On the Development of a General Educational Ontology for University Didactical Activities

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Abstract

The development of a web-based education requires the use of educational ontologies. Knowledge sharing between teachers and students is facilitated by using concepts defined in such ontologies. Any didactical activity from a university has three main phases: teaching, learning and examination. During each phase run specific models, methods, techniques, approaches, and styles are used, most of them being related to those used in the other two phases. In this context, the improvement of the whole didactical activity can be more effective if the educational ontologies include apart from the pure theoretical and technical course domain dependent concepts, some course independent concepts (e.g. from the pedagogical, methodological and psychological web-based educational views). Examples of such concepts are the teaching style, teaching method, learning style, student model, examination method and so on. The paper proposes a general educational ontology for university didactical activities, based on the guidelines of the EduOntoFrame educational ontology development framework.

Keywords: Educational ontology, Web-based education, Knowledge representation

Introduction

The importance of using ontologies in the university educational systems was increased by the new modalities of doing a computer and network-based higher education (as e.g. web-based education, e-learning platforms, virtual laboratories, collaborative educational and research networks, virtual educational environments). Ontologies provide a solution for solving the knowledge representation problem, and the interoperability of the systems [7]. An educational ontology can be defined as an ontology specific to the instructional process. Knowledge sharing between teachers and students is facilitated by using terms and concepts defined in such ontologies. A variety of educational ontologies were reported so far in the literature (see e.g. [1], [2], [3], [4], [5], [6], [8], [12]), each of them using particular development frameworks or methodologies. Educational ontologies can model a course for all three phases of a didactical activity: teaching, learning and examination. An educational ontology has general concepts and terms for any course, and specific concepts and terms for the knowledge domain of the current course. We have analyzed in [9] the use of educational ontologies as support tools for didactical activities, and we have proposed in [10] a general framework, EduOntoFrame, for educational ontologies development. During each didactical activity phase run specific models, methods, techniques, approaches, and styles are used, most of them being related to those used in the other two phases. The improvement of the whole didactical activity can be more effective if the educational ontologies include apart from the pure theoretical and technical course domain
dependent concepts, some course independent concepts (e.g. from the pedagogical, methodological and psychological computer-based educational views). Examples of such concepts are the teaching style, teaching method, learning style, student model and examination method. In this paper we propose a general educational ontology for all three university didactical activities of teaching, learning and examination.

The paper is structured as follows. In section 2 it is briefly presented the EduOntoFrame educational ontology development framework. A general educational ontology for university didactical activities is proposed in section 3. The final section concludes the paper.

The EduOntoFrame educational ontology development framework

We have started the design of the EduOntoFrame educational ontology development framework from the basic idea that any didactical activity follows a similar design pattern for each of the three activities, teaching, learning and examination. Figure 1 shows a general view of a full didactical activity cycle. During the phases of the didactical activity some course specific educational resources are used, each resource being based on the educational ontologies that include course specific ontologies and prerequisite courses specific ontologies.

