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Design of Merge Ontology for Metadata Sets between MIT OCW and KOCW

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Abstract–*OCW is a free and open digital publication that offers great potential for university education and can benefit learners with an interest in a particular topic. So MIT has launched MIT OCW in 2001, and Korea has KOCW in 2007 respectively. Because they have different metadata set models for learning object, it's hard to share their lots of learning objects in their e-learning system. So this paper proposed the merge ontology to integrate these two metadata models in order to reuse learning objects.*

Keywords —*Metadata, Ontology, OCW*

I. INTRODUCTION

Open Course Ware(OCW) is defined as a free and open digital publication of high quality university-level education materials[1]. These materials are organized as course and often include course planning materials and evaluation tools as well as thematic content. Such materials offer great potential for university education and can certainly benefit learners with an interest in a particular topic who want the information but are not concerned with earning academic credit [2]. OCW is a relatively recent addition to the online educational experience, launched by the Massachusetts Institute of Technology(MIT) in 2001 with content for over 1600 courses [3]. And now, it presently lists over 2000 courses in MIT OCW offerings. In Korea, Korea Open Course Ware(KOCW) is also launched in 2007 in order to share lecture video, note, and syllabus among lectures in university just like OCW. And now, it has over 3000 courses and associates about 120 universities with OCW partnership [4].

OCW is very effective and well-directed paradigm for lectures in university to share their knowledge, skill, and materials. OCW is consisted of lots of learning resources such as lecture videos, powerpoint files and lecture notes, as we call it Learning Object(LO) in e-learning system. LO is a collection of content items, practice items, and assessment items that are combined based on a single learning objective [5]. This term is credited to Wayne Hodgins when he created a working group in 1994 bearing the name though the concept was first described by Gerard in 1967 [6]. LO go by many names, including content objects, educational objects, knowledge objects, learning components, and units of learning. The main purpose of LO is the reusability, and the metadata for LO can be a chance for reusing it in many heterogenous e-learning system. From an lecturer's point of view, the metadata for LO enable its users to reuse and compile distributed units of learning materials to construct e-learning content.

But, many countries and institutes have developed their the metadata for LO such as LOM in SCORM, KEM in Korea, CanCore in Canada. Why these several metadata sets are existed? The important reason is that a world-widely used metadata set, known as LOM, has been designed to be hierarchical and rather complex, which has made the model hard to understand and practically use[7]. So there are many heterogenous metadata models of LO in e-learning and OCW system. For examples, KOCW enveloped their LO with KEM and MIT OCW use their own metadata model. If someone want to search one specific LO with keyword based searching in metadata at one time, it's very difficult to find LO because OCW and KEM are different system with different metadata sets. In order to share these different metadata-packed LO, finding the appropriate method for integrating these distributed heterogenous metadata models is necessary.

In order to illustrate the context of this study, the paper starts with a brief introduction to LO, KEM, OCW, and related works. After introducing some researcher's related works next section will present the reason why integrating heterogenous metadata about OCW and KOCW are needed and the method how to design and integrate these metadata sets.

II. RELATED WORKS

A major current focus in e-learning system is the efficient and adaptive production of LO that is interoperable and reusable. LO is an element of new type of computer-based instruction grounded in the object-oriented paradigm of computer science [8]. Object-orientation highly values the creation of components, called objects, that can be reused in multiple contexts and systems. This is the fundamental idea behind LO. Instructional designers can build small instructional components that can be used a number of times in different learning contexts. To facilitate the widespread adoption of the LO, the Learning Technology Standards Committee(LTSC) of IEEE formed in 1996 to develop and promote instructional technology standards [9]. And a venture called the Instructional Management Systems(IMS) Project was just beginning in the United States, with funding from Educom [10]. Each of these and another organization like Advanced Distributed Learning(ADL) begun developing technical standards to support the broad deployment of learning objects such as Learning Object Metadata (LOM) and Standard and Sharable Content Object Reference Model [11].

Metadata is data about data. It is intended to facilitate the discovery of LO from knowledge management system. Metadata describes certain important characteristics of LO, so the interoperability and reusability of LO can be possible by manipulating and managing the metadata of it, such as LOM. In Korea, Korea Education Metadata (KEM) has become something of a household name when it comes to the Educational Information Metadata, since December 2004 when it was designated as the first e-Learning related technology standard in Korea [12]. At the time, however, KEM was limited to the elementary and secondary education fields, and consequently did not meet the broader needs of higher education fields including university education. This has prompted many in the educational fields to raise the need for the regular revision of the Educational Information Metadata. In response to this situation, research aiming to expand the scope of KEM's support to higher education fields was carried out in 2005.

