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A Process for the Generation of Personalized Learning Scenarios based on Ontologies

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Abstract

The personalization of learning scenarios is based on the description of learning scenarios and also of learner profile. In this paper, we are concerned with learning scenario structure which deal at the same time with pedagogical theory in order to guarantee the learning scenario quality, and with the capability of inference in order to allow its personalization. We propose an ontology describing learning scenarios and a process for the personalization of learning scenario based on this ontology. The use of ontologies allows the conceptualization of theory by the definition of concepts and relations between them. Ontologies allow also the definition of axioms and relations properties that are the basic for the inference capability.

1. Introduction

Aristotle was the first philosopher who introduced the notion of ontology in Metaphysics (in the 4th century BC) [2]. Ontology means a particular theory about being or reality [18]. Recently, the computer scientists have used ontologies for knowledge engineering in different applications of the semantic Web. In this context and in order to share knowledge across different communities, three requirements should be considered when developing ontologies [4]: The first one is extensibility asserting that ontology engineers should be able to develop ontologies in an incremental way, the second one is visibility asserting that in order to make knowledge visible on the Web, additional common ontological ground on syntax and semantics is required between information publishers and consumers, and the third one is inferenceability asserting that ontologies on the Web should provide constructs for effective binding with logical inference primitives and options to support a variety of expressiveness and computational complexity requirements.

The use of ontologies in the web will support the human agents and the software agents for knowledge reuse. In particular, the use of ontologies in the E-learning will be beneficial for the learners and the instructors. In fact, the development and the personalization of learning scenarios according to the learner profile are well supported when the three requirements: the extensibility, the visibility, and the inferenceability are considered. In this paper, we present an ontological approach for the generation of personalized learning scenarios. Among the works which allow the personalization of educational materials, we distinguish: KOD [15] (Knowledge On Demand), and PERSO [3] (an hypermedia adaptive system for supporting E-learning). In these works, the selection of learning contents for learners has been limited to the systematic association of learner characteristics to the learning contents and does not combine this association with pedagogical methods. However, the learning result depends on the learner characteristics and the pedagogical method. The exploitation of pedagogical methods for guiding the learner during the learning process enhances the individual support of learner and improves the quality of E-learning. In this context IMS has developed the IMS LD specification language [7] [8] [9] offering abstract models for the design of learning. The IMS LD specification language is composed of three levels: Learning Design Level A which contains all the core vocabulary needed to support pedagogical diversity. Learning Design Level B adds properties and conditions to level A, to enable personalization and elaborate sequencing and interactions based on learner portfolios. Learning Design Level C adds notification to level B, which adds significantly to the capability

and the implementation task where something similar is not already in place.

IMS LD is pedagogically neutral and it is fundamental to transform it into concrete model dealing with pedagogical approaches in order to describe operational learning scenarios.

Furthermore, IMS LD specification language defines a common vocabulary for specifying learning scenarios but it do not define a process for the development of personalized learning scenarios. However, the absence of a process for guiding the instructor in the development of personalized learning scenarios is the reason for which there does not exist an operational method for developing personalized learning scenarios.

The paper is structured as follows: section 2 presents the development process of personalized learning scenarios. Section 3 presents the specification of personalized learning scenarios ontology. Section 4 concludes the paper.

2. Proposed process

In order to guide the instructor in the development of personalized learning scenarios, we define a process which contains three phases (refinement 1, refinement 2, and refinement 3).

