ReLOAMS: Towards a community authored, reusable learning objects management system

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As e-learning environments become more popular, many studies have been proposed to provide adaptive environments offering learners and educators customised courses for more effective learning and course construction. Some solutions are aimed at helping learners, while others are aimed at helping educators and course designers/developers. However, a serious lack of conceptual clarity of definitions and uses of learning objects, could have resulted in design and usability problems in current e-learning systems. This paper describes on-going work in developing ReLOAMS, a Reusable Learning Objects Authoring and Management System, prototype to address the seemingly lack of reusability of LOs in current e-learning systems. Through shared workspaces (or group workspaces) for learners who have similar learning interests to use, share and rate LOs, this paper describes the design rationale and philosophy of ReLOAMS, being implemented to promote an environment supporting community-authored and rating of learning objects. The paper then describes the systems architecture, and development of ReLOAMS concluding with recommendations and implications for the design of e-learning systems.

Keywords: learning objects, usability, reusability, e-learning.

Introduction

Although e-learning systems are beginning to play key roles in education, especially in the provision of information to learners, there is a lack of systematic support in ensuring that resources are continually being monitored and updated. This is far from desirable, since within the classroom environment, active learning is characterised by active engagement, problem-solving, inquiry, and collaboration with others so that each student constructs meaning and hence knowledge of the information gained (Ong et. al, 2004; Richardson, 1997). Consider for example, a group of high school students working on a course project. Typical activities would require these students to acquire content from the lecturer, gather reference materials from the library or other sources such as the Web, compile and make sense of all the available information, synthesise content, write the project report and submit the completed project for grading. An integrated work environment for instance, could allow students to collaboratively retrieve and store personal and group information objects relevant to the task at hand. Such an e-learning system would therefore depart from the traditional role of providing just easy access to digital content, but instead become an integral part of the learning process.

E-learning is changing the way we learn. A worldwide poll on e-learning decision makers in the higher education sector revealed the merging of physical and virtual campus, and also a trend towards hybrid or blended approach to learning (Gartner, 2007b). In 2006, over 57% of courses were hybrid, a jump from just over 30% in 2002. Blended learning, a hybrid of e-learning and traditional delivery methods, is dominant in most campuses. One form of blended learning involves the use of e-learning as pre-training before learners attend classroom training. In a Harvard Business School's MBA programme, e-learning was used to help incoming students brush up on "Accounting 101" before classes began. The resulting benefits were (Schank, 2002): (1) the professors spent less time teaching basic accounting and more time on teaching advanced topics; (2) the MBA programme was shortened to three semesters instead of four, and students got their degrees earlier; (3) it allowed the school to cater to individual learner's knowledge and learning pace that eventually cut down learning time; and (4) learning the subject matter was made more fun and interesting.

Despite such potential, many e-learning systems still offer basic levels of support for educational services, and users typically encounter one or more of the following problems:

- *Content access is a separate task from other applications*. Although advanced features for searching and browsing are available, e-learning systems provide, at best, limited support for sharing the retrieved content to other applications that support learning (Ancona et. al, 2005).
- *E-learning systems are not designed to cater to the needs of different learning activities.* Instead, they excel at generic tasks such as cataloging/classifying content and metadata, searching and browsing.
- *E-learning systems are often not designed to meet the learning needs of individuals or groups*. They are rather created as a generic collection of services for their target user populations at large. Support for individuals or sub-groups within these target populations requiring specialised services or content are typically lacking.
- *Users are not able to share findings with others.* In e-learning systems that support personalisation, content is accessed and manipulated individually via personalised workspaces. Thus while individual learning can be supported in such e-learning systems, collaborative group-based learning becomes more difficult.

