# Pedagogical Resources Representation Conceptual Model

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## Abstract

Pedagogical resources are available in various types and formats on many e-learning or online learning websites. Nowadays, e-learning is one of important channel for distribute and communicate between teachers and learners. It refers to the use of computer technologies to design, create, deliver, manage and support learning for students and help teachers to provide their resources on the internet. Our research is how to represent the several types of resources which are composing by course? How to define and represent the order of sequence of these resources? And how to represent several types of links between resources? We propose the conceptual model to represent these learning resources in respect in ontology and apply with S-node graph.


## 1 Introduction

Various types of learning resources are currently available on the web with the increasing of e-learning usage. E-learning technology helps teachers to provide their courses and learning material to students. When teachers want to prepare their courses, searching and collecting learning resources will be necessary in the primary step. Imagine in database scope, there are many courses that concerned with database in many levels, for example: introduction to database, database system principles, advanced topics in database systems, and database system implementation. Each courses are different in difficulty level but they are shared the same basic concept. For teachers who prepare these database courses, it is possible that they will use or refer to the same materials. The question is what is the effective way to share their materials or pedagogical resources? And for their own courses, how to representation these courses with several types of resources?

S-node representation is a representation for Web graphs proposed by (Raghavan & Garcia Molina, 2003). In this work, we apply S-Node Web graphs to represent learning resources. In section two, we propose the conceptual model for learning resources representation. Section 3 is the brief of S-node graph algorithm. In section 4 we describe metadata and domain structure and semantic relation. And we propose how to apply S-node graph with learning resources in section 5.

## 2 Learning resources representation conceptual model

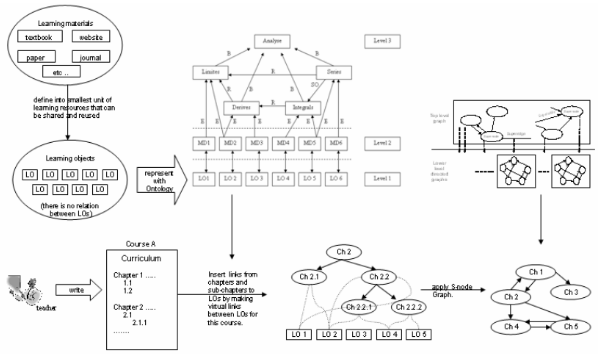


Figure 1. Conceptual model for learning resources representation.

The conceptual follow this model (figure 1):

***Step 1:*** Collecting and extracting learning materials.

1.1 Collecting learning materials from many available resources, e.g. text book, website, paper journal, etc.

1.2 Define those material resources into smallest unit of learning that can be shared and reused.

*Result of step1: learning objects without relation.*

***Step 2:*** Represent there learning resources with ontology.

2.1 Describe each learning resource with metadata by using metadata standard (e.g. LOM, SCORM or Dublin-Core).

2.2 Represent domain ontology with different types of relation.

2.3 Make links between metadata and related node in domain ontology.

*Result of step2: learning objects which are described with metadata and related with domain ontology.*

***Step 3:*** Teacher writes the curriculum of the course and defines prerequisites.

3.1 Teacher writes curriculum of course in chapters and sub-chapters that shows sequences of learning.

3.2 Teacher defines other different relations and prerequisite between chapter and sub-chapters, e.g. must (have to) or should (optional).

3.3 The example in figure 2 shows content of chapter with sub-chapters, chapter 1 composes of sub-chapters 1.1 and 1.2. In sub-chapter 1.1, there are 3 sub-chapters and 5 sub-chapters in sub-chapter 1.2.

*Result of step3: curriculum of course.*

1 Introduction to DBMS Implementation
1.1 Introducing: The Megatron 2000 Database System
1.1.1 Megatron 2000 Implementation Details
1.1.2 How Megatron 2000 Executes Queries
1.1.3 What's Wrong With Megatron 2000?
1.2 Overview of a Database Management System
1.2.1 Data-Definition Language Commands
1.2.2 Overview of Query Processing
1.2.3 Main-Memory Buffers and the Buffer Manager
1.2.4 Transaction Processing
1.2.5 The Query Processor

Figure 2. Example of chapters and sub-chapters in curriculum.

***Step 4:*** Build virtual links. Insert virtual links from chapters and sub-chapters to learning objects by making virtual links between learning objects for this course.

*Result of step4: learning objects with virtual links to chapters and sub-chapters.*

***Step 5:*** Apply S-Node web graph. Apply S-node web graph to represent and store in physical.

*Result of step5: course which is represented with S-node graph.*

Next sections is the brief of S-node graph algorithm

## 3 Structure of S-node web graph

S-node representation is a representation for Web graphs proposed by (Raghavan & Garcia Molina, 2003). It provides two key advantages: First S-Node representations are highly space-efficient. Such significant compression allows large Web graphs to be completely loaded into reasonable amounts of main memory, speeding up complex graph computations and mining tasks that require global/bulk access. Second, the top level graph serves the role of an index, allowing the relevant lower-level graphs to be quickly located. S-node representations reduce query execution time.

S-Node representation divides nodes of graphs into classed, each class of nodes is called supernode. Two-level S-Node representation of the Web graph as shown in Figure 3.

Used $W_G$: represent the direct graph of the Web.

$V(G)$: vertex set of graph G.

$E(G)$: edge set of graph G.

$p$: page is represented by a graph vertex.

$P = \{N_1, N_2, \ldots, N_n\}$ be a partition on the vertex set of $W_G$

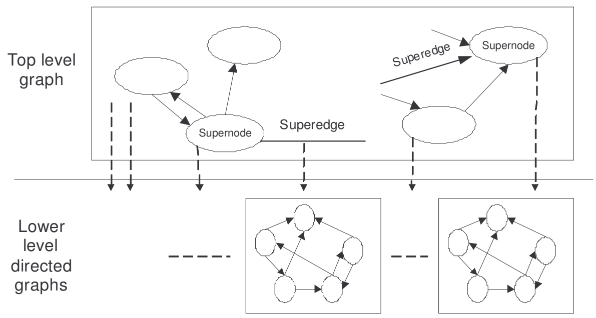


Figure 3. S-Node representation of a Web graph.

Supernode graph contains n vertices (call supernodes), one for each element of the partition. Supernodes are linked to each other using directed edges (called superedges). Superedges are created based on the following rule: There is a directed superedge Ei,j from Ni to Nj if there is at least one page in Ni that points to some page in Nj. Each partition is associated with an intranode graph. IntraNodei represents all the interconnection between the pages that belong to Ni.Positive superedge graph SEdgePosi,j is a directed bipartite graph that represents all the links that point from pages in Ni to pages in Nj. Negative superedge graph

SEdgeNegi,j is a directed bipartite graph, among all possible links that point from pages in Ni to pages in Nj.

In next sections, we will describe the metadata and ontology model.

# 4 Learning objects representation with metadata and ontology model

## 4.1 Metadata

Metadata is data about data that helps us to achieve better search results (Brase & Nejdl, 2003). The educational metadata provide descriptions and additional information about learning resources (e.g. multimedia contents, electronic books, software application, etc.). This information can be used not only for characterizing the resources but also for searching, cataloguing and improvement (Santos et al., 2003). One of the most common metadata schemes on the Web today is the "Dublin Core Schema" (DC) by DCMI, The Dublin Core Metadata Initiative (The Dublin Core Metadata Initiative, 2004). Each Dublin Core element is defined using a set of 15 attributes from the ISO/IEC11179 standard for the description of data elements. The "Learning Objects Metadata Standard" (LOM) (Learning Technology Standards Committee of the IEEE, 2002) by the Learning Technology Standards Committee (LTSC) of the IEEE was therefore established as an extension of Dublin Core. Each learning object can now described using a set of more than 70 attributes divided into 9 categories. Learning Objects are any digital resource that can be reused to support learning (Kolovski et al., 2004).

In (McGreal, 2004), Metadata includes a listing of commonly defined fields for each LO. These fields conform to an accepted set of rules. These rules provide a means of creating, handling and storing data and electronically transferring information using common standards that enable international interoperability. Institutions normally insist on a subset of mandatory fields. These are often accompanied by a larger listing of optional fields. Additional fields can normally be added, so that the specifications are generally extensible.

Learning resources or pedagogical resources can be described in many aspects. For example, the "Learning Objects Metadata Standard" (LOM) (Learning Technology Standards Committee of the IEEE, 2002) by the Learning Technology Standards Committee (LTSC) of the IEEE describes learning resource by metadata. In (Bich-Lien et al., 2004) uses OWL to describe metadata of learning resources and mentioned some definition from IEEE LOM to preserve the semantic given by it.

LOM provides a detailed description of learning resources. But LOM does not directly address the pedagogical purpose of a resource (Merceron et al., 2004). LOM fails to represent relevant information about learning objest, namely the instructional purpose of the objects. LOM's education category partly allows a description of resources from an instructional perspective. IEEE LOM fails to represent crucial information relevant from an instructional point of view (Ullrich, 2005).

## 4.2 The specificities of learning resources

We can categorize the several types of eLearning resources by many category functions from LOM (LOM, 2002):

**Categorize resources by type of pedagogical resource (material type),** for example, lecture notes, exercise, examination, course outline, reading, correction of exercise/examination, FAQ, bibliography

**Categorize resources by format type or media type.** If we categorize by format type, there are .doc (document file), .html (hypertext markup language file), .ppt (PowerPoint presentation file), .ps (post script file), .pdf (Adobe Portable Document Format) Or if we categorize by media type, they can be slide, video, audio, text / narrative text, etc.

**Categorize resources by content.** According to the field of knowledge or knowledge domain. For example, database course ontology in figure 4.

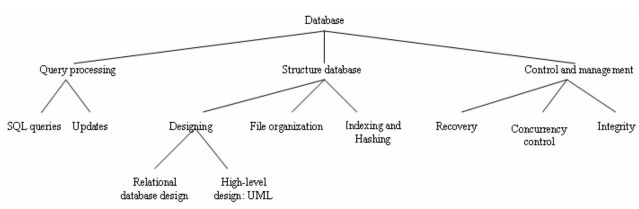


Figure 4. Database course ontology.

## 4.3 Ontology, domain structure and semantic relations

The pedagogical ontology contains the metadata of learning resources participating in a teaching program, created by teachers or educational organization and that are to be retrieved by a search tool (Bich-Lien et al., 2004). In (Brusilovsky & Vassileva, 2003), the domain structure contains the concepts/topic structure of the subject knowledge to be taught. It is represented as AND/OR graph while the node represent the elements of knowledge (concepts, topics, rules, etc.).The arcs in the graph represent relationship between the concepts. These relationships can have various semantics, for example: aggregation, generalization, casual, temporal, analogy and simple perquisite. It is possible to organizes the domain concepts/topics into a smaller, possibly interrelated AND/OR-graphs, representing relatively independent sub-areas of the domain, different 'views', or different levels of granularity. Every node and every link from the Domain structure is associated with a set of teaching materials (TMs), which instantiate different ways to teach the concept/topic (e.g. introduce, explain, given an example, exercise, or test). The domain structure is used for creating a plan of the course contents (a sub-graph of Domain Structure) to achieve a given teaching goal (concept).

The content of resource means the content that learning material is talking about. It is possible that many topics can be composed in a learning resource. This is concern with the ontology. The ontology provides a vocabulary that captures the "instructional semantics" of a virtual or text-book learning resource. In general, each learning object serves a particular pedagogical role. These roles are reflected in class of the ontology (Ullrich, 2004). In IMS, an author specifies the structure (e.g., sections and subsections) of a collection of learning materials and additionally provides information on how to guide the learner through this structure (Ullrich, 2003). In our work, we describe domain structure is an ontology.

### 4.4 Learning resource management with ontology model

In (Ullrich, 2004) describes an ontology of pedagogical objects that provides a vocabulary capturing the "pedagogical semantics" of a virtual or text-book learning resource. The pedagogical ontology contains the metadata of learning resources participating in a teaching program, created by teachers or educational organization and that are to be retrieved by a search tool (Bich-Lien et al., 2004).

In our work, ontology is concept that describes the central pieces of knowledge, the main pieces of information being taught in a course. Subclass of concepts are fact, definition, and different kinds of laws and process (Merceron et al., 2004).

In figure 5 (Bastide et al., 2004) defined the management of the knowledge is made on three levels which are interconnected: The first level, learning objects, is the lowest level of the data model. It concerns the storage of the learning objects without metadata. The second level, metadata, contains the descriptions of the learning objects. The metadata generally follow a schema which is defined by standards such as IEEE LOM or SCORM. The third level, ontologies, contains the representation of the concepts, the sub-concepts and the links. This part allows one to organize and to manage components contained in the previous two levels. The instances of the ontology model contain the metadata (Level 2) which are used to describe the learning objects (Level 1). The learning objects (Level 1) are described by metedata (Level 2) and regrouped by ontologies (Level 3).

The main relations which arise in ontologies of learning objects are the following ones: *Be_a_part_of (x,y,i)* means that x is a part of y. Thus, it is necessary to know the resource x if we want to study the resource y. The value i represents the validity index of the relation (i.e. Reliable indication of the relation). In fact, it is a weight. This value has the same signification in the three following relations. *Be_explained_by(x,y,i)* means that the resource x can be explained by the resource y. *Be_required(x,y,i)* means that the resource x needs the resource y as pre-required. *Be_suggested(x,y,i)* means that it is better to know the resource y before making the learning of the resource x. If you are interested in the resource x you can use it independently of the resource y. You don't have to know both resources.

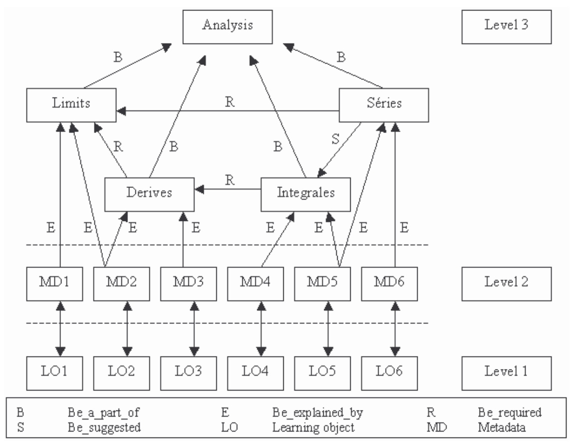

Figure 5. Example of an ontology model for mathematics.

The references supplied by the authors must be used to create semantic links between two resources. If a link doesn't exist between these two resources, a relation of type *"Be_suggested"* will be created. In this case, it is indispensable to create a relation which is the most flexible possible when we don't know the exact kind of link between two resources. Moreover, the kind of relation must be able to be modifiable by the authors of the resources. The goal of this operation is to improve the semantics of the model.

## 5 Course representation with S-node graph

Figure 6 shows the virtual links between learning objects and chapter. These links are different for each course, depend on curriculums. To apply with S-node graph, these node and links will be stored in lower level of S-node graph.

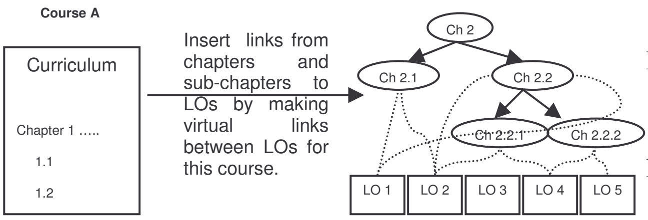


Figure 6. Virtual links insertion.

Nodes in super node level (upper level) will be grouped by chapter (figure 7). If there is at least one node of any chapter that points to the same learning objects as node in other chapters, this link will be exist and this means there is a link between these chapters in upper level.

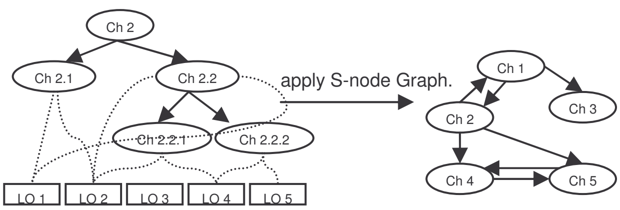


Figure 7. Nodes in super node level of S-Node graph.

## 6 Conclusion

We presented the conceptual model and showed how we can represent and store learning resources applying with S-node graph which provides two key advantages; highly space-efficient and reduce query execution time. Our work is addressed the problem of efficiently way to share learning materials or pedagogical resources and how to representation courses with several types of resources. This work is in progress and we plan to extend the model and hope to realize some experiments.

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