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RELOMS: DESIGNING FOR EFFECTIVE USE AND REUSE OF LEARNING OBJECTS FOR E-LEARNING SYSTEMS

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Abstract. There is a serious lack of conceptual clarity in the definitions and uses of learning objects, resulting in design and usability problems in current e-learning systems. The paper proposes ReLOMS, prototype reusable learning objects management system, being implemented to address the problem of usability and reusability of learning objects in e-learning systems.

E-Learning Systems and Learning Objects

Learning with technology has brought about many new expressions. Many educational institutions are using educational tools in the form of e-learning in course delivery. There is, however, no one definition of what constitutes a learning object or of what size such an object should be to maximise its reusability capability (Muzio, Heins and Mundell, 2001).

Urdan and Weggen (2000) define e-learning as the delivery of content via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM. Werner (2001) defines it as "learning by using a Web browser to access instruction delivered on a network or on the Internet". According to a glossary compiled by Kaplan-Leiserson (2002) of ASTD's (American Society for Training and Development) Learning Circuits, 'e-learning' covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration.

In the book *Empowering Enterprise e-Learning*, Himes and Wagner (2002) propose strategies for leveraging their content assets when developing and deploying e-learning. Developers can create content objects that can be used over and over again for a variety of applications. This is achieved through the use of modular pieces of content known as learning objects (LOs). ASTD Learning Circuits (2002) defines a learning object as "a reusable, media-independent chunk of information used as a modular building block for e-learning content". The Learning Object Metadata Working Group of the IEEE (2002, Section 1.1) Learning Technology Standards Committee (LTSC) defines reusable LOs as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning". In *The Instructional Use of Technology*, Wiley (2000) defines LOs as any digital resource that can be reused to support learning. Wentling et al. (2000, p.5) define "e-learning as the acquisition and use of knowledge distributed and facilitated primarily by electronic means". This form of learning currently depends on networks and computers but will likely evolve into systems consisting of a variety of channels (for example, wireless, satellite), and technologies (for example, cellular phones and PDAs) as they are developed and adopted. E-learning can take the "form of courses as well as modules and smaller LOs". E-learning may incorporate synchronous or asynchronous access and may be distributed geographically with varied limits of time.

Survey of Solutions to Address Reusability of Learning Objects

As e-learning environments become more and more popular, many attempts have been proposed to provide adaptive environments offering learners and educators customized courses for more effective learning and course construction (Muzio, Heins and Mundell, 2001). More recent concerns in integrated learning systems have been on managing the millions of LOs created, addressing disorganization, lack of use and reuse of these LOs in e-learning systems (Polsani, 2003). Some solutions are aimed at helping learners, while others are aimed at helping educators and course designers/developers:

For Learners

Recent educational research from a socio-cognitive perspective has validated learners' collaborative engagement with new technologies and heightened understanding of influential factors shaping the effectiveness of peer interactions, learning contexts and computer interfaces for enhancing learning. For example, in a study by Kimber, Pillay and Richards (2005) on 17-year-old female students, the focus was on the analysis of the complexity of knowledge in student-designed, electronically created texts for what they might reveal about learning with technology, mediated by the creation of electronic concept maps and Web files to represent their developing understanding.

For achieving the adaptive learning, a predefined concept map of a course is often used to provide adaptive learning guidance for learners. Tseng, Sue, Su, Weng and Tsai (2005) proposed a Two-Phase Concept Map Construction (TP-CMC) approach to automatically construct the concept map by learners' historical testing records.

Others like Escalada and Zollman (1998) investigated the effects of learning systems on students' learning and attitudes.

For Educators and Course Designers/Developers

Numerous studies (e.g. Mills, 1999; etc.) have been carried out to understand the use and perception of e-learning systems from the perspective of teachers' concerns and their influence on the way in which integrated learning systems could be implemented. Bonifacia, Demetrescua, Finocchib and Lauraa (2004) described Leonardo Web, a collection of tools for building animated presentations that could be useful for teaching, disseminating, and e-learning.

Conole, Dyke, Oliver and Seale (2004) proposed how models could be used to represent theoretical approaches and support practitioners' engagement with these. Their assertion was that a better articulation and mapping of different pedagogical processes, tools and techniques would provide a pedagogic approach that was more reflexive and consistent with practitioners' theoretical perspective on learning and teaching.

Wang and Hsu (2005) emphasized the design of electronic teaching materials (e-materials) to support teaching and describe a system to separate e-materials for use as teaching templates and LOs and to label the materials with use of semantic metadata for searching.

One of the most crucial prerequisites for successful implementation of e-learning is the need for careful consideration of the underlying pedagogy, or how learning takes place online. Govindasamy (2002) identified the pedagogical principles underlying the teaching and learning activities that constitute effective e-Learning.

ReLOMS: Architecture and Implementation

In contrast with other studies, we propose a **Re**usable **L**earning **O**bjects **M**anagement **S**ystem, called **ReLOMS**, to address the serious lack of conceptual clarity of definitions, and uses of LOs, resulting in design and usability problems in current e-learning systems (Polsani, 2003). We see ReLOMS as a practical LOs management system to help teachers and administrators manage the complexity of construction and deconstruction of LOs.