ReLOAMS: Design rationale

Student demands and pedagogical advantages are driving the need for more e-learning technologies in higher education institutions (Gartner, 2007b). Despite the enthusiasm in adoption and advancement in e-learning systems, a gap exists in the concept and use of learning objects (LOs). The definitions, and standards for LOs have been evolving over the last five years; and LOs are not as reusable as perceived to be (Polsani, 2003; Watson, Ahmed & Hardaker, 2007). Many LOs lack quality aspects and do not fully address learners' learning context, while customisation of e-learning systems and LO metadata to personalise learning have been attempted (Farrell, Liburd & Thomas, 2004; Hawryszkiewycz, 2004; Kumar, Nesbit & Han, 2005; Plodzein, Stemposz & Stasiecka, 2006; Vargo, Nesbit, Belfer & Archambault, 2003).

Nevertheless, e-learning systems are evolving from being static repositories of information in which access is limited to searching and browsing, to more organised, multi-faceted resources that offer a greater array of services. These include giving users new ways to access, interact and manipulate content such as annotations, workspaces and user content contributions, and towards a growing trend in recent years of community-based, participatory systems.

For LOs to be widely used and applied in educational institutions, they have to be readily available and sharable amongst academic staff. One well-established standard called the Sharable Content Object Reference Model (SCORM), helps to establish technical foundations of Web-based learning, providing guidelines for LOs or contents and systems to meet the following high-level requirements in areas such as: accessibility; adaptability; durability; interoperability; reusability; and "searchability". However, some researchers think that resolving the instructional/pedagogical issues is where real challenges lie. Reigeluth and Nelson's findings show on how teachers break the resource down into its constituent parts first, and then puts them together again in a different arrangement (Boskic, 2003). Thus, to avoid the deconstruction/reconstruction process, a LO should be that elemental constituent component that cannot be broken down any further and is ready for instructional use in different combinations. As for the size of LOs, Boskic (2003) suggests moving from the course level to the concept level of granularity, but at the same time be conscious that "the optimal level of granularity must be determined for each project based on its individual goals".

We can learn from the success of the Web. It became popular almost overnight with the introduction of the Mosaic, a graphical user interface, making it "very easy" for anyone to create and use information, giving power to users to be both readers and authors (Theng et al, 2001). In recent years, we also witness another phenomenal success of Wikipedia (http://www.wikipedia.com; retrieved 30 June, 2007), a community-contributed/moderated online encyclopedia, in which groups of individuals engage in participatory, collective effort contributing to the quality of digital resources.

Hence, drawing upon the successes of the Web and Wikipedia, we postulate that perhaps some of the above problems highlighted in current e-learning systems could be alleviated by allowing users to be active contributors of resources as well as tapping onto the collective intelligence of communities to improve the quality of the online resources. In this paper, we describe our project in the design and development of ReLOAMS, which stands for "Reusable Learning Objects Management System", 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) through the incorporation of a community-authored environment allowing sharing and comments of LOs. The paper then describes the system design and implementation of the group workspace. The remainder of the paper covers a

comparison of our implementation with other related e-learning systems, and ends with recommendations for on-going work.

ReLOAMS: Architecture and implementation

There are many tools (including both software and hardware) available for developing learning resources. Presently, software such as Microsoft Office and Macromedia Studio are some common application tools that bundled with other specific programs helping to create complete LOs such as documents, images, audio clips, videos, animations, virtual reality worlds, or multimedia exercises. However, for more effective deployment of reusable LOs, there need to be tools to publish metadata records of various resources, also considered as LOs. A metadata record consists of a set of elements, describing a multimedia resource. Examples of these elements are date of creation or publication, type, author, format, or title of a resource (Kassanke and Steinacker, 2000). For example, IEEE's specification of Learning Object's Metadata (LOM) defines the following nine categories for metadata Each of these categories groups appropriate metadata fields of a specific aspect (Standard for Learning Object Metadata, 2002): (i) General (metadata, such as the title, language, structure, or description of a LO); (ii) Life Cycle (status, version, and role of a LO); (iii) Meta MetaData (metadata describing the metadata used for a LO); (iv) Technical (all technical information about a LO, such as the format, the length, browser requirements, etc.); (v) Educational (information about the educational objective of a LO, such as interactivity, difficulty, end-user type, etc.); (vi) Rights (commercial use and ownership of a LO); (vii) Relation (references to other LOs); (viii) Annotation (additional information about a LO); and (ix) Classification (different purposes of a LO, together with its location within a taxonomy of keywords).

