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## **Ontologies applied to learning objects repositories for educational environments in the semantic web**

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The openness and simplicity of the nowadays Web have had as a result lots of resources indexed by search engines, also collections of specialized contents are available with catalogues and services to retrieve the information. However the problem of accuracy in discovery, search and recovery is still present, not only in the Web but also in repositories of learning content because content is not capable to give information about itself to the systems in order to be better organized or indexed. The Semantic Web and the ontologies are new technologies to make information easily searchable, making possible the enhancement of the services and the capabilities of Learning object repositories as is exposed in this document.

**Keywords** semantic web; ontologies; learning objects repositories.

### **1. Introduction**

Discovery and search in the Web is a common task for each Internet user, search engines have been an invaluable tool for this activity. Lots of data are indexed every day by these tools and put available through very well known sites providing this service. Nevertheless, because of information abundance, lack of order and not control of quality in the content, some organizations have decided to make digital collections of resources with a similar structure of a traditional library, so they are creating digital libraries with Web technology to keep their resources described, organized and stored.

In e-learning, these wide ranging digital libraries are not compatible enough with the technical and operational requirements and new kind specialized digital libraries appeared: the Learning Object Repositories. To have really functional repositories of learning content in e-learning environments, they must be capable to interoperate with on line learning systems, so they require specific metadata and standards adoption developed by the sector [1]. Efforts towards standardization are being done for important enterprises, institutions and groups, as a result, specifications and standards initiatives are increasing and spreading their adoption by important groups interested on the use and reuse of educative resources as main target, and creation of repositories as well.

The vision about the distributed and open learning systems is based on the integration of these standards to facilitate the interoperability of applications between organizations, technologies, platforms and resources. Although the systems are being communicated and the contents are being organized, stored and shared the problem of accuracy in discovery, search and recovery is still present. To face these difficulties both the semantic web and the *ontologies* are new topics to ponder in the e-learning universe.

### **2. Learning Object Repositories: educational content stored and retrievable**

Digital resources as texts, videos, images, audios and their combinations are actually widely used in traditional educational models and e-learning, but the diversity of formats and the lack of information about the resource limit the scope of use and reuse of that material. To provide more powerful learning resources their construction tends towards *learning objects* (LO). LO are small pieces of content used to

support learning, with the potentiality to be used in different contexts and described through metadata [2]. LO are resources that must be created with functional requirements: accessibility, reusability and interoperability, also with two basic principles: granularity and composition[3].

In order to develop structured collections of LO, it is necessary that the metadata used to describe the object follow up some recognized standard, such as LOM<sup>1</sup>, with this criteria the resources can be easily managed by standardized systems and translated to some other cores of metadata if it is necessary.

Learning Object Repositories (LOR) are collections of LO accessible via Internet [2,4]. They function like portals with a web-based user interface, a search service and a catalogue of the resources contained. The main purposes of LOR are search, utilization, reutilization, shareability and long term storage.

The catalogue of the LOR is built with the metadata record of each LO. In some repositories the object is allowed in the same server with their metadata, but in some other cases, with the benefit of shareability and reutilization, it is only linked and stored somewhere else in the Internet.

If a LOR is e-learning standards compliant, then technologically is capable to communicate data and content with both LMS (Learning Management Systems) and LCMS (Learning Content Management Systems), to export e import content packages<sup>2</sup> to perform in a course, and a common user also can download to their PC or upload to the server LO or content packages.

The potential use of LOR to manage learning content and deliver it ready to be processed in other applications, gives a relevant significance to their development and improvement. In this way, the application of ontologies in the description of resources standardize a semantic core, which facilitates discover, search and recovery of learning objects in both the e-learning content repositories and the global Semantic Web.

### 3. Semantic Web and ontologies

Although resources are very well constructed and described by metadata, the discovery and recovery of resources is still present as a difficult task, especially for systems that help humans to find the information. The linguistic problem, the inconsistent use of terms and the limitation of search engines (as well as LOR) to “understand” humans have as a result lots of not pertinent retrieved information.

The Semantic Web is a proposal to structure available resources with enhanced technology and make possible to attach semantic meaning, so software agents<sup>3</sup> will be capable to analyze and execute searching operations with better results and some other capacities as Anderson and Whitelock remark [5]: “The Educational Semantic Web is based on three fundamental affordances. The first is the capacity for effective information storage and retrieval. The second is the capacity for nonhuman autonomous agents to augment the learning and information retrieval and processing power of human beings. The third affordance is the capacity of the Internet to support, extend and expand communications capabilities of humans in multiple formats across the bounds of time and space.”

