

An adaptive e-learning model for the Semantic Web

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ABSTRACT

This paper argues that the semantic web can contribute for the development of tools able to facilitate the construction of adaptive web-based educational systems, by using semantic web resources. It will be possible by means of the reutilization of learning objects described by metadata, and of generical pedagogical and adaptive techniques. So that it can happens, the adoption of standards for representing information is necessary. In this paper, the IEEE LOM, and a set of standards defined by IMS and SCORM are pointed out.

Categories and Subject Descriptors

I.2.4 Knowledge Representation Formalisms and Methods
– *representation language*.

Keywords

Semantic Web, Adaptive Systems, Web-based Education

INTRODUCTION

Intelligent Tutoring Systems (ITS) [9], and Adaptive Hypermedia Systems (AHS) [3] aims at maximizing student learning through the construction of systems able to adapt to student's needs. However, many problems arise from the use of such technologies on web-based education. One problem pointed out by [4] is the excessive cost for creating web-based educational systems, that use ITS or AHS techniques. The high cost to develop such systems is justified by the fact that the pedagogical and adaptive techniques used nowadays are firmly linked to the domain to be taught, so they need to be reprogrammed according to each new system implemented.

New technologies are being studied to make possible the reutilization of those techniques on different systems, reducing their development cost. Among such technologies are metadata and ontology which support the development of the semantic web. This paper presents a proposal of a tool based on the semantic web for adaptive course construction.

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PROTOTYPE DEVELOPED

AMBAD is a tool that allows the construction and running of web-based adaptive courses, by means of the use of information contained in ontologies and in metadata descriptions. People interested in building a course should define some information, through the tutor module, such as instructional strategy and contents. Those information will be manipulated with data from the ontology, in order to define the course structure, its contents (learning objects), and adaptive behavior.

A domain ontology was built in order to facilitate course creation and the reutilization of some of its parts. It allows the standardization of the terminology used to describe concepts associated to a subject, as well as the metadata associated to learning objects stored on servers. Two main ontology classes are *concepts* and LOM, whose instances represent subjects or concepts related to a certain domain, and the learning objects that approach these concepts.

Instances of class *concepts* are related to each other through associations such as *isSubConceptof* or *isPrerequisiteFor*. In a similar way, instances of class LOM, which represent the learning objects stored on the servers, are related to each other through associations such as *isPartOf*, *hasPart*, *Requires*, *isRequired by*, etc., defined by Dublin Core and recommended by the LOM standard [8]. LOM instances are created at the moment the learning objects are described from the properties defined by LOM standard.

A conceptual map based on the classes of this ontology was built, so that the person in charge of the creation of a new course can select the concepts that will be included in the course, based on a standard terminology.

Only the concepts approached in the course will be defined by selecting the instances of the domain ontology. Based on the pedagogical ontology and on the information provided by the user, the AMBAD will be able to indicate the best way to structure those concepts, aiming at facilitating the student learning process, as well as defining which learning objects, among the ones existing on the LO Servers, are more appropriate for the kind of course that is being built.

The pedagogical ontology contains the educational process term definition. Its classes are presented next, along with some examples of its instances, which were built based on the works of [2] and [5]:

- **Instructional Estrategies** (Experimental Learning, Indirect Instruction, Direct Instruction);
- **Instructional Objectives Types** (Knowledge, Comprehension, Application, Analysis, etc.);
- **Type of Learning** (Verbal Information; Intellectual Skills; Cognitive strategy, and others);
- **Instructional Events** (Gaining Attention, Informing the Objective, Recall of Prerequisites, and so on);
- **Didactic Resources** (Example, Lecture, Exercise, etc.) .

After defining the activities, their structure, and the learning objects used in the resulting course, it should be available in such a way that the web-based educational systems are able to run them. Currently, the system is generating a course based on the SCORM Content Aggregation Model [1].

During the selection of the learning objects that will be part of the course, it is important to observe that more than one object about the same content will be chosen to compose the activities whenever possible, although with distinct characteristics.

The system will, once more based on pedagogical and adaptive ontologies, select which of these objects will be presented to the student, based on the student personal characteristics as well as on his results during the course.

Aiming at facilitating pedagogical and adaptive ontology acceptance by web-based educational system developers, the information on the students will be based on the IEEE PAPI [7] and IMS LIP [6] standards.

The web-based adaptive educational systems that will be used to deploy the courses created can be any LMS, either if it follows the SCORM standard or not. The difference is that the LMS SCORM compliant can run the course generated with no need of further interaction with the AMBAD, once they know the rules defined in [1].

However, as it is expected not to impose many barriers in the LMS development process as well as to allow the team to make design decisions in a flexible way, the Adapting Module was developed in the AMBAD, which will be implemented through a *web service* able to simulate the execution of a SCORM standard LMS.

So that LMS that do not adopt the SCORM standard can run the generated course, a web service able to simulate the running of a SCORM was developed in the AMBAD. LMS can make requests to the *web service* sending some data, such as student characteristics and the content he is accessing at a given moment. The adapting module will access the information of the course created by the AMBAD itself, will run the rules defined in [1], and will forward to the LMS the contents that should be presented next to the student.

CONCLUSION

There is an agreement that the adaptation of the content to the learner's characteristics is the key to obtain efficiency, and that the cost of development of adaptive systems is the

great obstacle that prevents more elaborated tools from being created.

The fusion of web-based education with adaptive systems, metadata and ontologies is surely a non-trivial process that involves the creation and the implementation of standards that can be used by different educational system designers. Besides the definition of such standards, there is the necessity of changes on the adaptive techniques used so far, due to the fact that they are based on the domain of the knowledge supposed to be presented.

Finally, it is important to point out that the presented project is in its development process, and the domain and the pedagogical ontologies are already being created, as well as the tools able to produce the course package, with the structure and the resources according to the SCORM Content Aggregation Model. The construction of the ontology of adaptation and the auxiliary modules that allow the definition of the adaptive behavior of the course still remain to be done, and it will be incorporated on the package that already exists.

REFERENCES

- [1] Advanced Distributed Learning (ADL). Sharable Content Object Reference Model – SCORM® . 2004.
- [2] Bloom, B.S. *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain*. David McKay, New York. 1956.
- [3] Brusilovsky, P., Methods and techniques of Adaptive Hypermedia. *User Modelling and User-Adapted Interaction*, 6(2): 87 – 129, 1996
- [4] Calvo, R. A., User Scenarios for the Design and Implementation of iLMS. In *Proceedings of Towards Intelligent Learning Management Systems*, pages 14 – 22, Sydney, Australia, 2003.
- [5] Gagne, R. M., Briggs, L. J., Wager, W. W. *Principles of Instructional Design*, 4th ed. Harcourt, Brace, Jovanovich, Orlando, 1992.
- [6] IMS - Global Learning Consortium, Inc. *IMS Learner Information Package - Information Model v1. 0*. 2001
- [7] LTSC, IEEE Draft Standard for Learning Technology – Public and Private Information (PAPI) for Learners (PAPI Learner). *Learning Technology Standards Committee. Institute of Electrical and Electronic Engineers*. 2000.
- [8] LTSC, IEEE Standard for Learning Object Metadata. *Learning Technology Standards Committee. Institute of Electrical and Electronic Engineers*. 2002.
- [9] Self, J., The Defining Characteristics of Intelligent Tutoring Systems Research: ITSs care, precisely. *International Journal of Artificial Intelligence in Education*, 10: 350 – 364, 1999.