In contrast with other systems (for example, Mispelkamp and Sarti, 1995; Valderrama, Ocana and Sheremetov, 2005; etc.), we see ReLOAMS as a practical LO management system to help teachers and administrators manage the complexity of construction and deconstruction of LOs (Theng et. al, 2006). In addition to the construction and de-construction of LOs described in earlier work (Theng et al, 2007), we describe new components added to address the problem of usability and reusability of LOs in e-learning systems to promote an environment encouraging community-authoring and rating of learning objects. Figure 1 illustrates the overall architecture of ReLOAMS (see Figure 1). Drawing upon related work that has helped to inspire the conceptual design of ReLOAMS, we describe briefly only selected modules for the purpose of addressing the reusability of LOs for construction, de-construction and collaboration.

ReLOAMS constructor

This module is concerned with the creation of LOs and consists of three components: (i) LO Search and Retrieval supports personalised 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. XML-driven construction module generates various documents as outputs of the ReLOAMS system. Template driven will still be used in the prototyping design as we need to control layout of the output documents. The LO components are maintained either in a Static LO Component Repository (for example, text, images, etc.) or a Dynamic LO Component Repository (for example, 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. For presentation layer, asp.net 2.0 is chosen for robust development. Custom Business Object implements the data access layer. The output of constructor module is in HTML format that can be converted further at Document Converter module. The created aggregated LO need to be tagged, the metadata tagger module is used to performs the tagging mechanism. Constructor module can be extended to be able to interact with other system by using web service gateway. Each ReLOAMS module will expose the WSDL file to other system.

ReLOAMS deconstructor

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 organise the LO components. The current prototype allows the documents to be extracted based on a template-driven mechanism. Some templates used in the prototype design consist of a slide template, a book chapter

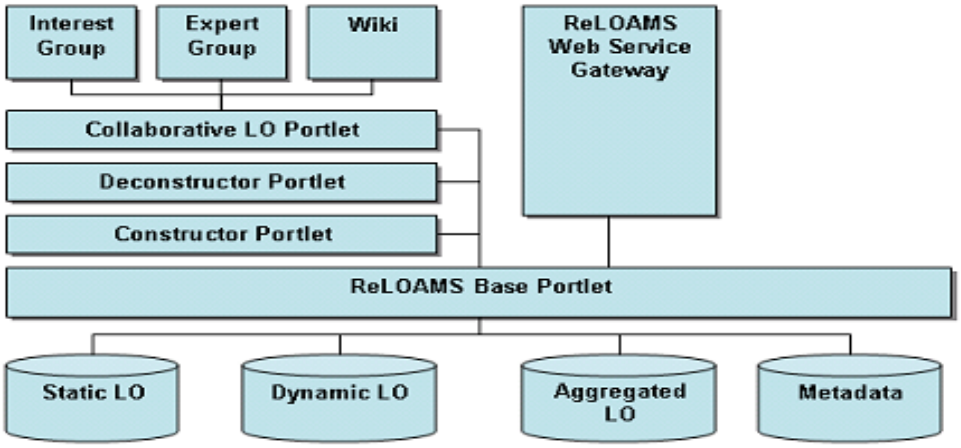

Figure 1: DotNetNuke based ReLOAMS system architecture

template, a journal template, and a conference paper template. The atomic level LOs will be extracted from the documents using its respective file extractor based on its document type (for example, PDF, HTML, Word, and PPT). The editor shows the data from extracted document in the HTML form (tree view) based on its page, its sections, and its paragraph. Final form of the extracted document will be an XML document based on specified schemas that the ReLOMS has predefined before. Metadata need to be created to explain the extracted documents. User needs to upload the aggregate file to be de-constructed, the file uploaded module facilitates the user to upload their aggregated LO. File extractors are other custom module to extract various aggregated LO uploaded by user. Current research development is to extract pdf file to be able to get the images and text from the aggregated pdf LO.