The formal definition for Ontology is defined as specifications of the conceptualization and corresponding vocabulary used to describe a domain [13]. It is well-suited for describing heterogeneous, distributed and semi-structured information sources that can be found on the Web. For e-learning we need to have ontology for semantics description. Ljiljana Stojanovic, et. al describes about ontology and their different usages in e-learning environment [14]. Some of the ontologies used for the e-learning system are domain, pedagogy and structured ontology. The domain ontology deals with the content or concept of a particular domain. The pedagogy ontology is a context-based ontology which can be represented in various learning and presentation contexts. And the structured ontology has the structure of combining learning materials that can be delivered to learner in e-learning system. Filip Neven has studied a LOM based repositories [15]. A LOM repository that stores both Learning objects and their metadata, by storing them physically together or by presenting a combined repository to the outside world, while the metadata or Learning objects actually stored separately. H. Choe and T. Kim have also proposed the ontology based LOM architecture that can be used in the 'history' subject class with e-learning system[16]. They built the pedagogy ontology to have historical information on the Korean history.

III. DESIGNING MERGE ONTOLOGY

The previous section described some of related research works for LO and ontology. This section will present the reason why integrating heterogenous metadata for LO in MIT OCW and KOCW are needed, and how to design the core metadata for integrating these two metadata.

Many Institutes have developed their metadata models of learning object such as LOM, MIT OCW and KEM. First of all, LOM was the first public and popular metadata standard model of LO. It has some elements as 'mandatory' and the rest as 'optional', therefore it is divided into two parts as the core element set and the optional element set. All elements in the core element set are mandated to be contained in a metadata instance, while elements in the optional element set may or may not occur in a metadata instance. So many institutes have developed their own metadata model in the way of integrating some LOM core element with localized element, or making a new metadata model based on LOM. The reason why many institutes have developed localized element is dependent on their characteristics of educational environment. So, MIT OCW has their new metadata model for lecture content and Korea has KEM as KOCW metadata model.

Table 1 show the distinction about LOM, MIT OCW and KEM. If the same title in one row are exist, the elements in MIT OCW and KEM will be the same synthetic and semantic meaning in metadata. Some elements in LOM, MIT OCW and KEM are exactly matched or synonymous such as Title, Language, Description, et al. And some elements are very different from each other in element names such as Identifier in LOM and KEM and MIT Master Course Number in MIT OCW.

The synthetic representations of these two metadata sets are xml-formatted and are designed to be hierarchical within their elements. And because semantic representation of these two metadata sets are based on the meaning of element in DC metadata model, approach based on the ontology to integrate these two metadata is possible. This study solved the problem of integrating these heterogeneous metadata by using ontology as a mean of a global integration schema. A ontology contains knowledge structures to share the meaning and schema of two metadata. An ontology defines the common words and concepts used to describe and represent an area of knowledge [8]. So it encodes knowledge in a domain and also makes that knowledge reusable.

Table 1. A portion of comparison among LOM, MIT OCW and KEM

LOM 1.0 (SCORM 2004)			MIT OCW			KEM v2.0		
No	ID	Element	No	ID	Element	No	ID	Element
1	1	General	1	1	General	1	1	General
2	1.1	Identifier	2	1.2	MIT Master Course Number	2	1.1	Identifier
3	1.1.1	Catalog				3	1.1.1	Catalog
4	1.1.2	Entry				4	1.1.2	Entry
5	1.2	Title	3	1.1	Title	5	1.2	Title
						6	1.3	Sub Title
6	1.3	Language	4	1.3	Language	7	1.4	Language
7	1.4	Description	5	1.4	Description	8	1.5	Description
						9	1.6	Table of Contents
8	1.5	Keyword				10	1.7	Keyword
9	1.6	Coverage				11	1.8	Coverage
10	1.7	Structure						
11	1.8	Aggergation Level	6	1.5	Aggregation Level	12	1.9	Aggregation Level
12	2	Life Cycle	7	2	Life Cycle	13	2	Life Cycle
13	2.1	Version	8	2.1	Version	14	2.1	Version
14	2.2	Status				15	2.2	Status
15	2.3	Contribute	9	2.2	Contribute	16	2.3	Contribute
16	2.3.1	Role	10	2.2.1	Role	17	2.3.1	Role
17	2.3.2	Entity	11	2.2.2	Entity	18	2.3.2	Entity
18	2.3.3	Date	12	2.2.3	Date	19	2.3.3	Date