In the EduOntoFrame general framework eight educational ontologies are generated, five course dependent ontologies (Course Basic Subject Ontology, Course Advanced Subject Ontology, Course Prerequisite Subject Ontology, Course Practical Activities Ontology, Course Examination Ontology), and three course independent ontologies (Basic Teaching Ontology, Basic Learning Ontology and Basic Examination Ontology). The last three ontologies are the core ontologies that will form a general educational ontology with concepts from the used educational, pedagogical, methodological and psychological didactical models.
The general framework for educational ontologies development, EduOntoFrame, is given as follows, under the form of a generic algorithm.

```plaintext
/********************
*****************************************************/
ALGORITHM EduOntoFrame – A General Framework for Educational Ontologies Development
Input: course, prerequisite courses, student, teacher
Output: Educational Ontologies for the course and specific student competences

Begin
1. do Teaching Activity Ontologies Generation // for the teaching activity
   /* generate the following ontologies:
   Course Basic Subject Ontology (BS),
   Course Advanced Subject Ontology (AS),
   Course Prerequisite Subject Ontology (PS),
   Basic Teaching Ontology (BT); // includes teaching models */
2. do Learning Activity Ontologies Generation // for the learning activity
   /* generate the following ontologies:
   Course Practical Activities Ontology (CPA),
   Basic Learning Ontology (BL); // includes learning models */
3. do Examination Activity Ontologies Generation // for the examination activity
   /* generate the following ontologies:
   Course Examination Ontology (CE),
   Basic Examination Ontology (BE); // includes examination models */
End.
/********************
************************************************************************/```

Figure 2 shows the educational ontologies generated by the EduOntoFrame general framework.

![Diagram of Educational Ontologies](image)

Figure 2. The educational ontologies generated by the EduOntoFrame general framework.

The general educational ontology for university didactical activities
The educational ontologies include general and course specific terms for all three stages of the didactical activity. A term can be a concept, a property or a relationship. Some of the terms are
course domain independent, and are basic notions for any didactical activity performed in a university (e.g. curriculum, syllabus, teaching model, teaching style, teaching method, teacher competences, course structure, pedagogical role, pedagogical resource, knowledge resource, research resource, student model, learning style, learning method, student knowledge level, student research ability, student examination method, teaching feedback, learning feedback, examination feedback). Among these terms some are specific to the pedagogical, methodological and psychological views adopted for the full didactical activity, especially when the education method is adapted to the student capabilities and student performances expectations, which are different for the main categories of students from a university: undergraduate, postgraduate, MSc and PhD students.

We have grouped all terms that are course domain independent in a general educational ontology. Basically, this is composed by the three course independent ontologies generated with the EduOntoFrame general framework (i.e. Basic Teaching Ontology, Basic Learning Ontology and Basic Examination Ontology). Figure 3 shows the structure of this general educational ontology.

![Figure 3. The structure of the general educational ontology.](image)

The Basic Teaching Ontology contains terms specific to any teaching activity performed in a university (e.g. general university educational terms, pedagogical terms, methodological terms, psychological terms). Examples of such terms are: pedagogical role, pedagogical resource, knowledge resource, teaching model, teacher-directed model, student-directed model, adaptive teaching, teacher competences, teaching style, interactive teaching, social teaching, teaching feedback, teaching tools, teaching goals, course description (title, duration, structure, curriculum, syllabus, target audience), course content (educational unit, prerequisite knowledge, course chapter, sub-chapter, module, sub-module, section, sub-section), course resource (software resource, hardware resource, research resource, course presentation, course tutorial, lecture notes and readings, textbook, references, course document file such as ASCII text, doc, html, audio, video, slide, pdf, ps, PowerPoint file etc).

The Basic Learning Ontology contains terms specific to any learning activity: student model, student knowledge stereotypes, beginner, average, advanced, expert, learning method, adaptive learning, learning styles, active reflective, sensing intuitive, visual verbal, interactive learning, student learning feedback, learning goals, practical activity, research activity, experiments, applications, student competences, learning object, resource, lessons learned etc.
The Basic Examination Ontology contains terms specific to any examination activity of an instructional process. Examples of terms are: examination method, written examination, oral examination, written and oral examination, computer-assisted examination, student knowledge level, student research ability, examination feedback, assessment, self-assessment, assessment items, exercises, individualized exercises, questions, tests, problems, theoretical problems, practical problems, research experiments and analysis, student synthesis capacity, student analysis capacity etc.

Figure 4 presents a selection from the general educational ontology hierarchy.

Figure 4. The general educational ontology hierarchy (selected ontology subtrees).

Figure 5. A screenshot with some classes of the general educational ontology for university didactical activities (in Protégé 3.0).
The vocabulary of the general educational ontology contains all basic terms specific to teaching, learning, and examination activities. The definition of the ontology involves apart from concepts identification and definition (i.e. vocabulary representation), the specification of the relationships between the concepts, and of the axioms that state the rules of using the terms in proper ways. Examples of relationships used by the ontology are as follows: is_a, ako (a kind of), has, part_of, order, required_by etc.

In Figure 5 it is shown a screenshot with some classes of the general educational ontology implemented in Protégé 3.0 [11], a Java-based ontology editor.

The general educational ontology can be used by the main actors of the instructional process, teachers and students through various computer or network-based higher educational systems such as the e-learning platforms, web-based educational systems, collaborative educational and research networks or virtual educational environments, during the university didactical activities of teaching, learning and examination.

Conclusion
The paper proposed a general educational ontology for university didactical activities (teaching, learning, examination), based on the guidelines of the EduOntoFrame educational ontology development framework. The ontology can be extended with new concepts specific to educational knowledge (including pedagogical, methodological and psychological knowledge). Also, it can be adapted to particular types of teaching, learning and examination approaches.

References