An Educational Ontology for Teaching University Courses

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Abstract

The developers of some e-learning platforms, that were reported in the last years, started to design and implement educational ontologies. Such ontologies are key issues for the web-based education. As an ontology represents a conceptualization of a knowledge domain, in the particular case of an educational ontology, the content of the educational modules of a course is modeled. Any university course has several characteristics such as a curriculum, a length, a specific audience, learning goals etc. The organization of a course can be, for example, under the form of chapters and sub-chapters or modules and sub-modules. The main concepts that has to be taught are included in the educational ontology. The paper presents an educational ontology, Univ_Edu_Onto, developed in Protégé, that has general terms for a university course, and specific terms for the course of Artificial Intelligence, that is taught to undergraduate students.

Keywords: Educational ontology, Web-based education, e-learning

Introduction

The importance of the educational ontologies development was highlighted in the last years, and many developers of e-learning platforms started to design and implement them, in order to provide an efficient web-based education. As an ontology represents a conceptualization of a knowledge domain [5], an educational ontology models the content of the educational modules of a course. The purposes of using ontologies are knowledge sharing and reusing. The development of the semantic web and of the adaptive e-learning systems are dependent on the use of ontologies. Moreover, the use of different ontologies for the same domain by several web-based applications raises the problems of ontology mapping and ontology merging. Thus, it is necessary to have standard ontologies or, at least, some mechanisms to match and merge the ontologies. In the case of university courses, the educational ontologies have general terms specific to any university course, and specific terms for the knowledge domain of each course. In this paper it is described an educational ontology Univ_Edu_Onto, developed in Protégé, that has general terms with some synonyms (for an easier ontology mapping), and specific terms for the course of Artificial Intelligence, that is taught to undergraduate students. The ontology can be adapted to the knowledge domain of other university courses.

The paper is structured as follows. In section 2 it is discussed the use of ontologies in education, and it is presented a brief overview of some work on educational ontologies that were reported in the literature. The educational ontology, Univ_Edu_Onto, is presented in section 3. The ontology was implemented in Protégé [11]. The final section concludes the paper.

Ontologies in education

The main purpose of education is knowledge sharing, and, in this context, it is obvious that the development of an e-learning system has to be based on specific ontologies. Such ontologies are
named educational ontologies. In an educational ontology the content of the educational modules of a course is modeled. Any university course has several characteristics such as a curriculum, a length, a specific audience, learning goals etc. The organization of a course can be, for example, under the form of chapters and sub-chapters or modules and sub-modules or sections and subsections, to name just some well known synonyms for the same entity, that of dividing a course by topic, in its main components. The concepts that has to be taught are included in the educational ontology. The educational resources of a course are presented by using the concepts defined in the ontology.

In [6] it is described the framework of an e-learning system, and it is proposed a methodology for knowledge management that apply recommendation algorithms. In this context, ontologies are used to personalize the educational resources, according to the attendants’ personality and preferences.

The evolution of IMA-CID, an integrated approach for modeling educational content is discussed in [2]. The authors had developed an automated tool for content modeling, AIMTool, based on Java, as a web application, that can be used to collaborative construction of the IMA-CID models (conceptual model, instructional model and didactic model). Ontologies are used as a supporting mechanism for modeling the content of the educational modules.

In [10] it is introduced the CADMOS-D method, based on UML, for the design of educational adaptive hypermedia applications. The conceptual model uses RDF-based ontologies.

The main issues and some methodologies used for the design and construction of educational ontologies are presented in [4]. Also, it is strengthen the necessity of developing educational ontologies for personalized learning and it is discussed the design and implementation of an educational ontology, named PEOnto, a Personalized Education Ontology.

In [8] it is presented an ontology model for specifying a knowledge domain in the teaching/learning process. The ontology can be used in different learning contexts.

In order to better use the educational resources, a framework for supporting communication between existing ontology-based educational repositories is described in [3]. The authors had defined a communication ontology.

