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Restructuring E-learning With Ontologies

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Abstract

This paper examines the role of ontologies in the e-learning environments. A brief review of various ontologies is discussed in three areas: Learning design, learning content and learner profile. A new perspective for curriculum and instructional design is proposed.

1. Introduction

The evolution of educational technology causes transformation in learning environments and gives rise to various methods in content delivering. This transformation encounters us with a mass of information in e-learning environments. E-learning provides easy access to learning resources but in this information pool there is a growing need for semantic organization. Moreover adaptivity is another concern of e-learning. Semantic organization of information and personalized environments could be provided with ontologies. Ontologies differ from taxonomies as to presenting concepts' relationships, specifications, functions and instances.

The requirement of ontology development for e-learning systems could be explained by underlying four reasons; firstly, sharing common understanding of the structure of information among people or software agents. Secondly, enable reuse of domain knowledge with domain ontology. Thirdly, separate the domain knowledge from operational knowledge and finally, analyze terms and their specifications [1].

2. Ontologies in e-learning environments

Developing and using ontologies could contribute to e-learning environments in many dimensions. With the use of ontologies, learning content has become reusable and learning design could be personalized according to learner. Also the design of learning with learning objects gets more convenient. In this study the use of ontologies in e-learning will be discussed in three lines of development: Learning design, learning content and learner profile. Studies vary among the combination of these developments.

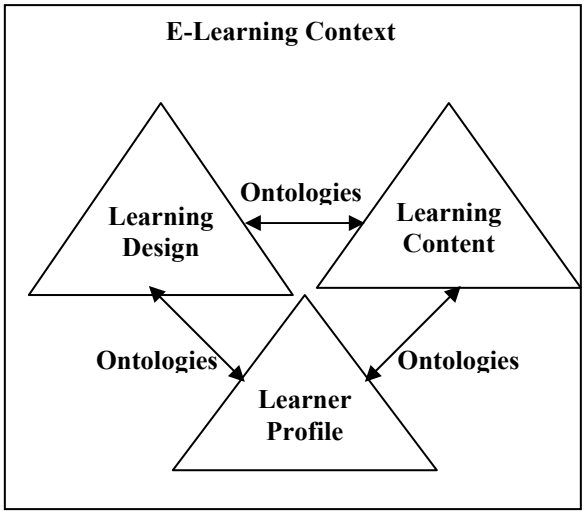

Figure 1. Ontology use in E-learning

Firstly learning design dimension of ontology use will be discussed. There are several studies which are aimed to use learning object integrated with ontologies in order to make learning design more personalized. Jovanović, Gašević, Brooks, Knight, Richards, McCalla, are studied to develop an ontology-based framework inside of a learning design which explicitly represents the context of the use of a learning object [2]. The proposed framework in study is learning object context ontology that leverages a range of other kinds of learning ontologies (e.g. domain, user modeling, learning design etc.) to capture the context-specific metadata. In order to illustrate the

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benefits of their proposal for personalization of learning design they developed the architecture of an adaptive educational system.

Another purpose of ontology use in learning design is reusability of learning materials. Generating high quality teaching materials and adapting them into e-learning environments enhance the quality of the learning environment system. By combining several learning objects, a convenient environment for producing and selecting teaching material can be given to the teacher and learner. For reusability of e-materials a system developed – the Teaching-Material Design Center, this follows the standard of Sharable Content Object Reference Model – to separate e-material as teaching templates and learning objects and to label the material with use of semantic metadata for searching [3]. This system provides a convenient environment for constructing customized e-material for various requirements and finds existing teaching templates and learning objects for e-material designers. System is implemented and found that it is efficient in finding teaching templates and learning objects and shortening the e-material development process.

Connecting domain knowledge and learning design with ontologies is an essential process because of using them together. For this purpose an ontology-based framework that bridges learning content and learning design is developed [4]. The framework aimed to explicitly specify all learning designs, learning objects, and the relations between them, and show how this use of ontologies can result in more effective tools and services that increase the level of reusability. In the study, a three-part conceptual model used ontologies to facilitate the representation of these concepts: LOCO is a new ontology based on IMS-LD, ALOCoM is an existing ontology for learning objects, and LOCO-Cite is a new ontology for the learning object contextual model.

