

Ontologies for Education and Learning Design

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INTRODUCTION

In the last years, the growing of the Internet have opened the door to new ways of learning and education methodologies. Furthermore, the appearance of different tools and applications has increased the need for interoperable as well as reusable learning contents, teaching resources and educational tools (Wiley, 2000). Driven by this new environment, several metadata specifications describing learning resources, such as IEEE LOM (LTCS, 2002) or Dublin Core (DCMI, 2004), and learning design processes (Rawlings et al., 2002) have appeared. In this context, the term learning design is used to describe the method that enables learners to achieve learning objectives after a set of activities are carried out using the resources of an environment. From the proposed specifications, the IMS (IMS, 2003) has emerged as the de facto standard that facilitates the representation of any learning design that can be based on a wide range of pedagogical techniques.

The metadata specifications are useful solutions to describe educational resources in order to favour the interoperability and reuse between learning software platforms. However, the majority of the metadata standards are just focused on determining the vocabulary to represent the different aspects of the learning process, while the meaning of the metadata elements is usually described in natural language. Although this description is easy to understand for the learning participants, it is not appropriate for software programs designed to process the metadata. To solve this issue, ontologies (Gómez-Pérez, Fernández-López, and Corcho, 2004) could be used to describe formally and explicitly the structure and meaning of the metadata elements; that is, an ontology would semantically describe the metadata concepts. Furthermore, both metadata and ontologies emphasize that its description must be shared (or standardized) for a given community.

In this paper, we present a short review of the main ontologies developed in last years in the Education field, focusing on the use that authors have given to the ontologies. As we will show, ontologies solve issues related with the inconsistencies of using natural language descriptions and with the consensus for managing the semantics of a given specification.

ONTOLOGIES IN EDUCATION

In the educational domain a number of ontologies have been developed for authors. Thus ontologies have been developed to describe the learning contents of technical documents and formalize the semantics of learning objects; model the elements required for the design, analysis, and evaluation of the interaction between learners in computer supported cooperative learning; and describe the learning design associated to a unit of learning in which the learning flow is explicitly declared.

Ontologies in Learning Contents and Metadata

The main purpose of these ontologies is to describe the contents or features of documents in order to favor its indexing and retrieval from applications. Thus Kabel, Wielinga, and Hoog (1999) develop three ontologies that annotate technical documents from a given domain: these documents are converted in a large collection of information elements described by a number of attributes to which values are assigned from the ontologies. These attributes are referred to the subject matter in the application domain, structural and representational properties (paragraphs, sections, etc.) and the potential instructional roles of the information elements. Following this approach the ontologies represent the

semantics of the documents, enabling its indexing and retrieving from databases.

Other interesting ontology in this field is proposed by Brase, Painter and Nejdl (2004). Using an ontology language as TRIPLE, this ontology describes the semantics of the LOM specification, adding formal axioms and rules to the metadata representation of the standard. With this formal description the semantics of the LOM specification is not changed, but it helps to define the constraints on LOM fields, making clear the meaning and use of these LOM fields, resulting in easier exchange of LOM metadata between different applications and contexts.

Ontologies in Collaborative Learning Environments

These ontologies are used to model the interaction between the learning actors (typically teachers and students) in collaborative environments. Thus Inaba et al. (2001) present an ontology a collaborative learning ontology that facilitates the design, analysis, and evaluation of a collaborative learning session. This ontology describes the concepts of several well-established learning theories, defining the semantics of what learning goal concept is and connecting this concept with the theories which are formulated in a taxonomy. In this work, authors have used the ontology to facilitate users the design and execution of the instructional process in a collaborative environment (Barros, Verdejo, Read, & Mizoguchi, 2002).

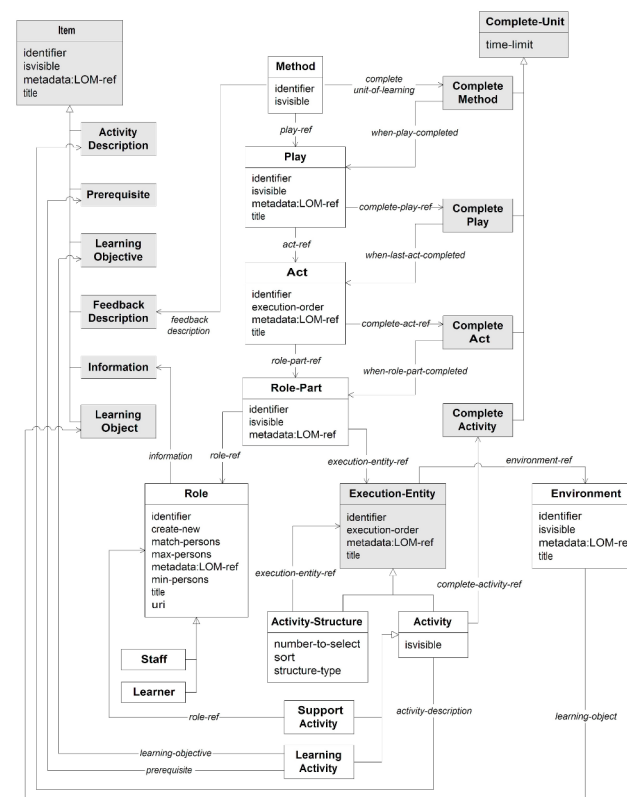
Ontologies in Learning Design

These ontologies focus on the semantic description of the learning design modelling which defines the learning flow of the activities to be carried out by teachers and students. The ontologies developed in this field are based on the IMS Learning Design (IMS LD) specification which has risen as a de facto standard for defining learning designs. This specification has: (1) a well-founded conceptual model that declares the vocabulary and the functional relations between the concepts of the learning design; (2) an information model that describes in an informal (natural language) way the semantics of every concept and relation introduced in the conceptual model; and (3) a behavioural model that specifies the constraints imposed to the software system when a given learning design is executed in

runtime. In other words, the behavioural model defines the semantics of the IMS LD specification during the execution phase. Figure 1 depicts the main concepts of the IMS LD specification.

Knight, Gasevic and Richards (2006) present a general framework whose purpose is to save the gap between learning designs and the learning objects used in them. For achieved this, the framework considers the development of three ontologies that describe the learning design, the learning objects and the context in which these objects are used. LOCO is the ontology, defined in the language OWL (Dean & Schreiber, 2004), that deals with the description of learning designs. It represents the semantics specified in IMS LD and, particularly, in its conceptual model, which means that LOCO integrates the concepts and relations defined in the conceptual and information models of the IMS

Figure 1. Main concepts of the IMS Learning Design specification (Amorim et al., 2006)



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