In [12] it is described a semiautomatic framework, TEXCOMON, that produces domain concept maps from text, and then, derive domain ontologies (e.g. educational ontologies) from these concept maps. TEXCOMON can be used to build domain ontologies from English text.

A framework to automatically generate adaptive feedback from metadata of items, used by educational ontologies, is introduced in [7].

In [1] it is presented the AquaRing educational ontology and its use to annotate and retrieve learning contents within the AquaRing architecture.

The importance of defining and incorporating ontologies in the knowledge management system of a university is highlighted in [9], where it is described an ontology for knowledge management (KM) in universities. Such KM ontologies include apart from the ontologies specific to university management, the specific educational ontologies, for the disciplines that are taught in the university in different programmes of studies (undergraduate, postgraduate, doctoral, postdoctoral).

**Univ-Edu_Onto: An educational ontology for university course teaching**

We have developed an educational ontology, Univ_Edu_Onto, for a university course teaching. Figure 1 presents a block schema of a university course teaching system.

The course is taught by using an e-learning platform. Any course has some characteristics such as objectives, curriculum, length, audience, learning goals, overview, content, prerequisite courses. Each course has its pedagogical resources: pedagogical modules (PM), databases (DB - for applications, problems, exercises etc.), electronic books, articles, course notes (e.g. powerpoint slides or pdf documents); and an ontology (UC_KD_Ontology – University Course Knowledge Domain Ontology).
The ontology of a university course has a vocabulary with general terms and specific terms. Figure 2 shows the general structure of a university course ontology. The general terms are valid for any course and such examples are as follows: discipline, curriculum, length, audience, objectives, pedagogical resource, learning resource, number_of_credits, content, chapter (with the synonyms section, module), sub-chapter (with the synonyms sub-section, sub-module), examination (test, exam), problem, application, exercise, solution, lab, project, software, basic_concept, advanced_concept. The specific terms are particular to each course and include concepts from the domain of knowledge that is taught under that course. In the case of the Artificial Intelligence course some examples of specific terms are as follows: knowledge, inference, heuristic, cognitive_system, reasoning_system, informed_search_strategy, knowledge_base, inference_engine, knowledge_based_system, expert_system etc. In Figure 3 it is given a subtree from the Univ_Edu_Onto ontology hierarchy with some specific terms from the Artificial Intelligence discipline.
Each term from the ontology has a description and several characteristics. Between the terms of the ontology there are some relationships. The main relationships used by the Univ_Edu_Onto ontology are has, part_of, order, required_by, is_a etc. Some examples of relations are given below:

- part_of(course, chapter1); // chapter1 is part of the course
- order(chapter1, chapter2); // chapter1 should be taught/learned before chapter2
- required_by(chapter1, chapter3); // chapter1 is required by chapter3
- is_a(heuristic, knowledge); // a heuristic is a particular type of knowledge
- has(A*, heuristic_function); // the A* informed strategy has a heuristic function.

The terms given in Figure 3 are specific to the artificial intelligence discipline, more exactly to the chapter of problem solving in artificial intelligence (AI). In this chapter it is studied the application of various search strategies in solving different problems (toys problems such as chess, Tic-Tac-Toe, 8-queens, or real world problems such as robot navigation, automated planning).

The ontology was implemented in Protégé, a Java-based ontology editor. In Figure 4 it is given a screenshot with some classes of the ontology (in Protégé 3.0), and in Figure 5 it is given a screenshot with the Search_Space slot description for the Search_Algorithm domain (in Protégé 3.0).
Figure 3. A subtree from the Univ_Edu_Onto ontology hierarchy with specific terms from the Artificial Intelligence discipline (search strategies – chapter: Problem solving in AI).

Figure 4. A screenshot with some classes of the ontology (in Protégé 3.0).
Conclusion
The paper presented an educational ontology, Univ_Edu_Onto, that was implemented in Protégé, and has general terms for any university course and specific terms for the course of Artificial Intelligence, taught to undergraduate students. The ontology can be incorporated in the university e-learning platform that is used for the teaching and learning activities.

References