In personalized environments learning design should take in consideration of learner characteristics and metacognitive skills as an essential dimension of learner characteristics. The use of specific ontologies as the basis for incorporating information about metacognition in learning objects is proposed [5]. With this incorporation Learning Management System can select and recommend tasks designed for the development and/or improvement of the learners' metacognitive skills within the context of e-learning. As a result it is concluded that knowledge representation sketched by the metacognitive terms in the ontology presented can lead to a new design paradigm for learning objects, where some learning objects would be designed with (or including links to) additional content promoting metacognitive activities to help students to improve their performance.

The other type of ontology use in e-learning is learner profile. Kalz, Van Bruggen, Rusman, Giesbers, & Koper suggested that if there were competence ontologies inside the learner profiles and the competence development program learner can be positioned through the ontologies [6]. With a well defined ontology of learner in e-learning network, e-portfolios have become usable and exchangeable in order to make learner information sharable. Also learner information could be helpful for designing personalized learning.

In e- learning, users construct a learner network among the system by collaboration. Among different e-learning systems, the exchange of the learner's information is important. To make this information exchange possible a Web Ontology is constructed to make different e-learning systems to cooperate with each other in order to reach a set of learner information richer than the information that can be found in standard e-learning systems [7].

In order to represent the interrelations between the elements of a system, developing a computational approach is needed. To represent the basic collaborative learning concepts ontologies would be useful. [8] studied the use of ontologies for defining and constructing the computer supported collaborative learning environments. They studied an integrated ontology between collaborative environments and real practical environments in order to give rise to the structured elements that form the collaborative learning environments.

For the purpose of supporting the complex instructional design process for collaborative learning an overview of the Collaborative Learning Ontology is built and proposed two systems to support the instructional design process for collaborative learning: a group formation support system, and an interaction analysis support system [9]. The group formation support system helps both human users who don't have expertise of the learning theories and computer systems such as agents in terms of effective group formation. And the interaction analysis support system helps humans to analyze interaction process in collaborative learning. It is proposed that these systems will be beneficial to interpret what type of collaborative learning is occurred in the learning session and identify why a learning session is not effective.

The development of ontology for K-12 education which is a domain-specific ontology called PoleONTO, incorporated into an e-learning environment is discussed [1]. POLE emerged as a

result of combination of various learning processes and concepts in defining an expectation, learning objective or a standard. Learning processes were defined as a set of cognitive skills, which were embedded in the curriculum and requested by instructors. In POLE context, skill is defined as the interaction and any processes between persons and concepts. For example, the concept of table is envisioned in one's mind; yet, they can ***restate*** it, they can ***transform*** the table ***into*** some other thing (i.e., a playhouse by turning it upside down), which is ***creative thinking***. The table can be manipulated by its location, which requires ***problem solving***. These skills are initially tacit or latent; however, this relationship can be explicitly canalized into various expectations, objectives or standards through a learning design.

Concepts in PoleONTO are the solid knowledge articulated across the curriculum. Mass, nouns, optics are some examples. The main characteristics of concepts in an educational setting would be their relationship and hierarchical interactions. For example, in order for a student to understand the concept of scaled maps, s/he needs to have mastered the ratios and fractions. In order to pinpoint the reason why a student fails in answering a map question, we also need to check the related concepts. Thus, any suggested ontology should be comprehensive enough to show the concepts' inter-dependency as well as the required learning processes between concepts [1].

3. Conclusion

The conventional curriculum design is based on expectations or learning objectives which involve both the domain and skills that are expected from the students to perform. On the other hand the relations between them are linear and hierarchical which makes the environments difficult to personalize the e-learning environments. Ontologies are knowledge representation frameworks that allow us to express knowledge in an explicit and expressive way with well-defined semantics. Ontologies structure an area of knowledge by defining the common concepts of that domain and the concepts' properties and relationships [10]. More recently though the use of ontologies has been extended and used in information and science management fields as a way of denoting the hierarchical structure of knowledge by subcategorizing information based on its qualities. This makes ontologies a powerful data structure because they not only show ordering the information but the implicit relationship between information and their domain, as well as the relationship between multiple domains [11]. Ontologies will help to construct adaptive, personalized e-learning design and semantic interpretation of learning content. Moreover, with a well defined learner profile ontology interoperability of design and content ontology e-learning context could be more adaptive and intelligent.

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