# Educational Ontology Development

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## INTRODUCTION

Amount of data on the web is constantly growing day by day and it is a new skill to be developed for users to reach the information for their needs, tasks and/or goals among vast amount of information. Likewise, in educational domain, it is a big challenge for teachers and learners to find educational resources on the web and to be sure that these resources meet their requirements. Semantic web technologies, including ontology use, offer a solution for those problems to be solved within educational domain by using domain ontologies.

Ontology provides a framework to determine a domain of interest and to build a common understanding in this domain between different applications by representing concepts and relationships that exist between these concepts. Ontology use in education environments can be explained in three main groups: content access and/or retrieval, content creation, and personalization. Use of ontologies also helps content creators to design and develop online courses; provide smart searches and content suggestions; and, design personalized learning environments for learners. All these advantages come with a price, though: It is not always possible for educators to find the best ontology for their needs in their Learning Management System (LMS). Consequently, users generally have to create their own ontologies from scratch.

In developing an ontology, there is no single and/or standard method to follow that can be ap-plied to all domains since they are widely differ across domains as in law, medicine, information technologies, education, military etc. Since the ontology creation is a complex process, it might not be always easy or even possible to create an ontology for a selected domain and use it across domains.

To address these concerns, in this paper, first, a review of state-of-the art literature regarding the ontologies in educational domain will be reviewed. Second, the challenges and difficulties in ontology development process for educational domain will be addressed and explained in detail. Finally, design suggestions to the difficulties expressed in the literature and further opportunities in ontology design and development will be presented taking the existing ontology evaluation frameworks into account.

## BACKGROUND

### Approaches to Ontology Development for Educational Purposes

There are several classification methodologies when developing ontologies in education, among which are domain-task, task, and domain ontologies (Breuker, 1999; Devedzic, 2004; Allert et al., 2006; Al-Yahya et al., 2014). Based on their purposes, we can categorize educational ontologies in three groups:

- Ontologies for content access (Aroyo et al., 2002; Mitrovic & Devedzic, 2004; Lemnitzer et al., 2008; Lama et al., 2012; Solomou et al., 2015),
- Ontologies for content creation (Simon et al., 2004; Neto & Gauthier, 2006; Boyce & Pahl, 2007; Oprea, 2011; Manganello et al., 2013; Çelik et al., 2014)
- Ontologies for personalization (Henze et al., 2004; Karampiperis & Sampson, 2005; Fok, 2006; Vargas-Vera & Lytras, 2008; Chen et al., 2011; Clemente et al., 2011)

In the following section, each of these groups will briefly be described.

## Ontologies for Content Access

Content access is usually related to providing an access to the existing content within the curriculum in a domain. The main assumption is to list all the standards/goals in a specific course curriculum and map the ontology to these standards accordingly. In their ontology development, for example, Al-Yahya et al. (2014) have designed a curriculum ontology named CURONTO. In their research, they used CURONTO to manage and assess the existing curriculum to provide feedback to the teaching program. They also claimed that, their ontology model is used to establish relations between goals, learning process and the curriculum so that the related stakeholders could benefit from querying the ontology to monitor to what extend the curriculum is aligned with their existing goals and learning processes.

Some researchers took the curriculum model a step further by integrating a user model within the ontology. Clemente et al. (2011, 2014), for example, created a student model by using the ontology as a knowledge representation model. In their ontology, student's cognitive process is taken into account so that with use of ontology, a link is created between student's cognitive process, knowledge and teaching goals. The overall system included three ontologies working in line with each other. First one, student profile ontology, is used to keep personal information; second, student state ontology is used to track learning process of student; and, learning objectives ontology is used to assess learning outcomes.

## Ontologies for Content Creation

Çelik et al. (2014) created an ontology based agent-based Educational Activity Discovery System which is designed to propose educational methodologies for parents or educators about pervasive developmental disorder. They used OWL to build knowledge base and created an ontology of pervasive developmental disorder with concepts and relations of this disorder. By the help of ontology, the system allowed educators to create semantic searches and to support their teaching processes.

Karkar et al. (2014) proposed an educational system for children with intellectual challenges, by creating multimedia tutorials for children dynamically. Researchers used several techniques to create tutorials, such as natural language processing, text extraction, ontology usage and online content retrieval. Researchers went further to claim that their system could dynamically customize learning content by taking learners' preferences into account. Ontology of the system is built from scratch and SPARQL queries are used to list and propose multimedia content.

Marzano and Notti (2015) used ontologies for educational assessment, to assess the system and learning in particular. They created a learning environment in their previous study named EduOntoWiki. This environment is aimed to create an ontology based repository for learning objects. Users of this environment can create content by using ontological structures. EduOntoWiki is used as a test environment for educational assessment in this research. They finally stated that with this approach of educational assessment, it is possible to use different methodologies and models in order to assess systems automatically in an efficient and effective way.

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