As a consequence of these affordances, it is expected that the Semantic Web empowers new applications in nearly all disciplines, including education of course, that make use of Web technology as an important tool.

In the basics, for the operation of the Semantic Web three main technologies are involved[6]: XML (eXtended Markup Language), RDF (Resource Description Framework) and ontologies. The last one, the ontologies, plays a fundamental role for the common understanding in resources description and relationship.

An ontology is a formal specification of a knowledge domain, it provide, for example, the definition of what individuals and classes of individuals there are in an specific domain, the relationships between these individuals and classes, and their component parts. Specific programming languages have been developed to implement ontologies (i.e. OWL<sup>4</sup> and DAML+OIL<sup>5</sup>) and make possible the design of content to be processed by machines instead of just presenting it to humans.

<sup>1</sup> LOM (Learning Object Metadata). <http://ltsc.ieee.org/wg12/index.html>

<sup>2</sup> Content packages are a set of files of content, metadata and other files needed to interoperate with e-learning systems.

<sup>3</sup> Software agents are programs created to act autonomously for a period of time.

<sup>4</sup> <http://www.w3.org/TR/owl-features/>

In the repositories of learning content, through the use of metadata organized in numerous interrelated ontologies, information could be tagged with descriptors that facilitate its retrieval, analysis, processing and reconfiguration.

In the scope of the LOR what is missing are tags which can be used to help a learner or a teacher to certainly contextualize contents into a knowledge domain. Work to do in this area, and others, is around the development and implementation of specific ontologies, systems that relate and map different ontologies to each other and systems that learn and mine ontology connections, to finally have public and common vocabularies and its relations with other contents or actors in the educational environment.

#### 4. Challenges and benefits expected

It seems like a lot have to be done in order to extend the capabilities of the information in the Web and to have more powerful search engines and repositories. Nowadays, in the practice the Semantic Web is not operable yet and that draw a highlighted line between what is working now and what is going to work after its effective activity.

Despite some negative criticism, because the implementation of the Semantic Web and also creation of tagged content is not so easy as the original Web, early optimistic adopters are looking for applications in the ones teacher and learners could use the Semantic Web to make learning activities more efficient and with better access to learning objects.

Prerequisite, and an extremely challenging task, to the effective functioning content in the Semantic Web is the existence of “networked ontologies”. In that way, the public definitions and tags will be used by both humans and agents to retrieve process and otherwise manipulate information and resources found on the Internet, in digital libraries or in LOR.

The real impact in the use of ontologies is unpredictable because the creation of these relations needs lots of work of specialized personal and systems, but the benefits could really worth to try it. Working in standardized and integrated environments will make the activities simpler and more efficient because machines will help in much more activities with more accuracy. Software agents in the Semantic Web might undertake some routinely tasks in order to drive teachers and students through a better automated learning environment:

“They (agents) communicate with individual student agents, tracking student progress, providing automated lists of resources such as tutorials, remedial help, and assisting scheduling and time allocation tasks. They schedule personal time between teachers and students to maximize the effect and affect of these interactions. Teacher agents will track professional interests of teachers relating to their field of subject expertise, developments in new pedagogies with active evaluation and testing of pedagogical interventions. Teacher agents will assist teachers in routine marking tasks, record keeping, and document control for assessments requiring manual effort. Student agents will assist learners in working collaboratively, finding sources of expertise and assisting students in documenting and archiving their learning products.”

An additional faculty of the Semantic Web is realized when agents extract information from one application and after utilize the data as input for other applications, in the same context or even different. In this way, agents create greater capacity for automated collections, processing and selective dissemination of data and content.

In brief, the ontologies will provide the interoperable semantic data in a specific area while the services (agents aided) have to take advantages of it, and all users will receive the benefits of standardized and interoperable systems, common languages to describe resources and most intelligent and efficient repositories to dig on.

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<sup>5</sup> <http://www.daml.org/>

## 5. Conclusion

Undeniably, the Semantic Web is the beginning of a new revolution in the way of creating, processing and manipulating digital resources. The growing and spreading of ontologies definitions in the educational environments will transform the services and capabilities of learning objects and their repositories.

But beyond the technological advances there are too many human work to make possible a better new Web and applications running on it, and it is a reality that Semantic Web in education will be truthfully made useful until it's end-user applications become simple enough to be manipulated by teachers and students.

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