Implementing a Prototype for Web Based Reusable Learning Objects Frame

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Friday, April 30, 2004

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1. Introduction

This grant project proposed to explore a method of initiating and supporting a collaborative practice of reusable learning objects for any member of the NSU teaching community. This grant project successfully initiated and supported this practice by (1) designing the prototype of a web-based, user-friendly interface to assist any member of the NSU teaching community with creating and depositing a reusable learning object into a campus-wide accessible repository and by (2) developing appropriate metadata to identify, define, and retrieve each reusable learning object. The development of metadata model will followed the specification of IEEE Learning Object Metadata Standard, draft v6.4.

In order to meet these two tasks, this project developed a small, sample set of 4 reusable learning objects (1) that could be accessed by any member of the NSU teaching community teaching a similar course and or (2) that could can be combined with other learning objects to create a new course of instruction or a new instructional activity. Using the term RLO reflects the extent to which technology and computer-based thinking has infused our teaching and learning practices. The term emerged from the object-oriented paradigm of computer science that values the creation of components (called "objects") that can be reused in multiple contexts.

Although the term *RLO* is rarely used by professors, the practice underlying RLO's is commonplace. Unfortunately, the collaborative nature of RLO's has had scant systematic practice on most campuses. As individual professors preparing a course, we often find ourselves searching through our personal computer files for some material (objects) we may have written for a prior semester's class that can be used again in another class by either slight modification or no modification. Not only do we waste time either searching for or re-creating these objects, we rarely have any opportunity to see similar objects other professors have created that may fit the learning needs of students in another courses.

Attempting to practice technology-supported collaboration among the NSU teaching community by placing RLO's in a campus-wide, web-based accessible repository brought us the challenge of developing the specifications for identifying and depositing the RLO's. This grant enabled us to meet this challenge by developing metadata to identify each learning object as well as to develop the prototype for a user friendly interface to assist any member of the NSU teaching community with depositing a RLO into an accessible repository.

Although there have been attempts to create widely accessible repositories by such organizations as the Multimedia Educational Resource for Learning and On-Line Teaching (MERLOT) project, they have not taken care to consistently develop RLO in small enough objects. This grant project specified RLO's as atom-like, digital objects that can be reused or recombined to support learning. One of the definitions given by Academic ADL Co-Lab is as follows:

"*Learning objects [are] self-standing, reusable, discrete pieces of content that meet an instructional objective. Learning objects may be tagged with meta-data so that users can easily identify and locate specific learning objects in a Web-based environment.*"

As more and more faculty make use of WebCT or other web based, digital technologies to support their teaching and enhance student learning, we think the benefits of this project will become obvious. With a repository of well-described RLO's any member of the NSU teaching community can easily access a learning object to incorporate into a course or an instructional activity.

In a traditional classroom environment, course materials are prepared individually as large structures that are difficult to repurpose into searchable and reusable objects. For example, a course could be composed of several lectures, with each lecture composed of many slides in Microsoft Power Point format. For such a course structure, it is quite difficult to identify a particular slide inside a Power Point file that might be used for other lectures or even other courses. Even if the slide is believed to be inside a particular file, the only method of locating this slide is to go through the whole file.

Therefore, course materials prepared in this way cannot fulfill the need for similar knowledge and skills to be taught in such media driven environments as Web based online teaching and learning. We believe RLOs can address this problem.

Reusable objects are quite popular in the fields of human technology and knowledge information management. Other terms used in the industry include:

- Educational objects
- Learning objects
- Content objects
- Training components
- Nuggets
- Chunks

Now, this concept has filtered into the field of education (Bannan-Ritland, Dabbagh & Murphy, K., 2000, Bratina, Hayes & Blumsack, 2002, Martinez, 2001, Sumner, 2002, Wiley, 2001). Some educational researchers argue that the time a professor saves developing already existing material is better spent interacting with students.

Because an important characteristic of the RLOs is that they should be able to be identified, searched, and reorganized easily. The RLOs must therfore be described by metadata in a database driven environment.

The idea of using metadata for the description of objects is not new. In library science and archiving, metadata formats have a solid background in standards of pre-Internet era. Such approaches enable an end-user to search for a stored object by typical publisher provided query fields such as "title", "author", or "year of publication". The Dublin Core Metadata Initiative has been the leading cross-domain metadata initiative since the invention of the Web. It has distilled the key aspects of other larger library-based

metadata schema and removed repository borders offering a user-oriented approach to describe a variety of information objects on the Web by defining a minimal set of essential and extensible descriptors.

