3 Ontologies and Semantic Web for E-Learning

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This article discusses the area of ontologies and semantic web technologies in E-Learning and compares the state of research in years 2004 and 2006. It considers the impact of ontologies on the web-based educational systems (WBES). It then presents an ontology of the area of ontologies for education along with a community web portal (O4E) driven by that ontology. Finally, it presents a use case of semantic web technologies as enabling technologies for building WBES: the case of TM4L. Topic Maps for E-Learning (TM4L) is an authoring environment for building ontology-aware standards-based repositories of learning materials (objects).

3.1 Introduction

The semantic web (SW), envisioned as an extension of the current web (Berners-Lee et al. 2001), was proposed to provide enhanced access to information based on the use of machine-processable metadata annotating the web resources. A key enabling technology for the semantic web are ontologies. Ontologies offer a way to cope with heterogeneous representations of web resources and their interoperability. An ontology representing a model of a specific domain can be used as a unifying structure for giving information a common representation and semantics. Ontologies are becoming very popular due to their promise to allow a shared and common understanding of a domain that can be communicated between people and applications (Davies et al. 2003).

For educational system researchers and technologists, the semantic web vision opened a new venue promising to meet the increasing challenges E-Learning was facing due to the fast-growing web. Although some early efforts of using ontologies in intelligent educational systems can be found
(see Ikeda et al. 1995; and Mizoguchi et al. 1996), the initial SW in education-related activities can be linked to year 1999, when the first ontology-focused workshop (collocated with AIED’99) (AIED 1999) took place. Among the pioneering projects employing ontologies and SW standards in education were SmartTrainer Authoring Tools (Jin et al. 1999), Edutella (Nejdl et al. 2001), the LOM RDF binding project (Nilsson et al. 2003), etc. Several SW-related projects were reported at the Workshop on Concepts and Ontologies in Web-Based Educational Systems (ICCE 2002) and at the Workshop on Semantic Web for Web-based Learning (CAiSE 2003). The year 2004, however, can be considered the breakthrough point, when three workshops (Adaptive Hypermedia 2004; ITS 2004; ISWC 2004) took place, and the first special journal issues focused on the application of Semantic Web and Ontologies in E-Learning (three that year alone!) were published (Sampson et al. 2004; Dicheva and Aroyo 2004b; Anderson and Whitelock 2004). In addition, a number of papers appeared in other related conferences (e.g., Dolog et al. 2004; Gašević et al. 2004), journals (e.g., Devedžić 2004a) and books (e.g., Mizoguchi 2004; Brase and Wolfgang 2004).

This article presents the area of ontologies and semantic web technologies in E-Learning and compares the state-of-the-art in 2004 and 2006. It further focuses on considering the impact of ontologies on the web-based educational systems (WBES). An ontology of the area of ontologies for education (O4E) and a community web portal, driven by that ontology, are presented. Finally, a use case of semantic web technologies as enabling technologies for building WBES is discussed. The use case is TM4L, an authoring environment for building ontology-aware standards-based repositories of learning materials.

### 3.2 Overview of WBES

Web-based educational systems are employing semantic web technologies in an effort to better serve the increasing and complicated needs of the education community.

#### 3.2.1 WBES at a Glance

The development of WBES has distinct generations that have different features with their own particular challenges: