between the educational category elements and the aspects described in the evaluation model that is as follows:

- In the psychopedagogical category we have considered the following: intended end user role element; typical age range; and difficulty element. We’ve mapped these three elements because on this category we consider criteria related with the users’ characteristics.

- In the didactic-curricular category we have considered: learning-resource type element; context element; typical learning time element and description element; These elements describe some didactic curricular features of the LO, like the description of some comments on how the LO should be used.

- In the technical-aesthetic category we have considered the following elements: semantic density element; language element. These two elements are strictly related with technical and aesthetic aspects from where we can consider different types of measures to evaluate the usability of the LO regarding the use we want to give the LO.

- In the functional category we have considered the following elements: interactivity type element; interactivity level element. These features reflect aspects like interactivity of learning resources related to the type of interactivity of the users, promoting active participation.

On this feature of our platform we can see how metadata becomes indispensable on the evaluation of learning objects, functioning not only as mere descriptive information but also adds value to the LO, since it incorporates the evaluation process.

6. Conclusions

In this article we’ve presented how metadata contributes to AHKME in terms of knowledge representation and knowledge management adding semantics to all the resources in the platform.
The IMS specifications, which use the combination of potentialities of metadata and XML, is an excellent way of representing knowledge, dividing information in several meaningful chunks (learning objects) 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 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 advantages of AHKME platform are its adaptive functionalities based on students' characteristics, and its knowledge representation and knowledge management capacities, as well as the interoperability and compatibility of its learning components that come from the use of the IMS specifications.

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 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.

7. Future work

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 what is important to govern the flow of events in a pre-determined manner taking into account the student progresses and characteristics, providing this way some accessibility features.

In the adaptive sub-system we will add some functionalities according to the IMS Question and Test Interoperability and Enterprise specification. In the knowledge management sub-system we will add the feature of analysis of quality of the learning design, through the development of a standardization knowledge model to import external courses and evaluation tools made for this purpose.

To evaluate LDs we are developing a similar process as done for LOs, we’re studying a knowledge model to standardize LDs to allow the importation of courses, and an evaluation method to classify and evaluate the LDs.

We also want to include the feedback from the adaptive subsystem to consider on the process of evaluation the students and teachers interests that may emerge from the platform’s use.

8. References