However, while this has helped establish a foundation for cross-domain resource discovery, many educational organizations have felt a need to provide more specific information about the objects they create, store, or deliver, and thus offer their vision of metadata for educational resources. In the next section, three problems are identified and addressed.

2. RESEARCH PROBLEMS STATEMENT

Specifically, the following problems exist in the current research of reusable learning objects.

1. Lack of systematic methodology and framework addressing the complete cycle of developing reusable learning objects, from designing, depositing, re-authoring, retrieving reusable learning objects, and eventually delivering new course materials;
2. Lack of a metadata model for seamlessly describing multi-media reusable learning objects for online courses. To ensure and enhance the quality of online teaching and learning, multi-media elements become an essential part of course materials. However, in several existing metadata models, gaps can be identified between metadata that describe reusable learning objects and their presentation method: usually the metadata for reusable learning objects are described by relationships stored in a database, while the major presentation media for delivering online course is an HTML pages. A middle layer has to be implemented in order to transfer the reusable learning object to HTML languages;
3. Lack of integrated software tools designed for instructors without any technical background.
4. Lack of integrating instructional design principles to the creation and use of RLOs.

To address the four problems listed above, a prototype framework for developing reusable learning objects was proposed and developed in this grant. (Figure 1).

The content developer usually is an instructor without much technical background. With a web based Graphic User Interface (GUI), the content developer can identify and manipulate reusable learning objects in the course(s) that s/he is teaching. When a decision to deposit a RLO is made, the depositing function embedded in the software tool will be evoked, and the identified reusable learning object will be wrapped up in an XML-based metadata model, and sent to the repository.

When a content developer needs to develop new course materials by retrieving any RLO, the software tool will help him or her to search and navigate through the repository in order to locate the appropriate objects, and eventually organize these into the presentation method chosen, such as HTML pages.

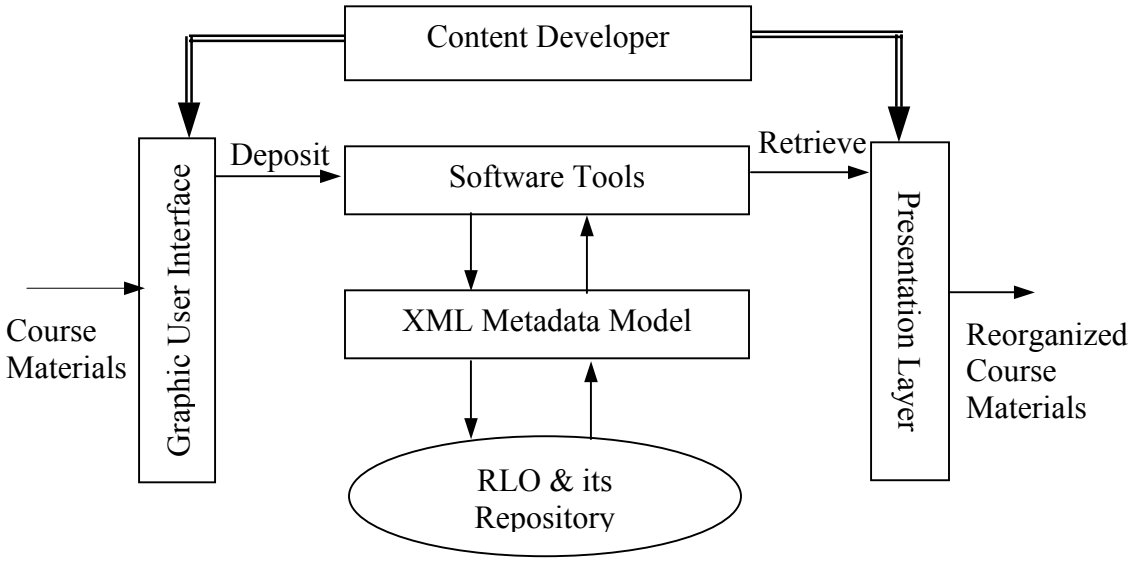

Figure 1. Prototype of a Framework for Developing Reusable Learning Objects

Due to the Bush grant's supporting time line, the objectives of this research project were divided into long-term and short-term goals.

The short-term objective was to refine and finalize, and validate a prototype framework for developing reusable learning objects by applying the developed framework to a limited course set (e.g., MIS 105, Introduction to Computer, ELRN 766, Vector-based Graphic Environments, and EDFN 750, Technology in Education).

The long-term objective was to extend the framework to support cross-domain reusable learning objects, and to develop a repository with a certain amount of RLOs that will support teaching activities for Northern State University.

5. SIGNIFICANCE OF THE RESEARCH

The Internet provides a platform for sharing and disseminating information and knowledge. However, if information and knowledge are not organized well, even with Internet, they cannot be shared. The RLOs resolve this problem by using XML as metadata model. As a general methodology, RLOs can be applied to virtually any course that can be taught online. Specifically it can provide the following benefits to Northern State University:

1. Save time for instructors. The accompanied software tool will provide functions for instructors to locate certain learning objects easily, and use them for future classes.

2. Improve quality of teaching materials. RLOs makes it easier to share the learning objects, therefore, instructors can select the best teaching materials that are available in the repository and use them in their own classes.
3. Improve quality of teaching and learning. With the saved time and improved quality of teaching materials, instructors can focus on interacting with students, and develop new teaching and learning materials. Therefore, the quality of teaching and learning can be improved.

6. Implementing a Prototype

Creating RLOs

The RLOs created in this project are in avi format. The purpose of each clip was to teach students how to operate the Microsoft Office suite. The size of each clip, and its complexity, were determined by the instructor who designed and delivered them, since instructors are considered expertise in their fields. An example of such clip is shown in **Figure 2**.

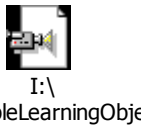

Figure 2 An example of reusable learning objects

Packaging RLOs based on XML model

Although the created RLOs satisfied the definitions for reusable learning objects, in reality it was difficult to reuse. The only identification for this object was its file name. Even a good file name can only describe very limited information about this object. If a user wanted to use some RLOs created by others, first, he/she had to know the existence of such objects; secondly, he/she had to know where objects were stored; finally, he/she might need to know information regarding the copyright of these objects, and how they could be used. All these pieces of information could be described by a single file name. Therefore, before a RLO can be truly reusable, it has to be packaged.

An XML data model (in **Appendix I**) is developed for this purpose. The model is based on SCORM. Naturally it is SCORM compatible. A web interface is built for the ease of inputting information by users. **Figure 3** shows a simple interface that has links to various functions of the developed RLO management system. When a user is ready to input a new RLO, he/she can click the link of "Deposit a RLO", and will be lead to another interface, shown in **Figure 4**. Since the XML model is for general usage, it tries to define every kind of information that is necessary for every user. When it comes to an individual user, he/she may not need to define them all. In this research, for example, necessary items that have to be defined include the file name, its relative path, keywords.

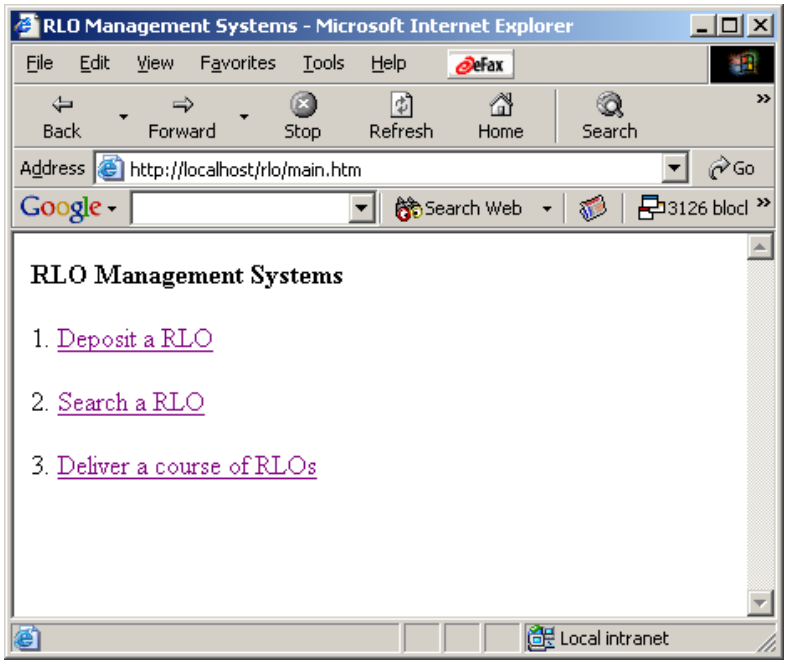

Figure 3 Interface for Web Based RLO Management System

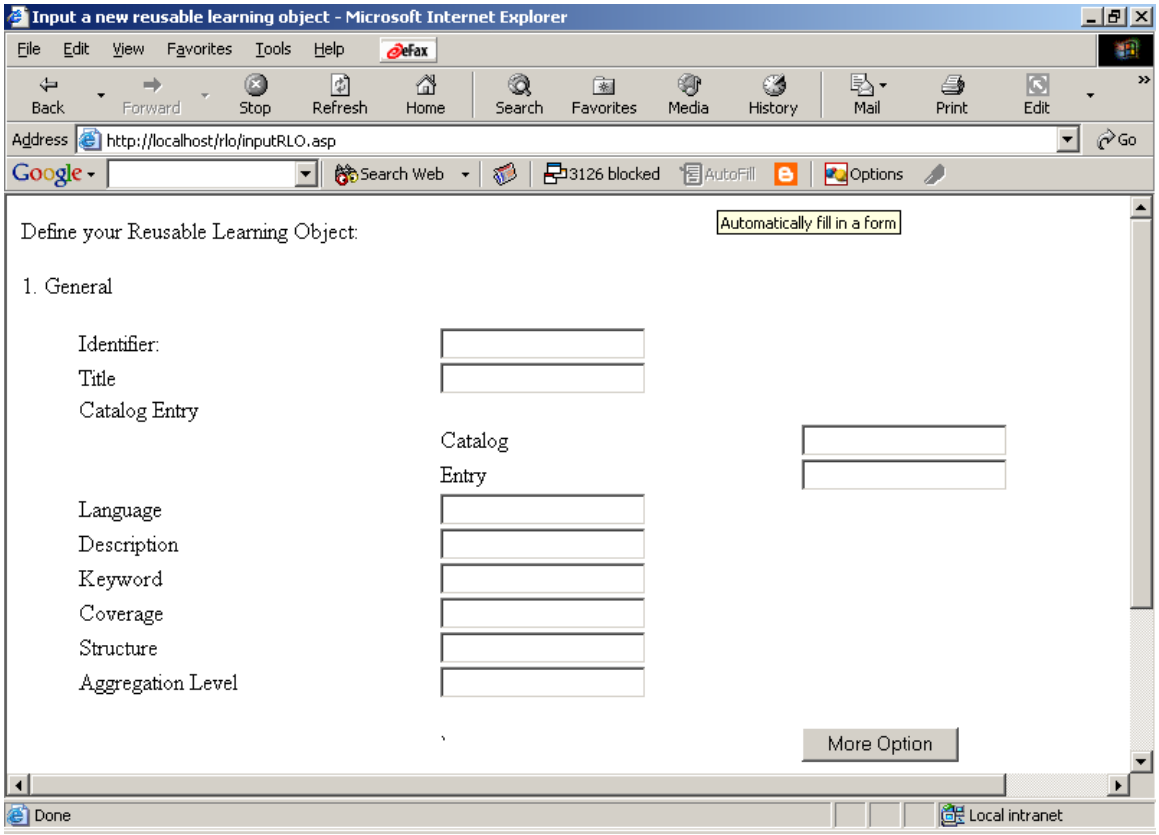

Figure 4. The Form Designed to Accept User Input about the RLO

Searching RLOs

A simple function for searching was implemented in the RLO management to demonstrate the effectiveness of packaging the RLOs using XML. By inputting different keywords, a series of RLOs that match those keywords can be retrieved.

