An Approach to RLO Design for Data Structures and Algorithms Courses Using Topic Maps

Kattiya Tawsopar and Dr. Kittima Mekhabunchakij

Information Technology, Graduate School,
Sripatum University
Thailand
E-mail: kattiya.kty@gmail.com

Abstract

As the area of Data Structures and Algorithms (DSA) is crucial in computing science, the materials for teaching and learning DSA are often reused in related courses in such programs as Computer Science, Information Technology and Business Computer. This paper presents an approach to the design of Reusable Learning Objects (RLO) using XML Topic Maps (XTM) to organize a wide range of course materials, including programming codes, Java applets for data-structure demonstration, and algorithms visualization tools. The approach is intended to create a highly interactive Web-based learning and exploration environment, in which students can learn through experimentation. The RLO design applies Topic Mapping for classifications of learning resources in two dimensions. In one dimension, the Concept Space is defined as the knowledge representation in form of a DSA ontology. In the other dimension, the Engagement Taxonomy with six different levels of engagement in combination with Visualization materials is used to describe the Media Space.

Keywords: Computer Science Education, Reusable Learning Objects (RLO), Topic Maps.

1. Introduction

In accordance with ACM Computing Curricula 2005, the Data Structures and Algorithms (DSA) is considered fundamental in many areas of Computing such as Computer Sciences (CS), Information System (IS), Software Engineering (SE), Computer Engineering (CE), Information Technology (IT) and Business Computer (BC)[1]. DSA is intended to help students understand the concept of creating algorithms and extremely useful in writing software programs. However, creating an efficient software is rather difficult for the students. Writing programs requires the complicated thinking process in a system manner. Therefore, to create programs, the learners should have the opportunity in practices in order to improve their thinking process. Due to the abstraction of DSA content, most of the students are not able to get through the process, not understand the algorithmic content. Thus, Information Visualization (IV) has been applied in teaching DSA course to enhance student’s learning and better understanding in algorithms. Jeliot 3 and JHAVE 2.0 [2], [3] shown in Figure 1 and 2, respectively, are example IV tools for
DSA. IV tools are commonly used for collecting and fast presenting huge data in graphic animation. With this type of application software, the students can experiment themselves and learn DSA outside the classroom.

Our approach to RLOs design uses Topic Maps to categorize the learning resources of into two dimensions: Concept Space and Media Space [6]. Concept Space is defined as the knowledge representation in a Ontology form. The other dimension is Media Space which categorizes the learning resources by Visualization tool. Different levels of engagement in course content combined with Visualization tools can be classified: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

2. XML Topic Maps (XTM)

Topic Maps is XML based XTM Conceptual Model specification [7], [8]. It is the standard for the presenting on web-site. XTM has the schema and structure requirements, can form the structure of Information resources being used for naming the topic, having correlation topic with name and sources of information resources. Topic Maps can be appropriate to be used as the database for knowledge management.

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The purpose of this research is to assist teacher to design RLO lessons, on the exploration environment of Learning Management System in which each course has been combined with an example of the experiment, course syllabus, context, quizzes, discussions, web-site or training and evaluation.

The components of course content can be grouped into 5 categories, as the following:

- **P**: Presentation tool, such as in Microsoft Power point or Open Office.
- **W**: Web-based text resources are on web-site.
- **C**: Source codes, to be presented as examples of programming codes.
- **A**: Standalone/Client-side tool for writing Algorithms, e.g. Blue J., Java Applet [9], [10], for the experiment labs.
- **S**: Server-side tool, such as JHAVE which is required to work with some client-side LOs.

In general, teaching DSA in several areas that has been discussed in section (1) can share common LOs. In order to design RLO, it begins by taking LO to create the RLO lesson for the advantage of DSA teaching method. Different curricula has be in different name of DSA course. For example, CS and IT, or File processing in BC. In this research, we form the LO structure from two courses, CS211 and BC302 courses. Figure 4 shows Ontology graph created by using Protégé Software. The software is used to create a Topic Maps for course design approach to RLOs.

As the LO structure in Figure 4 indicated that LO cooperatively will be used in designing RLOs. The example in Figure 4 shows the relationship of CS211 and BC302 in Ontology. In the part of the course CS211, teaching methodology will be completely designed with teaching media according to the course syllabus. In BC302 the content will be similar therefore, the system will be designed so that LO will be commonly used in both CS211 and BC302.

### 3. The Architecture of Reusable Learning Object under LMS

As discussed in section (2), as the category of Learning Object, Application tools and the involving courses in DSA, we can then design the RLOs that connect to the Architecture of Reusable Object under LMS, The five categories of the components in course content (Section 2)
are presenting Figure 6 as part of the architecture.

Figure 6 Architecture of Reusable Learning Object under LMS

The basic structure of Teaching and Learning method, connect the RLOs between the learners and the educators in LMS environment. The LMS used in this research is Moodle. The Architecture are composed of these three core elements.

- **Learner:** is learn through LO; Digital and Non-digital
- **Educator:** is be designed the RLO lesson according to the curriculum.
- **Process:** is the process here both learners and teacher actively participate in teaching and learning, such as Presentation or Simulation in Animation. This can be potentially led to make a more complete learning.

In term of functionality, the architectural accommodate three functions, as follows.

- **Discovery:** Search for RLO and telling the copywriters and what subject is.
- **Assembly:** Taking RLO to adapt with the other context.
- **Decomposition:** Taking a few parts of RLO tree to add up to create a new RLO.

4. Experimentation

This research experiments instruction design of DSA an open-source in LMS called namely Moodle [11]. This system helps decrease lesson preparation time, and help in storing lesson content in the web-based system more conveniently. In preparing RLO under LMS we can package several types of content, including course material, announcement, assignments, exercises, quizzes and tests. As shown in Figure 7, the data storing LO which is the resources as early discuss in previous topic by using Reload program [12], [13]. As shown in Figure 8, Moodle can be used to unpack the RLOs into a new lesson. Figure 9 shows the Moodle system used to import SCORM Package. Moreover, we can use Data Saving function, Learner status Tracking, and Knowledge-Test level Tracked Access information functions. Figure 10, shows the access to the student information and instruction information.
This paper describes an approach to instruction design, by taking for creating Reusable Learning Object (RLO) of course contents. DSA course as for example includes Code Programming Language and Supplementary etc. In addition to RLO design, Topic Maps is applied to categorize the resources of Learning Object (LO) into 2 dimensions: Concept Space and Media Space.

1) The Architecture as a result is composed of three core elements: Learner, Educator and Process.

2) The Process element requires to accommodate the components of course can be grouped into 5 categories: Presentation tool, Web-based text resources, Source codes, Standalone / Client-side tool and Server-side tool.

Finally our experiment uses Protégé software prepared by the Ontology of CS211 and creates RLOs in SCORM package in Moodle for further use in BC302.

In the future the researcher would like to develop Moodle Plug-in program in order to (1) build RLO automatically in SCORM package and to (2) track RLO used in the design of other lessons or courses. This method helps the educators in protecting intellectual property of his/her course design, and allowing them to freely assign RLOs authentication to other teachers with ease.

6. References