ReLOAMS collaborative space

The objective of this ReLOAMS collaborative LO as additional feature of core ReLOAMS system is to introduce a group workspace for e learning so that learners within the group can put together LOs which is of their interest. Inspired by the literature review, LORI and MERLOT etc., a system is planned to be developed for learners to create and maintain groups, search and browse LOs to include into the group and also receive alert and notification of new LOs contributed into the group. To have better context in learning and improve LO reusability, ranking of LOs for their quality attributes will be introduce in this ReLOAMS collaborative LO project. Group members comprising educators, subject matter experts and learners will be able to provide qualitative and quantitative input against LOs. Figure 2 explains the architecture of collaborative custom module in ReLOAMS portal system. The collaborative ReLOAMS porlet contains two modules: Interest Group and Expert user. User can create new group, join existing group, leave group. The user interaction with LO are by displaying LO, adding LO and rating LO. User role management controls the privilege of interest group and expert group users.

ReLOAMS is being currently implemented using DotNetNuke 4.0 as a portal engine. Each module of ReLOAMS is being developed as a portlet and can be ported into the ReLOAMS portal. ReLOAMS base portlet contains the core module of DotNetNuke portal engine. It controls the relational object mapping using DotNetNuke Custom Business Object. RELOAMS portal supports user's role-based system using profiling feature in ASP.NET 2.0 that has been implemented in DotNetNuke portal; and each user will be assigned to one or more roles.

The Constructor module combines the atomic level LOs into aggregated LOs that can be used based on options provided. The options of constructor module in order to construct aggregated LO are slide show, book chapter, journal paper and conference paper. In this prototype, ReLOAMS has developed the slide show template driven in construction of the aggregated LO process. Text editor is needed in implementation of constructor module. Figures 3 and 4 show the list of constructed LOs and the viewer displaying the detailed constructed LO. From the viewer, ReLOAMS constructor module provides the feature for user to convert the HTML based text to other file format.

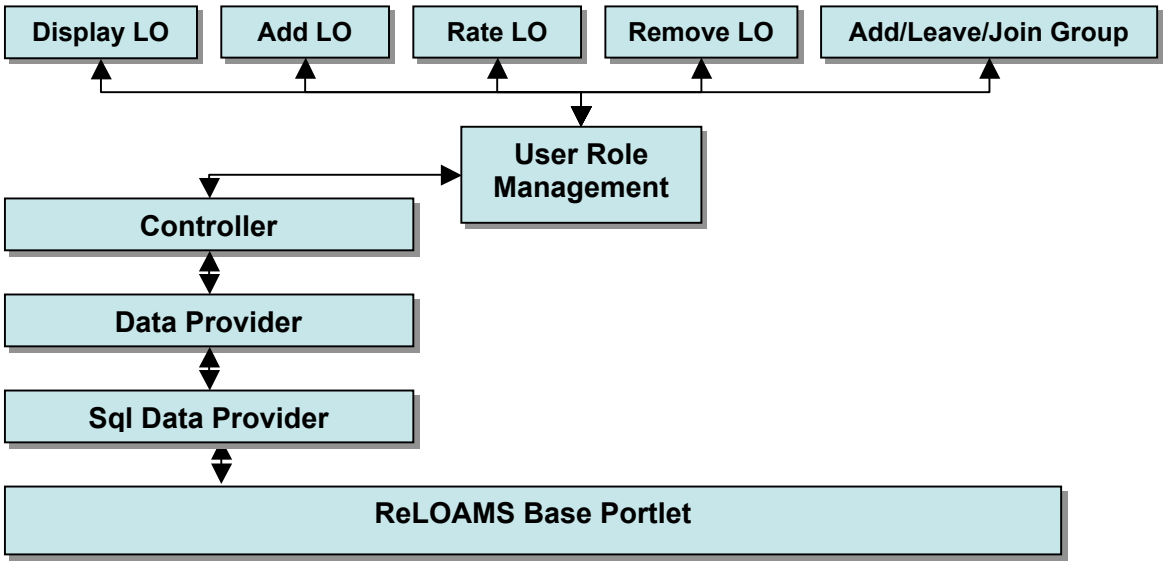

Figure 2: ReLOAMS Collaborative Portlet Architecture

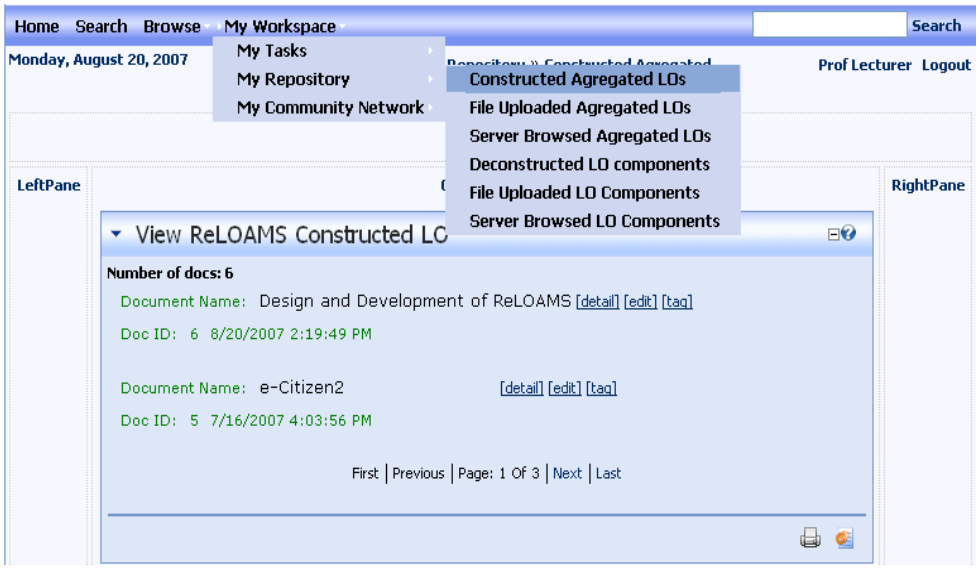

Figure 3: List of constructed aggregated LOs

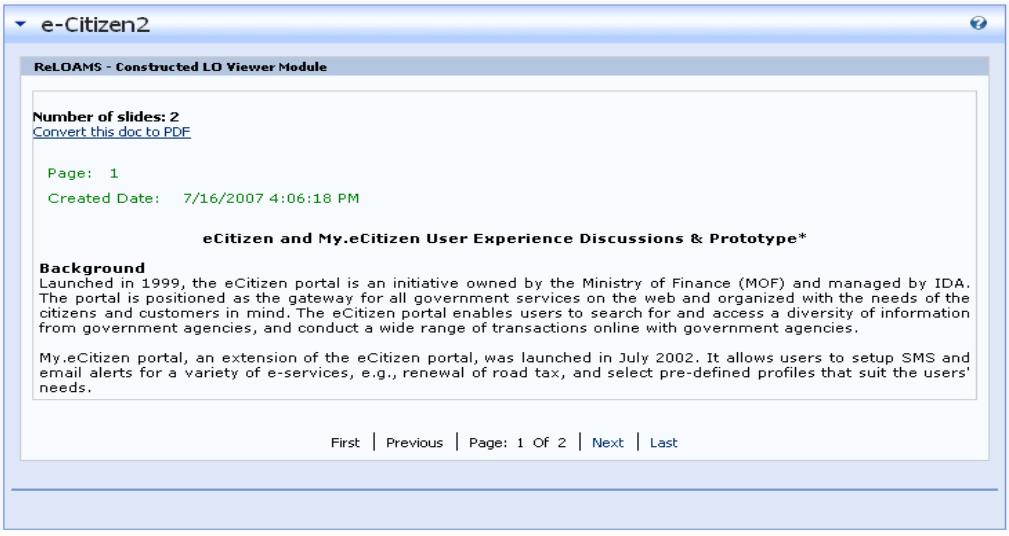

Figure 4: Constructor viewer to show the constructed aggregated LOs

In the Deconstructor module, users can obtain the atomic level of LOs by deconstructing the aggregated LOs. This prototype provides the ability for users to extract the text and images from aggregated LOs and users are required to tag the 'must-have' metadata element such as the title element, creator element, subject element and format defined by system administrator.

The ReLOAMS Collaborative Workspace has been implemented as a portlet application that can be plugged into the ReLOAMS portal, which includes the presentation layer for adding, displaying and rating LOs based on privileges given to users identified by the roles or groups joined:

- *Adding Learning Object.* The user has to first search for LOs from ReLOAMS in order to add LOs into the group workspace. There are two ways to search from ReLOAMS: (1) searching by keywords; or (2) searching by group keywords. The search results for LOs will be displayed where users are able to read or save the whole document by clicking the URL path. A pagination feature is provided to help users traverse from one page to another by entering the page number in the textbox. To add LOs into the group workspace, users have to click on the checkbox on the right side of the screen accordingly (see Figure 5).

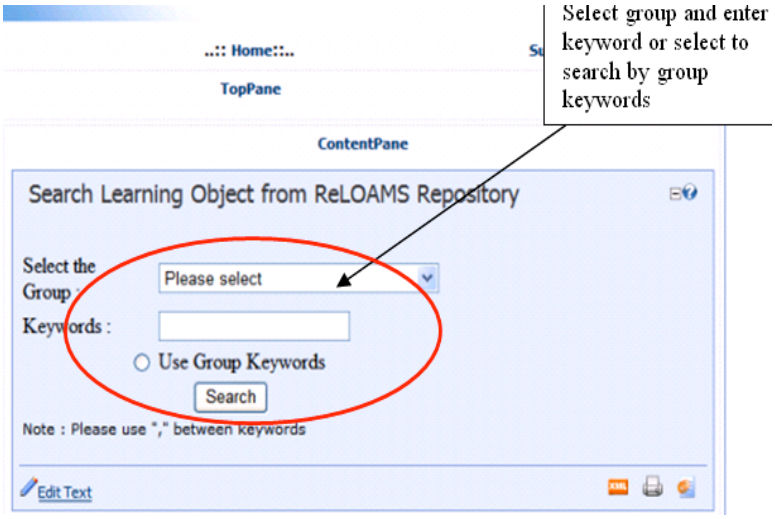

Figure 5: ReLOAMS search LO collaborative module

- *Rating Learning Object.* Before rating the document, users can read the whole document. For qualitative comments, text-entry box is provided, whereas for quantitative feedback, a Likert-scale of 1-5 is used.

- *Displaying Learning Object.* Relevant documents will be displayed according to descending rating score. Reviewers' qualitative comments are also shown under comments column. If a user belongs to more than one group, all relevant documents will be displayed with group identity code (refer to Figure 6).

Related work and discussion

Learning has a context and e-learning needs to take place with the learner in mind where each individual has a unique way of learning and learning styles (Hawryszkiewycz, 2002; Koohang, 2004). Whether in business or in a university, LOs become more meaningful and useful if they are placed in a context. For instance, unlike traditional education in schools and in universities, corporate training exists to improve business performance, and not make employees smarter. The training goals and learning context in business and university environments can be different. Schank (2002) suggested the use of e-learning systems for such training and learning opportunities because e-learning systems and LOs can be developed to simulate the environment that is closest to the real world using scenarios and storylines. Several studies (Hawryszkiewycz, 2002; Muehlenbrock, 2006; Schank, 2002; Vicente, 2005; Watson et al., 2007; etc.) have been proposed to introduce workspaces for groups of learners, and personalise e-learning systems to address these issues of learning contexts and LO reusability. In particular, Hawryszkiewycz (2002) proposed a customisable e-learning portal called Livenet where students form groups, define roles, and add LOs to facilitate learning through interaction and moderation by teachers.

Features such as alert, notification, and setting user profile and views were also suggested as part of the customisation efforts.

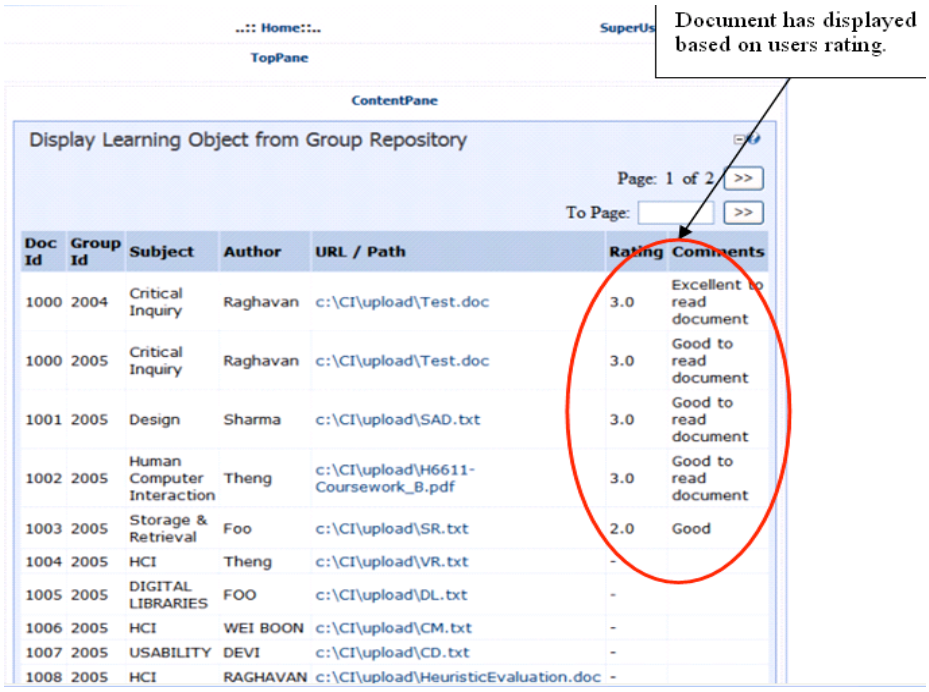

Figure 6: ReLOAMS displaying LO collaborative module

Other than the portal customisation mentioned earlier, the tools and operations that will be useful to manipulate LOs in collaborative model whereby students can exchange LOs from individual workspace to a shared workspace, share the results of past learning activities and learning context, and increasing the reusability of LOs in the process such as (Farrell et al., 2004; Vincente, 2005): (i) assembling LOs in a coherent and logical sequenced learning path; (ii) letting learners drive the assembly of the learning path; (iii) allowing query, search or browse LOs; (iv) editing and manipulating contributions like criticisms, questions and answers against the selected LOs; (v) posting contributions to the shared workspace and notifying other users of the new contribution; and (vii) presenting different views according to the degrees of awareness and roles of the user.

The learner groups formed can be based on learner profile such as class, knowledge, competencies and preferences (Muehlenbrock, 2006). The use of learner profile for group formation can support a wide range of functions in providing peer help, expert tutoring, teacher/tutor supervised learning, or for group problem solving. Other criteria for forming a group can be based on complementary skills, that is, people with same level of experience and knowledge base are grouped to help each other or to work together. An extension of such criteria is to allow a number of people with similar interest to join as an *Interest Group* or to have a number of teachers/tutors, banded together such as an *Expert Group*.

The evaluation of LOs is a relatively new concern. The growing number of LOs and development of new repositories in recent years has generated interest to devise methods to better judge the quality and usefulness of LOs (Kumar et al., 2005; Vargo et al, 2003). While the evaluation of LOs has its origins from evaluating learning materials and courseware, the goals of sharing and reusing differentiate LO evaluation from other evaluation approaches. For example., Vargo et al. (2003) designed a process for the evaluation of LOs known as the Learning Object Review Instrument (LORI), where an evaluator can rate and comment on the quality of the LO. Each quality factor was weighted equally and rated with a five-point scale. LORI can be used by individuals to give ratings or used in a collaborative environment to give group ratings. In both cases, the raters (at least two) should be subject matter experts of the LO concerned so that the ratings given will enhance the sharing and reusability of LOs. Vargo et al. (2003) believed that LORI can reliably assess some quality aspects of LOs after minor refinements. Today, a refined LORI can accessed from Canada's e-Learning Research Assessment Network (eLera), a distributed group that researches and evaluates e-learning that provides tools, information and online learning resources for LO evaluation and research (Nesbit & Li, 2004). The reviewers can evaluate using the refined LORI which has nine dimensions of quality for LOs as: (a) content quality; (b) learning goal

alignment; (c) feedback and adaptation; (d) motivation; (e) presentation design; (f) interaction usability; (g) accessibility; (h) reusability; and (i) standards compliance.

Another example, Educational Resources for Learning and Online Teaching (MERLOT) portal, is the leading LO metadata repository for higher education in the United States of America. Established in 1997, MERLOT provides an online community for faculty, staff, and students from around the world to share their educational materials freely. There are currently more than 44,000 members and over 16,000 LOs. The use of quality ratings is a key element in achieving reusability of LOs in MERLOT (Kumar et al. 2005). LOs which have been highly rated are returned ahead of LOs that have lower ratings or have not been evaluated in MERLOT search results. MERLOT uses a peer review process to evaluate LOs where faculty members are invited by the MERLOT editorial board. Alternatively any faculty member of MERLOT can give also comments about a LO they have just used which includes remarks and ratings. The evaluation criteria used in MERLOT fall into three broad areas: (i) quality of content; (ii) potential effectiveness as a teaching-learning tool; and (iii) ease of use. A five star scale is awarded for each of the three evaluation criteria above. In addition, there is an *Overall Rating* awarded for the LO based on the number of comments, number of personal collections, and number of assignments.

The Custom Course System uses a search engine and LO content and metadata to automatically assemble LOs, and create a generalised course outline. The Custom Course System seems suited to cater to courseware and course outlines for the general audience (Farrell et al., 2004).

In contrast, ReLOAMS Collaborative Learning Object System application uses a search engine to match metadata against keywords entered. The search results are returned with rankings and comments for the LOs. Thereafter, users can decide whether to include these LOs that are of interest to the group, or to make the LOs as part of a courseware. Also, we believe our ReLOAMS Collaborative LO addresses learning context better by providing LOs for selection with quantitative and qualitative ratings. LOs can then be assembled based on the interest of the group, or based on the learning needs of individuals to produce the e-learning courseware. Learning is more personalised as it provides what the learners want to learn. There is also time-saving, as learners need not go through a course that has been rated *low*.

In the area of quality ratings, nine dimensions of the quality of LOs are used in LORI, while MERLOT has at least three types of quality ratings for LOs. Both LORI and MERLOT are using five-point scale for scoring. The extended RELOAMS implementation is a simplification of MERLOT by having an overall rating for LOs based on a five-point scale, and qualitative comments only. It may be worthwhile to consider capturing more dimensions of quantitative ratings so as to better understand the variety of feedback given on the LOs.

Conclusion and on-going work

This is on-going work. In this paper, we describe the ReLOAMS prototype being developed to address the seemingly lack of reusability of LOs in current e-learning systems through shared workspaces (or group workspaces) for learners who have similar learning interests to use, share and rate LOs. The use of evaluation methods, such as rating LOs, to improve reusability of LOs is a new area that will require further investigation. The terminology and classification scheme need to be defined so that ratings can be given in a consistent (and transparent) manner, for instance, a 3-point scale versus 5-point scale, expert versus non-expert raters. These become important when LOs are to be included from several e-learning repositories and databases. Learning standards and specifications such as SCORM and IEEE LOM prescribe consistent implementation of LOs. But this is as far the specifications can go. SCORM and IEEE LOM are inadequate to address the quality of LOs and their reusability. Extensions to the specifications are necessary to address reusability of LOs. However, the SCORM or IEEE LOM specifications are rather lengthy. The approach taken in ReLOAMS is to adopt a subset of the IEEE LOM metadata supported by literature review and existing systems implemented. More studies need to be carried out to adopt an appropriate metadata schema for LOs and the respective taxonomies.

On-going work also involves carrying out preliminary user studies to investigate perceptions on usability and usefulness of ReLOAMS with lecturers, students and library administrators across different schools and disciplines within the university.

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