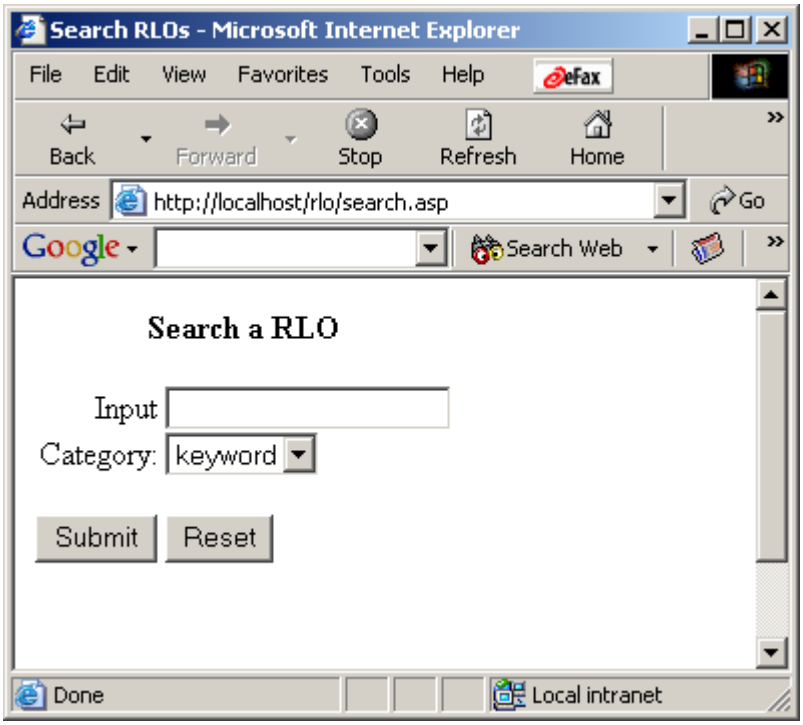

Figure 5 An Interface for Searching a RLO

Delivery Course of RLOs

When an instructor plans to deliver a course, he/she must think about the learning style of students. With developed RLOs, it becomes possible technologically feasible to concurrently support different learning styles. What an instructor needs to do is to specify the learning style the instructor thinks will fit the targeted audience (Chen, J. et al, 2004). Two simple examples implementing linear sequence and linear sequence with control are shown **Figure 6**

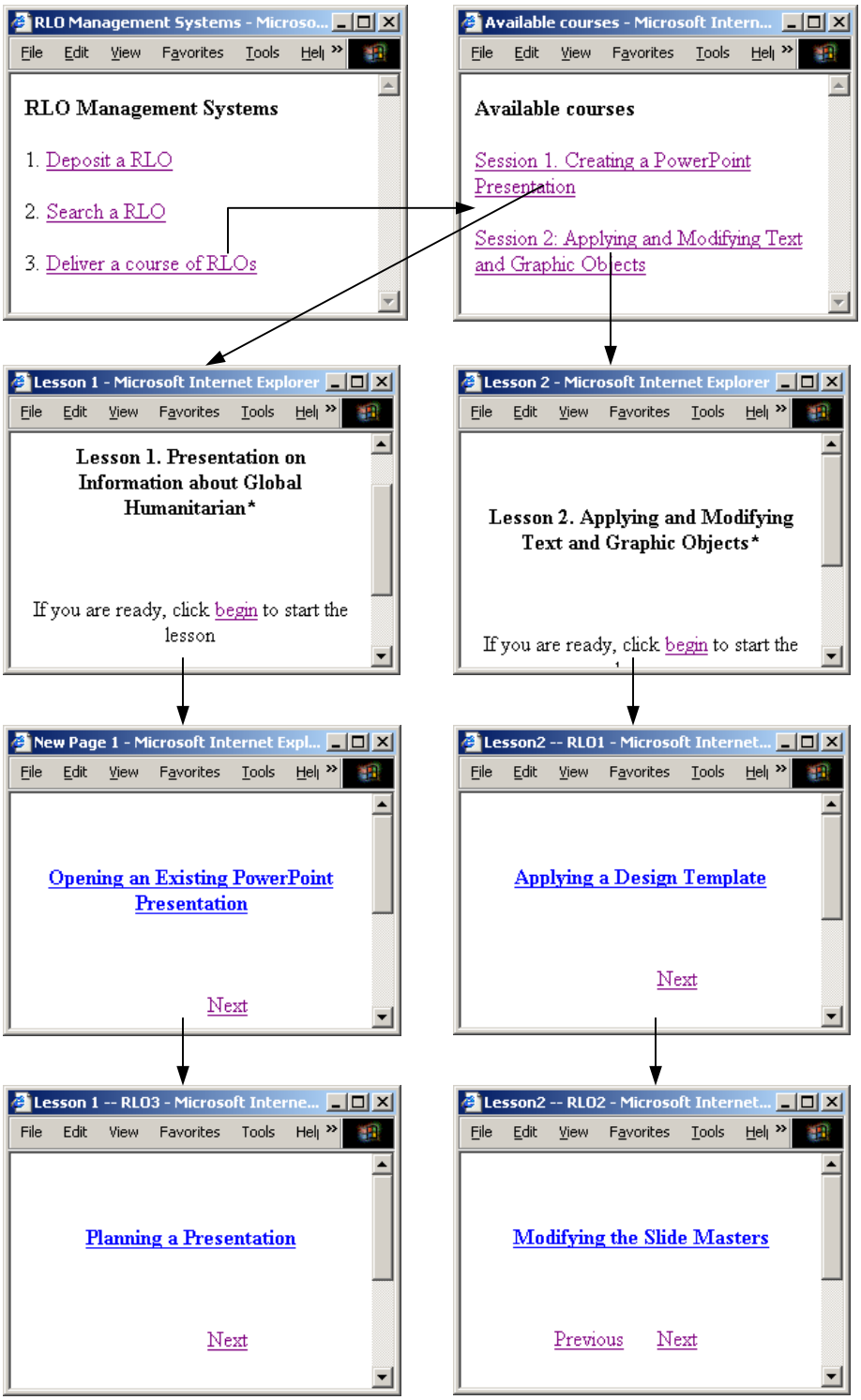

Figure 6. Lessons Composed of RLOs are delivered in Linear Sequence and Linear Sequence with Control

7. RESEARCH METHODOLOGY

To validate the effectiveness and usefulness of the developed metadata model and the associated software tool, three experiments were designed. The subjects of these three experiments were instructors and students from the following three courses: MIS105, Introduction to Computer (2 sessions given by Prof. Zhang), ELRN 766 Vector-based Graphic Environments, and EDFN 750, Technology in Education.

Experiment 1 investigated the instructor's satisfaction level of using the developed software tool. It had two main components: 1. a survey filled by each participating faculty member to measure his or her satisfaction level to the developed software tool. 2. Comparison and statistical analysis of the time spent preparing for course using the software and that not using the software. The research hypotheses in this experiment were:
H_0: The satisfaction level of faculty members is higher in the case that they use the software than that when they do not use the software.
H_a: The time each faculty member spent preparing for course is less with the assistance of the software than that without the assistance of software.

Experiment 2 was to validate the students' satisfaction level of using the course materials developed by using the software tool and metadata model. The research hypothesis for this experiment was:
H_0: The satisfaction level of students using course materials developed with the assistance of the software tool is equal or higher than that of students using course materials without the assistance of the software tool.
H_a: The satisfaction level of students using course materials developed with the assistance of the software is lower than that of students using traditional course materials.

Experiment 3 was to investigate the relationship between the time spend using the software tool and the satisfaction level for each instructor. The research hypothesis was:
H_0: The satisfaction level of faculty members is equal or higher when they are more familiar with the software.
H_a: The satisfaction level of faculty members is lower when they are more familiar with the software.

In this experiment, the familiarity degree was measured based on the time that each faculty member expended on the software. The research assumption underlined is that the more time they spent on the software tool, the more familiar they would be with the tool.

Due to low class enrollments, experiments 1 and 3 were not conducted. Experiment 2 was replaced with an attitude survey in MIS 105. The survey was listed in

Appendix **II**, and the results are listed in **Error! Reference source not found.**, and are discussed in section 8.

8. BUSH GRANT OBJECTIVE ADDRESSED

There are seven assessment objectives for the Bush grant:

1. Comparison of Student performance on course exams.
2. Mean scores on ACT-CAAP proficiency tests given to all sophomore students.
3. Mean student GPA.
4. Comparative level of student attendance and classroom participation.
5. Change in institutional retention rates.
6. Student performance on program assessment instruments.
7. Student responses to attitude surveys.

The addressed Bush grant objective is No. 7, student responses to attitude surveys. Total there are 21 students participated the experiment, and completed the survey. The survey results are listed in Table 1.

