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Factors Affecting the Development and Use of Learning Objects

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This study explored barriers and facilitating factors affecting the development and use of learning objects in developing instructional materials and their use in supporting individualized learning. Over a two-month period, students in a graduate-level instructional design course developed instructional materials incorporating learning objects or developed learning objects in selected areas or disciplines. Qualitative analysis was conducted to explore students' experience and examine the skills and knowledge required to develop and use learning objects successfully. Through this analysis, three facilitating factors and nine barriers were identified. The authors conclude that the successful development and use of learning objects will be promoted by overcoming the barriers and strengthening the facilitating factors identified in this study.

Learning objects are often seen as a way to reuse previously developed instructional materials, not only to enhance learning but also as a means to reduce development costs. Most of the literature to date, however, has focused primarily on various technical aspects related to the storage, retrieval, and reuse of learning objects. For example, much has been written about what a learning object is or is not, about issues of granularity or how large or small a learning object should be, and about metadata and how to tag learning objects to assist in locating appropriate ones for the instructional task at hand.

In terms of defining a learning object, many definitions have been proposed. The Learning Technology Standards Committee of the Institute of Electrical and Electronic Engineers (IEEE) in their Learning Objects

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Metadata (LOM) standard document (IEEE 2002) provided an expansive definition of learning objects, defining them as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (1). Wiley (2002) proposed a somewhat narrower definition, defining a learning object as any digital resource that can be reused to support learning. Further refinements to the definition have been added; for example, Sosteric and Hesemeier (2002) included the notion of context, defining a learning object as "a digital file (image, movie, etc.,) intended to be used for pedagogical purposes, which includes, either internally or via association, suggestions on the appropriate context within which to utilize the object" (13). Noting the shortcomings of earlier definitions, Sicilia and García (2003) added two other characteristics: that learning objects are "digital entities," and the requirement of a "metadata record" that describes the potential contexts in which the learning object may be used. Ally (2004) added still another facet to the definition—that of learning outcomes—proposing a more specific definition of learning objects as "any digital resource that can be re-used to achieve a specific learning outcome" (87).

In addition to defining a learning object, several authors have also discussed features of learning objects that need to be considered to design an effective learning tool. For example, Ally (2004) suggested that a learning object should include a prelearning component to prepare the learner for the information, an interaction component to enable the learner to process the materials at a high level, and a postlearning component to check for mastery and allow for practical applications. Longmire (2000) recommended that students should be able to select and customize learning objects based on their needs and learning styles to build a personalized learning sequence. Hamel and Ryan-Jones (2002) advised that learning objects should be able to stand alone as an independent segment of instruction, be independent of instructional context, and use generic information as much as possible. Wiley (2000) noted that users should be able to revise learning objects without affecting other learning objects. Finally, learning objects must be designed so that they can be reused many times without becoming obsolete (Barritt 2002).

In terms of granularity of a learning object, the literature suggests a tension between increasing the educational value of a learning object and maximizing its reusability (Littlejohn 2003). Larger learning objects tend to have high educational value but low reusability because of their size—the finer the granularity, the greater the potential for reusing the learning object in different learning situations. Granularity can be considered in various ways, such

as the amount of instructional time required to complete the learning object, the amount of learning achieved, and the amount of content covered. Attempts have been made to specify what constitutes the optimal granularity of a learning object. For example, Polsani (2003) recommended that granularity be limited to a single concept or a small number of related concepts; Hamel and Ryan-Jones (2002) recommended that the granularity of a learning object be at the level of a single educational objective. Quinn (2000), however, recommended that granularity should be at a level where instructionally different, individualized choices could be made. He claimed that designing learning objects at a fine level of granularity requires a different instructional design approach in which the components of the instructional process are designed separately and for stand-alone use and questioned if this was a good direction for educators to take.

The lack of specificity that characterizes the definition and granularity of learning objects is also evident in tagging and metadata creation. At present, the IEEE's LOM standard is the only officially approved standard for learning object metadata; however, many initiatives have been created to catalogue digital objects and have developed systems or "standards" (e.g., CanCore, SCORM) for their identification and retrieval. Metadata records commonly take one of these alternate formats as they are easier to use or considered more suitable for educational purposes.

Metadata is comprised of domain-specific elements and qualifiers. It functions like an entry or card in a library catalogue and includes searchable "access points" such as title, author, date, location, and subject (Friesen, Roberts, and Fisher 2002). Examples of descriptors in the IEEE LOM metadata model include the contributor role, technical requirements, interactivity type, difficulty, and intended end user, among others (Learning Technology Standards Committee 2002). A comprehensive metadata record enhances the usability of a learning object—the more complete the metadata, the greater the likelihood that the learning object will be found and reused. Hamel and Ryan-Jones (2002) recommend that, to be easily located and ultimately reusable, learning objects should be tagged with metadata that provide descriptive information about the object such as format, size, delivery requirements, authorship, ownership, version number, instructional role, instructional characteristics, and type of interactivity. Quinn (2000) described different categories of educational tags for learning objects. The first category, interactivity type, covers flow of information between resource and user. The second category, learning resource type, describes specific types of resource such as exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, or experiment. Another

category is interactivity level, which may range from very low to very high. Other categories of tags Quinn identified included

> end users (teacher, author, learner, manager), context of use (an open vocabulary, but examples include primary education, secondary, higher education, different university levels, technical schools, etc.), typical age range, difficulty (again, a range from very low to very high), typical learning time, a text description of the resource, and a language choice from the international standard codes. (15)

Far less has been published to date on the actual development or repurposing of learning objects for their use in online or other forms of delivery. In a recent case study, Krauss and Ally (2005) examined the process of designing and evaluating a learning object to help students understand the principles in a course. Their study analyzed and documented the process of designing a learning object and evaluated the outcome of applying instructional design principles for the development of learning objects. Results revealed that the learning object was rated highly in the areas of content quality, learning goal alignment, and motivation; however, interaction, usability, feedback, and adaptation were identified as areas for improvement. In other recent studies, several authors have noted the complexities of developing learning objects. For example, Metros (2005) commented on how technologically challenging it is for faculty to develop quality learning objects. Petrinjak and Graham (2005) noted that transforming existing educational content into learning objects with a semantic structure requires a major effort from educators. Investigating whether or not transferring learning objects from online repositories facilitated course production, Wilhelm and Wilde (2005) concluded that the transfer of certain qualities and features from learning objects to a new course context was difficult, costly, time-consuming, and technically difficult. The results of Wilhelm and Wilde's study underscore the importance of developing learning objects so they can be seamlessly integrated into existing and new courses. Another recent study exploring the reuse or repurposing of learning objects (Koppi, Bogle, and Bogle 2005) found that learning objects appear to work better in certain subject domains, such as the sciences, and noted that repositories are populated with learning objects in these disciplines. The authors suggested that the lack of development and use of learning objects in other domains, such as the arts and social sciences, might be attributed to the difficulty of defining content into specific segments in the development of learning objects in these disciplines.

The purpose of this study was to identify barriers and facilitating factors that affect the development or repurposing of learning objects for instructional purposes, thereby adding to our understanding of the issues and processes for developing quality learning objects.

Method

The study involved twenty-seven graduate students enrolled in the Masters of Distance Education (MDE) program at Athabasca University. All were senior-level students, having completed at least four previous courses in the program. Most were employed in the teaching or training sector. Many had extensive experience as a teacher or instructor; however, few had previous experience in the design and development of distance education materials, particularly Web-based instructional materials.

Students were registered in the master's level course, MDDE 604: Instructional Design and Program Evaluation in Distance Education. In this project-based course, students progress in a stepwise fashion, applying the instructional systems design process. Over a two-month period, participants engaged in the analysis, design, and development phases of the instructional systems design process, either developing a learning object or integrating one or more learning objects into an instructional unit.

