Chapter 8.7
On the Convergence of Formal Ontologies and Standardized E–Learning

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ABSTRACT

Current efforts to standardize e-learning resources are centered on the notion of a learning object as a piece of content that can be reused in diverse educational contexts. Several specifications for the description of learning objects—converging in the LOM standard—have appeared in recent years, providing a common foundation for interoperability and shared semantics. At the same time, the Semantic Web vision has resulted in a number of technologies grounded in the availability of shared, consensual knowledge representations called ontologies. As proposed by several authors, ontologies can be used to provide a richer, logics-based framework for the expression of learning object metadata, resulting in the convergence of both streams of research towards a common objective. In this article, we address the practicalities of the representation of LOM metadata instances into formal ontologies, discussing the main technical and organizational issues that must be addressed for an effective integration of both technologies, and sketching some illustrative examples using modern ontology languages and a large knowledge base.

INTRODUCTION

The increasing interest in Web-enabled education and training (often referred to as e-learning) has fostered a growing interest in the definition of specifications and reference models for digital educational contents, in an effort to standardize them (Anido et al., 2002). The objectives of such

standardization efforts include facilitating their interchange, their composition, and, ultimately, their mass customization (Martinez, 2001). At the same time, the vision of a Semantic Web (Berners-Lee, Hendler, & Lassila, 2001) has resulted in a renewed interest in the provision of shared, consensual knowledge representations (Davis, Shrobe, & Szolovits, 1993) for the annotation of documents, or, in a more general sense, of knowledge assets. The fact that e-learning and Semantic Web technologies somewhat intersect has been raised in several recent research papers—Hoermann et al., 2003; Sicilia and García, 2003a; and Stojanovic, Staab, and Studer, 2001—that focus on the convergence of two key concepts: learning objects and ontologies. On the one hand, learning objects are an approach to instructional design centered on the notion of reusability (Wiley, 2001) and understood as the capability for a digital content element (a learning object) to be used in several different learning situations, possibly in combination with other contents that were not originally designed for the same context (Sicilia & García, 2003b). Learning object metadata records are used to describe technical requirements, educational properties, and other kinds of information about learning objects, all of them in a standardized format, thanks to the availability of the IEEE LOM standard (IEEE, 2002) and several other conforming specifications. On the other hand, ontologies are logics-based consensual knowledge representations that are advocated as a means to annotate Web resources (or electronic resources in general) to provide them with semantic, machine understandable meaning, thus becoming enablers for knowledge management tools and processes (Fensel, 2002a). Consequently, it also provided that learning objects are a specific kind of digital resource (with an explicit instructional intention), ontology-based annotations are a candidate for expressing learning object metadata records as summarized in Sicilia and García, 2003a.

Since ontology formalisms are based on specialized logics (Baader et al., 2003) carefully designed for expressiveness and computational efficiency, they could be used to provide a richer (Kabel, 2001), semantic enabled computation framework for metadata-based e-learning. In fact, the use of formal ontologies to express metadata not only preserves current principles and practicalities that are applied to standardized metadata (Duval, Hodgins, Sutton, & Weibel, 2002), but also provides a richer framework for its realization and its subsequent use by automated tools. Principles like modularization and extensibility are addressed by the use of open XML-based formats prepared for the Web (Fensel, 2002a), while the principle of refinement is formally defined by the logical interpretation of subsumption. The practicalities of building application profiles for particular usages can be realized by means of constructing specialized ontologies from more general ones, adding specialized terms that restrict cardinalities, value spaces, or relationships among metadata entities. In addition, the satisfiability requirements of a given ontology can be used as a means to assess the completeness of metadata records.

But the integration of formal ontologies with the paradigm of learning objects poses several problems that have not been addressed yet. These problems can be categorized roughly in technical and organizational issues. Technical issues include the practicalities of expressing the structure, properties, and prospective contexts of the use of learning objects as description-logics expressions, and thus entail a notion of what a complete and consistent metadata record should be. Organizational issues are those that would eventually be caused by the adoption of ontology-based learning objects in organizations, as part of an integrated value process (Lytras, Pouloudi, & Poulymenakou, 2002b). These issues include the need for specific user interfaces, the provision of intraorganization conceptualizations coherent with shared ones, and new approaches for the assessment of the quality of metadata records.

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