Question	Positive Response*
The RLO was easy to use	85.71%
The RLO was interesting and engaging	57.14%
The RLO integrated well with the module and other teaching sessions	85.71%
The RLO was well structured and easy to follow	90.48%
The images and animations were valuable components of the RLO	90.48%
I needed more support when using the RLO	14.29%
The RLO has aided my understanding and I feel I have achieved the learning objective	75.00%
The RLO has aided my understanding	80.95%
The RLO was pitched at the right level for me	71.43%
The RLO encouraged me to reflect on the material	57.14%
I will use this RLO again	71.43%

Table 1. Results of Student Attitude Survey
*Positive Response refers to “Strongly agree” or “Agree”

From the data presented in Table 1, it can be concluded that most of students found that RLOs were easy to use; integrated well with other teaching materials; no support was needed; and the RLOs could help their understanding of the course material. Students agreed less on the question asking if RLOs were more engaging and encouraging to their learning process. These results could be partially attributed to the fact that the contents are not challenging enough. Another reason could be that no RLOs of assessment were developed and included in the lessons.

By incorporating reusable learning objects into course materials, and presenting these learning objects in different learning styles, positive impact of this research can be identified, or expected: instructors will save precious time preparing a class, and students will be able to work with the learning style that best fits their needs.

9. DISSEMINATION OF RESEARCH RESULTS

The deliverables for this research were:

1. A repository with a handful of reusable learning objects, and course materials derived from them;
2. The development of a prototype of software tools that automate the depositing and retrieving of reusable learning objects, including a GUI.
3. A paper (Chen, J., et al. 2004) was published. Another paper derived from this paper is under work.

10. BUDGET EXCUTION SUMMERY

		AMOUNT REQUESTED
Salaries and Wages:		
Project Directors:		
Dr. Jianhao Chen:	25 Hours @ $65 / Hour	$1,625
Mr. Joel McKinney:	25 Hours @ $65 / Hour	$1,625
Dr. Salley Sawyer:	25 Hours @ $65 / Hour	$1,625
Dr. Lu Zhang:	20 Hours @ $65 / Hours	$1,300
Total:		**$6175**
Associate Researcher(s)		
Fringe Benefits: (13.80% for NSU and other state employees)		$852.15
Student Labor: ($10 per hour; maximum of $920 per student)		
2 student researchers: Not used		$1840
Contractual: (Outside Consultants)		
Honorarium		
Travel		
Per Diem		
Travel: (May not exceed $1000)		
Supplies and Materials:		

Total Grant Request (May not exceed $9,000)	**$8,867.15**

Appendix

Appendix I XML model based on SCORM

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Appendix II Survey Questions

RLO Student Evaluation

Please answer all the questions by marking the category which best reflects your view.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The RLO was easy to use	1	2	3	4	5
The RLO was interesting and engaging	1	2	3	4	5
The RLO integrated well with the module and other teaching sessions	1	2	3	4	5
The RLO was well structured and easy to follow	1	2	3	4	5
The images and animations were valuable components of the RLO	1	2	3	4	5
I needed more support when using the RLO	1	2	3	4	5
The RLO has aided my understanding and I feel I have achieved the learning objective	1	2	3	4	5
The RLO has aided my understanding	1	2	3	4	5
The RLO was pitched at the right level for me	1	2	3	4	5
The RLO encouraged me to reflect on the material	1	2	3	4	5
I will use this RLO again	1	2	3	4	5

Open-ended comments

What did you like about this RLO?

How could this RLO be improved?

Thank you for taking the time to complete this questionnaire

Reference:

Bannan-Ritland, B., Dabbagh, N. & Murphy, K., 2000. Learning object systems as constructivist learning environments: Related assumptions, theories, and applications. In D. A. Wiley (Ed.), *The Instructional Use of Learning Objects: Online Version*. Retrieved from http://reusability.org/read/chapters/bannan-ritland.doc

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Sumner, T., 2002. Creating reusable educational components: Lessons from DLESE. *Journal of Geoscience Education*, 50 (1) 25-30.

Wiley, D., 2001. Peer-to-Peer and Learning Objects: The New Potential for Collaborative Constructivist Learning Online. *Proceedings IEEE International Conference on Advanced Learning Technology: Issues, Achievements and Challenges*, 6-8 August 2001. IEEE Computer Society, 494-498.