A Learner Oriented Ontology of Metadata to Improve Effectiveness of Learning Management Systems

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Abstract

This paper presents an ontology for an e-Learning Management System (LMS), which arranges metadata, and defines the relationships of metadata, which are about learning objects; belong to academic courses and user profiles. This ontology has been incorporated as a critical part of the proposed architecture. By this ontology, effective retrieval of learning content, customizing LMS is expected. Metadata used in this paper are based on current metadata standards. This ontology specified in human and machine-readable formats. In implementing it, several APIs were defined to manage the ontology. They were introduced into a typical open sourced LMS. Proposed ontology maps user preferences with learning content to satisfy learner requirements. These learning objects are presented to the learner based on ontological relationships. Hence it increases the usability and customizes the LMS.

1. Introduction

A popular topic among academic world e-learning has been defined as *"E-Learning is just-in time education integrated with high velocity value chains. It is the delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts"* [12].

Therefore it is important to develop effective e-learning systems to customize and to individualize. In this process ontology and metadata can play a critical role.

Metadata provides details of learning objects in a learning repository. If an LMS can maintain metadata, that helps to define ontological relationships and customize the LMS. Ontology concentrates on semantic relationships between learning objects in the LMS.

Recent researches have on ontology and on e-learning have concentrated on various aspects; industrial e-learning ontologies [2] [3], increasing reusability with ontologies [4], learning paths [5], information retrieval [6] of scholarly articles [7], ontologies for student modeling [8], evolution of ontologies [9].

E-learning standards for LMSs have been proposed recently. One such effort is Advanced Distributed Learning (ADL)'s Sharable Content Object Reference (SCORM) Model [10]. Some more related work exists.

Discussion on improving usability and customization of e-learning systems with extensive use of ontology, metadata and user profiles [11] could not be found. Therefore in this research a study of related topics has been done, an ontology-based architecture has been proposed with the details of the

proposed ontology. It was defined in human and machine-readable formats, and used to match user profiles with the learning content in a learning repository in order to satisfy learner needs. The main objective of this research is to increase the usability of learning content and customizing a LMS to make it learner oriented.

The rest of this paper is organized as follows; section 2 describes "ontology of learning content metadata", section 3 presents proposed architecture for an LMS, proposed learner oriented ontology is presented in section 4, section 5 describes matching user preferences with learning objects, section 6 is about ontology and it's implementation, the conclusion is given in section 7, and references in section 8.

2. Ontology of Learning Content Metadata

2.1 Ontology and e-learning

Ontology is a specification of a conceptualization [1]. Ontology consists of concepts, properties, constraints on their usage and relationships between the concepts. Ontologies have a wide application scope.

Domain ontology, detailed description about an application specific domain is definitions of concepts, entities, attributes and processes related to a given application domain [15]. In this research, our domain is e-Learning systems.

2.2 SCORM and Learning content Metadata

The three main metadata standards defined are, IEEE Learning Object Metadata (LOM), Dublin core metadata and SCORM metadata [13]. Out of them SCORM has the widest scope [11] and it consists of 49 student metadata elements.

This research used only a subset of SCORM metadata, which can be extended. These belong to the learning state of domain objects. We expect to extend the usage and number of metadata in the course of future implementation. The metadata what have been utilized in the ontology are, title, identifier entry, content type, content status, intended end user role, aggregation level. (Constraints were defined on them).

2.3 User Profiles and attributes

When learners access the LMS it captures their profiles (interests and preferences), which will be stored in the learning repository. These user profiles are more descriptive. So in this research we capture them in to a compact representation space in a digital format [17].

We have used a set of attributes to represent user profiles. They are, name, age, gender, occupation, education level, language, topics of interest, education type and education format. These are helpful in the matching process and in creating user communities.

3. An Architecture For An E-Learning Management System

We have taken the proposed ontology as a part of a typical LMS. In this architecture (figure 1) the component, user & course manager is responsible for capturing user interests, giving access to learning objects for learners, matching user profiles with the learning content and selecting the learning content satisfying the user interests. The assets and SCO manager is used by the authors to create SCOs using assets and other SCOs and by the teachers to create new units and courses, the ontology manager is used by the author or administrator to update and improve the ontology.

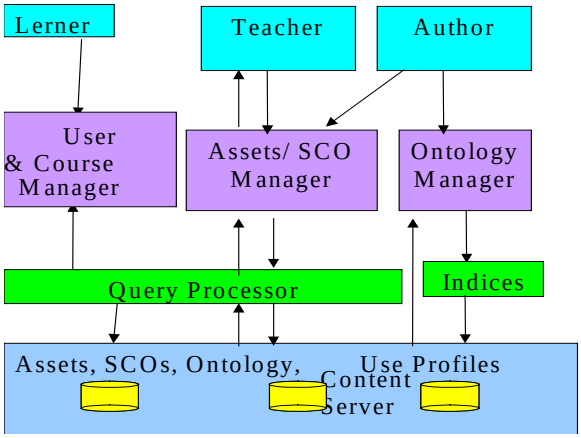

Figure 1: User Oriented Ontology Based proposed LMS architecture

The query processor helps to pass queries coming from the learners and teachers to the learning repository and to retrieve results of queries and pass them back to learners. Indices are defined on metadata to increase the efficiency of queries.

