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Jian Qin

*Syracuse University, School of Information Studies*

Christina Finneran

*Syracuse University, School of Information Studies*

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# Ontological Representation for Learning Objects

Jian Qin and Christina Finneran

School of Information Studies

Syracuse University

Syracuse, NY 13244 USA

+1 315 443 5642

{jqin, cmfinner@syr.edu}

## ABSTRACT

Many of the existing metadata standards use content metadata elements that are coarse-grained representations of learning resources. These metadata standards limit users' access to learning objects that may be at the component level. The authors discuss the need for component level access to learning resources and provide a conceptual framework of the knowledge representation of learning objects that would enable such access.

## Keywords

Learning objects, component access, intelligent access, knowledge schemas, metadata, ontologies

## INTRODUCTION

As the design of search interfaces advances, digital libraries are witnessing limitations based on the underlying representation of the data. The describing author defines the granularity of a resource statically through using current metadata schemas [8]. The granularity of digital library resources will inevitably limit the user from retrieving finer-grain resources. Our paper will discuss an ontological approach to representing data within a digital library to enable more component level access.

Learning objects refer to any entity, digital or non-digital, that can be used, re-used or referenced during technology-supported learning [9]. Broadly speaking, learning resources usually refer to documents or collections, whereas learning objects to the components of a document or collection. However, "learning objects" according to IMS [6] standards refers to any object, regardless of granularity.

Within the domain of education digital libraries, one of the important goals of metadata is to enable the retrieval and adaptation of one learning object to another learning situation [1]. Providing the learning objects that the users seek, whatever the granularity, is the essence of contextual design [3] and essential for an effective digital library interface. Representations of learning resources must support the finest-grained level of granularity required by the core technologies as suggested in [7], in addition to application and support technologies. Objects within a

learning resource need to be encoded in a way that they can be recognized, searched, referenced, and activated at different granularities. Other researchers have been addressing related technological solutions, such as dynamic metadata and automated component descriptions [2,8]. We will focus on the knowledge representation needs, and introduce a conceptual framework of an ontological approach toward metadata. Finally, we discuss how component-level representation contributes to user-focused interface design.

## ONTOLOGICAL APPROACH TO METADATA

Metadata standards pose different levels of representation granularity, as demonstrated in Figure 1. Dublin Core (DC) [4] provides basic factual description, which is used most commonly in creating collection or resource level metadata. The educational extension of DC specifies contextual factors, such as the resource's target audience and pedagogical goals. IEEE's Learning Object Metadata (LOM)/IMS metadata standard defines more specific educational and technical parameters for learning resources [5,6]. These three metadata standards are best situated to represent learning resources at the collection or resource level. To reach a finer-grained level, where components in a resource are represented and correlated, knowledge schemas play an important role in in-depth representation and more refined user access.

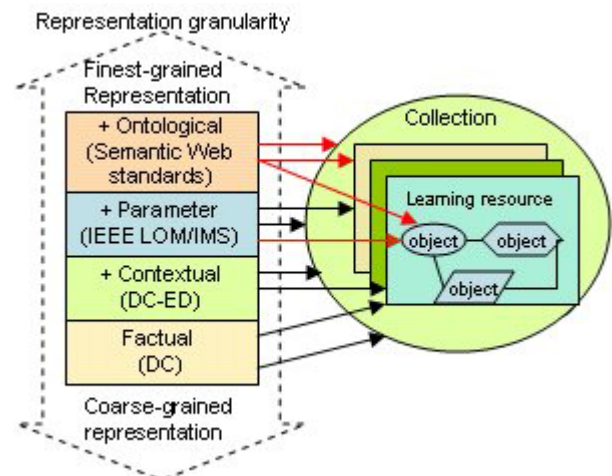


Figure 1. Representation Framework

Through an informal survey of the NSDL collections, we found that search, browsing, and navigation capabilities vary widely depending on the purpose, scope, and subject area of the collection. However, collection or document

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level metadata dominates all types of searches available. A lack of finer-grained representation is becoming a crippling factor for user interfaces to provide in-depth searching for learning objects.

### SAMPLE MODEL FOR COMPONENT REPRESENTATION

An ontological representation defines concepts and relationships up front. It sets the vocabulary, properties, and relationships for concepts, the result of which can be a set of rich schemas. The elements accumulate more meaning by the relationships they hold and the potential inferences that can be made by those relationships. The key advantage of an ontological representation within the realm of learning objects is its ability to handle different granularities. In order to describe learning resources at the collection level (e.g. web site) and further describe each of the components (e.g. interactive applet, image), relationships must be identified when the data are input. Only by having description at the component level will specific learning objects be able to be retrieved by users.

Figure 2 demonstrates how even with a seemingly simple laboratory-learning object, fine-grained description of the component level can enable better access. For example, if an instructor is interested in a graph of steam gauge metrics, s/he should be able to search at the component level, rather than having to guess what type of resource (e.g. textbook, lab) might contain such a graph.

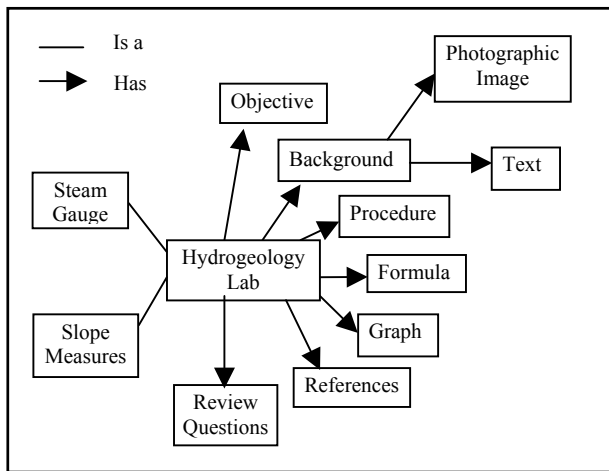
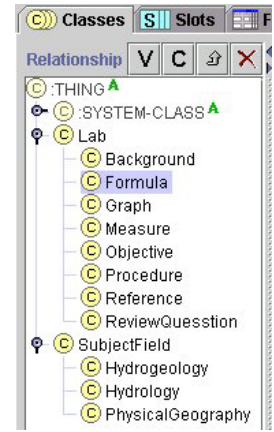


Figure 2. Portion of a learning object's structure

An ontological model may be created based on the example in Figure 2. Each component in the model is normalized into a group of classes under class Lab. The attributes for Lab include "object subject," "object URI," and "parent source," which are inherited by all its subclasses. The "object content" attribute is local to subclass Formula and also reused in other subclasses. A unique feature in this sample model is the reuse of classes in defining attribute types (e.g., the Hydrogeology class is reused in attribute objectSubject). This model can be converted directly into a Resource Description Framework (RDF) format, which can then be used as the motor behind intelligent navigation and retrieval interfaces. By creating ontologies for learning resources, we will be able to

generate a set of knowledge schemas for building knowledge bases and repositories that can be shared and reused by system developers.



Template Slots			
Name	Type	Cardinality	
objectContent	Any	multiple	
ObjectSubject	Instance	multiple	classes={Hydrogeology}
objectURI	String	multiple	
parentSource	Instance	multiple	classes={Hydrogeology}

Figure 3. A sample component representation model

### CONCLUSION

The goal of education digital library interfaces is to support users, whether they be educators or learners, in accessing useful learning objects. The user will determine what is useful, and they also should be given the opportunity to search for components that may be useful. The ontological approach to representing learning objects provides a framework upon which to build more intelligent access within digital libraries.

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