System Architecture

Figure 1 shows the ReLOMS system architecture with two major modules to support construction and deconstruction of LOs:

- Constructor Module. This module is concerned with the creation of LOs and consists of three components: (i) *LO Search and Retrieval* supports personalized and collaborative searching and browsing; (ii) *Editor* provides an environment to create and edit new LOs; and (iii) *Control Authentication* incorporates authentication of users and LOs before allowing them to be stored in the respective databases.
- De-Constructor Module. This module supports the de-construction or de-composition of LOs into smaller units of LO components with a learning objective, and consists of three components: (a) *LO Component Extractor* allows meaningful LO components be extracted for reuse; (b) *Metadata Tagger* provides a systematic, role-based workflow to complete the metadata details of the LO components; and (c) *LO Content Management* provides a course content management environment with a proper taxonomy structure to organize the LO components.

The LO components are maintained either in a *Static LO Component Repository* (e.g. text, images, etc.) or a *Dynamic LO Component Repository* (e.g. video clips, animation, etc.). To store complete LOs used in different scenarios for teaching, an *Aggregated LO Repository* is created. An *Addressing System* is designed to separate LO content from location as a matter of good software engineering practice for better maintenance.

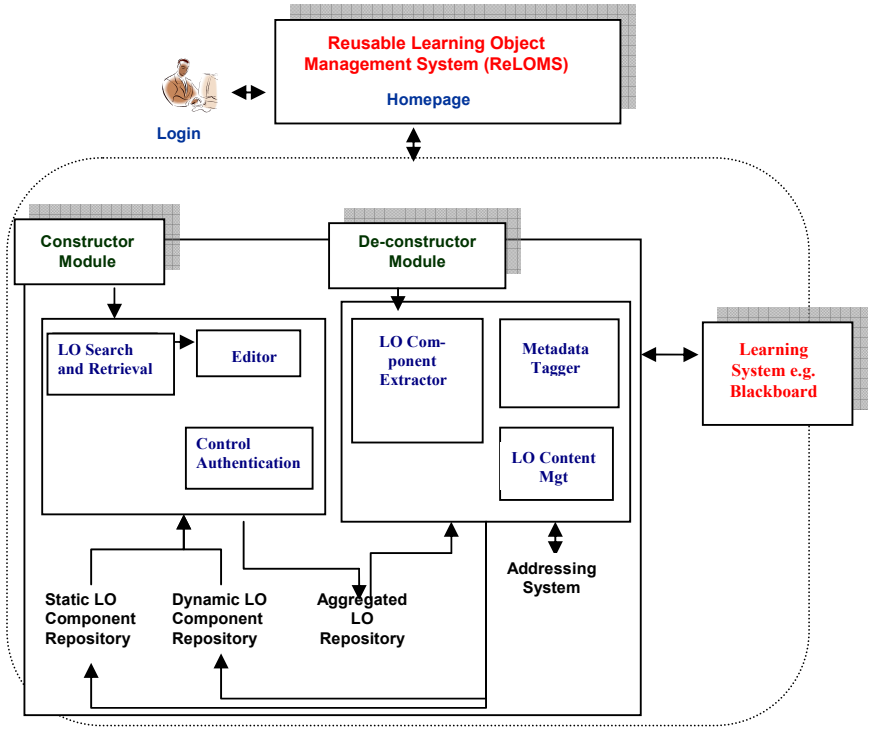

Figure 1. ReLOMS Systems Architecture

Implementation

ReLOMS is designed to be integrated with Nanyang Technological University's existing learning management system, powered by Blackboard. Figure 2 shows the ReLOMS prototype homepage. A three-tier architecture employing various open source components is used to implement ReLOMS:

- *Presentation Layer*. The Struts Framework (http://struts.apache.org/) is used. Here, Struts' Model-View-Control design pattern allows for easy development and maintenance.
- *Business Logic Layer*. Spring Framework (http://www.springframework.org/) is a 'lightweight container' for managing business logic components. In the present work, ReLOMS components will be deployed on top of the Spring Framework to achieve a loosely coupled architecture for maintenance and extensibility.
- *Persistent Layer*. The Hibernate Framework (http://www.hibernate.org/) is used as a high performance object/relational persistence and query service.

Conclusion and On-Going Work

Initial feedback on ReLOMS has been positive. On-going work involves validating the taxonomy frameworks and structures for specific domain areas, and evaluating it with different categories of stakeholders such as teachers, students and administrators.

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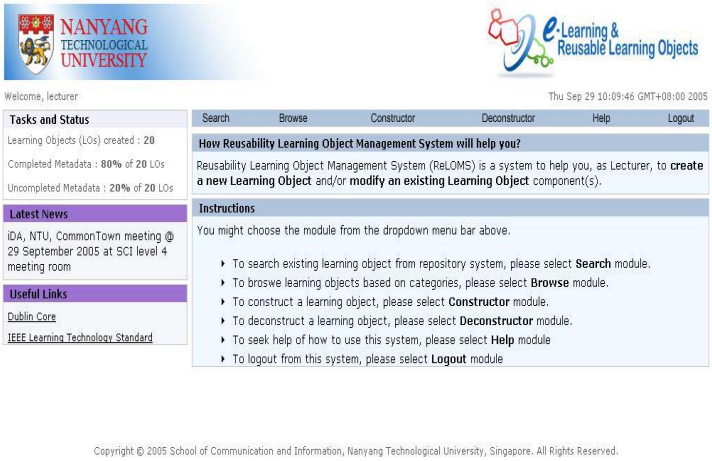

Figure 2. ReLOMS HomePage

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