4. Proposed Ontology

4.1 Proposed Learner Oriented Ontology

The proposed ontology consists of e-learning objects and their relationships (figure 2). Therefore via these ontological relationships the required learning resources can be located and their metadata can be retrieved. Then matching of user profiles and learning resource metadata can be done to ascertain the relevance of them.

This ontology can be extended according to the changes to user profiles and learning content.

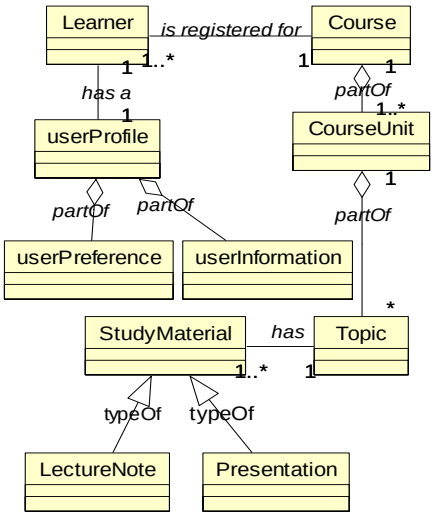

Figure 2: a part of ontology as a class diagram

5. Matching User Preferences With Learning Objects

When we try to satisfy learner requirements we need to match the user profiles with the learning objects in the system. However, a direct matching between the learning objects and user profiles is not efficient enough and it will take lot of memory. Therefore it is done in this research by referring to metadata retrieved through the ontological relationships. Therefore it becomes efficient.

6. Ontology And It's Implementation

6.1 Specifying Ontology for Interchange

Early ontologies have been proposed in Knowledge Interchange Format (KIF) [16]. Later ontologies have been presented using XML and RDF (Resource Description Format) [14]. Then ontologies were presented using ADML (DARPA Agent Mark up Language)+OIL and the latest W3C recommendation is OWL (Ontology Web Language).

Here the ontology has been specified in OIL (figure 3). OIL uses it's syntax to define classes, the relationships between them and the constraints on the facets.

```
class-def UserPreference
        slot-constraint for
        has-value CourseObject
        slot-constraint for
        has-value LearningObject
        slot-constraint for
        value-type SCO
        slot-constraint for
        value-type Asset
```

Figure 3: a class of ontology specified in OIL

These ontological relationships given in RDF schema [14], can be converted into relational tables (table 5 & 6). Matching process uses these data at run time. For example
hasPart(http://107.0.0.1/moodle/course/BIT, http://107.0.0.1/moodle/mod/resource/Lectur 1).

Table 5: RDF Schema for part of Ontology Domain

Source	Target
hasPart	Writer

Table 6: Data for part of Ontology hasWritten

Source	Target
http://107.0.0.1/moodle/course/BIT	http://107.0.0.1/moodle/mod/resource/Lecture1

6.2 Use of Proposed Ontology with an Existing LMS

The ideas we have presented in this paper have been implemented by modifying the open sourced LMS "MOODLE" (figure 4). Two new APIs called profile API (profile.php) and ontology API (onto.php) have been added including the required functions, classes and variables.

Figure 4: Retrieving learning objects using modified LMS, MOODLE

7. Conclusion

Do ontologies increase the effectiveness and usability of e-learning systems? Do they improve the flexibility of integration of content managed by learning management systems? Do they increase the creation of people centric communities? Our work is aimed at exploring acceptable solutions to these questions.

In our work, we have observed that ontologies can be used successfully to increase the effectiveness and usability of e-learning systems for learners using typical LMS. The LMS enabled a user to retrieve the learning content satisfying his/her learning needs. This is further improved by the constraints defined for the facets. So the user will not waste his/her time for searching the required content. The effective matching process uses only the concepts in the ontology, not the bulky learning contents. Thus, the system requires low memory and low bandwidth.

The ontology integrated with the user profiles generates better results in an e-learning system. Most of the early and current e-learning systems use no ontology

or basic ontology. Therefore, by incorporating user oriented ontologies to e-learning systems can increase their user acceptance.

In this paper we showed how to capture user preferences into user profiles and matching them with corresponding metadata. In future, it is expected to use the ontology in creating people centric learning communities; also we expect to refine the ontology APIs and code in order to obtain more benefits.

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