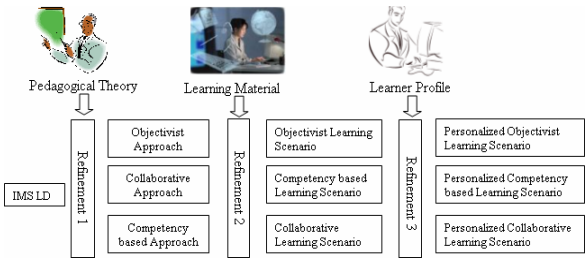

Figure 1. Development process of personalized learning scenarios

Refinement 1 consists of refining the IMS LD specification by adding specific pedagogical approaches: objectivist approach [1] [6], competency-based approach [14], collaborative approach, etc. Refinement 2 consists of adding learning materials to built learning scenarios which deal with IMS LD specification and pedagogical theory. Refinement 3 consists of adding personalization capability based on learner profile. To do so, we add preconditions and post conditions to learning scenario. The precondition allows the entering in the learning scenario, and the post condition will be used for updating the learner profile.

3. Specifying personalized learning scenarios ontology

In this section, we specify an ontology of personalized learning scenarios. In fact, ontologies are a promising solution to overcome common problems for artificial intelligence in education [13]. As UML can be used to model ontologies and domain knowledge [13] [5], we specify the proposed ontology with Figure 2. We use also OWL [12] to implement this ontology. OWL is based on XML and RDF [17]. It is recommended by the W3C for the definition of ontologies in the web. For the edition of this ontology (Figure 3), we exploit Protégé_3.1 [16].

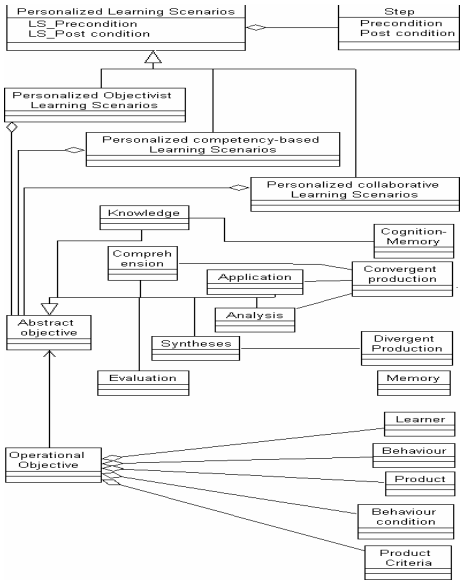

Figure 2. Personalized learning scenarios ontology

A personalized learning scenario is composed of a precondition and a post condition, and a set of steps. It can be: a personalized objectivist learning scenario, a personalized competency-based learning scenario, a personalized collaborative learning scenario, etc. A personalized learning scenario allows the learner to achieve an objective which can be defined according to the Bloom's taxonomy [1] [6] (knowledge, comprehension, application, analysis, synthesis, evaluation). In the Figure 2, the operations of the Guilford model [11] are associated to the levels of the Bloom's taxonomy. In particular, the operation cognition memory of the Guilford model is associated to the knowledge level of the Bloom's taxonomy. The operation convergent production is associated to the levels: comprehension, application and analysis. The operation divergent production is associated to the synthesis level. The Bloom's taxonomy levels are

associated also to the operational objectives structure defined by V. de Landsheere and G. de Landsheere [10] (Learner, Behaviour, Product, Behaviour condition, Product Criteria).

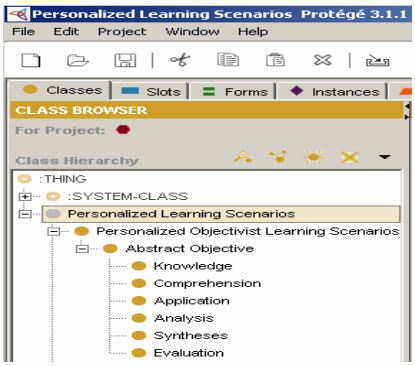

Figure 3. Implementation of personalized learning scenarios ontology

4. Conclusion

In this paper, we have defined an ontology for personalized learning scenarios and we have introduced this ontology in IMS LD language. This ontology deals with pedagogical theory and with the capability of inference. We have also developed a process for the generation of personalized learning scenarios based on the proposed ontology. Hence, IMS LD becomes a specification language offering abstract models for the design of learning and concrete ones including pedagogical approaches.

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