As we see the same or different elements of metadata sets in table 1, we need to integrate heterogeneous metadata standards in order to reuse the learning object enveloped with their own specific metadata model. Debra Hiom suggested a general relationships between the mapping sources as synonymous or exact matches[17]. These relationships are proper to our mapping works and ontology design. Ontology is the possible solution to integrate three heterogenous metadata models. Many formal languages to specify ontology have been proposed such as RDF, OML, OIL, and OWL.

Figure 1 shows the snapshot of the ontology containing these metadata models in Protégé ontology editor, and Figure 2 show the portion of the merge ontology source represented in OWL. 'Identifier' in Figure 1 is the unique identifier of LO in e-learning repositories and its information was presented in the right panel of Protégé editor. Identifier is the same elements in LOM and KEM, and is equivalent to the element as 'MIT Master Course Number' in MIT OCW. And it's a subclass of 'General' property. Figure 2 shows these relations of 'Identifier' elements among LOM, KEM and OCW with OWL source code.

Figure 1. A snapshot of the LOM and KOCW ontology in Protégé

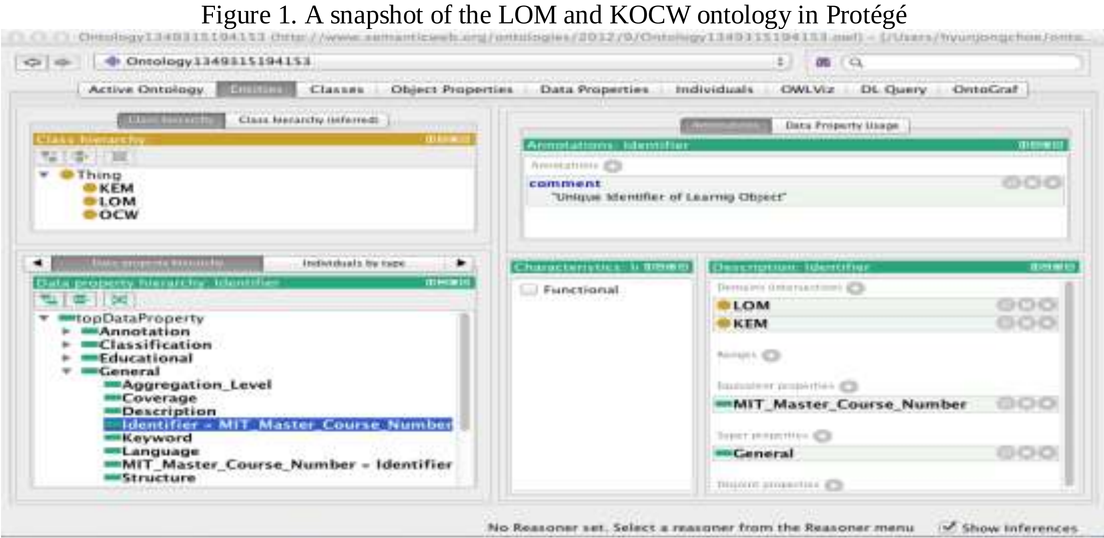

Figure 2. A portion of the LOM and KOCW ontology in OWL

```
<owl:DatatypeProperty rdf:about="&Ontology1349315194153;Identifier">
      <rdfs:comment>Unique Identifier of Learnig Object</rdfs:comment>
      <rdfs:subPropertyOf rdf:resource="&Ontology1349315194153;General"/>
      <rdfs:domain rdf:resource="&Ontology1349315194153;KEM"/>
      <rdfs:domain rdf:resource="&Ontology1349315194153;LOM"/>
      <owl:equivalentProperty
rdf:resource="&Ontology1349315194153;MIT_Master_Course_Number"/>
   </owl:DatatypeProperty>
```

IV. CONCLUSION

A The merge ontology proposed in this paper intends to provide an efficient solution for sharing lots of learning object packaged with other metadata models. To evaluate our model, I have a plan to develop a prototypical learning content management system with ontology based searching and structuring. I believe that this proposed model, which contains a hierarchical concepts structure and semantic relationships between concepts, can provide related useful information for searching and sharing learning resources in e-learning system.

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