Students had the choice of either developing a new Web-based learning object or developing an instructional unit (in a sense, a larger or higher level learning object), which contained one or more existing learning objects. In the former case, students were advised to aim for a medium level of granularity, developing an object that comprised about twenty to twenty-five screens of material, which would take learners about fifteen to thirty minutes to complete. In the latter case, students were advised that their learning materials should comprise about twenty pages of print in a paper-based format, which would take learners approximately one hour to complete. Regardless of their choice, all materials developed were required to be in digital format, that is, able to be accessed via a computer or the Internet. On completion of the project, students were encouraged, but not required, to complete a metadata record for their learning object and to enter it into the Athabasca Digital Library (ADLIB) learning object repository.

Students were asked to keep a learning journal to record and reflect on the process and experience of using learning objects to produce instruction. Then, as part of their course assignments, they were required to write a four- to six-page essay discussing their experience with learning objects and the barriers or problems they encountered, as well as any resources that

facilitated the process. They were instructed to integrate excerpts from their learning journal into their essays. These essays, which formed part of the data analyzed in this study, were submitted to the instructor for grading and feedback at the same time as their learning objects or instructional units were submitted. In preparation for data analysis, essays were cut and pasted into a separate file, and any identifying information was removed.

While students were working on their assignments, an asynchronous computer conference on the topic of learning objects was conducted. The conference topic was stated as follows:

> What are the key things to remember when you are using learning objects to create instructional materials? In your search for learning objects, what helpful resources did you find? What particularly good examples of learning objects have you found? What difficulties or barriers have you encountered?

Once the course was completed, a transcript of the conference postings was obtained and redacted, that is, identifying information was removed to ensure the anonymity of participants. The redacted transcript formed part of the data analyzed in this study.

Data Collection and Analysis

As noted previously, two forms of data were analyzed. They were comprised of the following:

1. Essays discussing the students' experiences in their development and use of learning objects. These essays included excerpts from students' learning journals but not the actual journals themselves.
2. A transcript of students' conference postings and responses.

Two researchers independently analyzed the essay and transcript data using manual and open coding techniques to identify common themes. Units of analysis were as follows:

1. Individual postings, in the case of the conference postings.
2. Excerpted paragraphs, for the essays.

Although there was marked agreement between the two researchers regarding the categories into which conference postings or paragraphs from

the essay assignments should be assigned, there were occasional areas of difference. In these circumstances, differences were discussed until consensus was reached as to the category in which the particular posting or paragraph in question belonged.

Data also included the students' instructional products themselves. These were categorized according to subject area and whether the student had developed a stand-alone learning object or an instructional unit that incorporated existing learning objects. Given the straightforward nature of the task, one researcher completed this categorization.

Results and Discussion

Students developed a total of twenty-seven learning objects in a variety of disciplines. The topics of the learning objects were categorized into four major areas: postsecondary education (primarily the college sector), K–12 (elementary, junior high, and senior high school levels), workplace learning (primarily corporate training, but also including the public service and the military training sector), and health education. Topics are presented in Table 1.

Of the twenty-seven assignments submitted, eight involved the creation of new learning objects. The remaining nineteen assignments were presented in the form of a study guide (or higher level learning object), which included one or more existing learning objects.

Facilitating Factors

In the analysis of conference postings and essay assignments, comparatively few factors facilitating the development and/or use of learning objects were identified. Based on the analysis, facilitating factors took three main forms: stand-alone exemplars of good learning objects, recommended Web sites containing skill-related information, and evaluation-related resources suggesting how to assess instructional materials.

Exemplars. Good examples of learning objects were identified as models that students could emulate or as indicators of how a high-quality learning object should appear.

Students visited repositories, most for the first time, and were generally excited by what they found. Several reported how they had spent hours searching the sites and completing the activities of some of the outstanding objects. The repositories listed here were repeatedly cited as excellent sources of learning objects:

Table 1. Topics of Learning Objects

Postsecondary Education	K–12	Workplace Learning	Health Education
Art—elements of design	*Language arts—genres*	*Excel spreadsheets*	*Preparation for CT-scanning*
Writing composition	*Mechanics of writing*	Using mail merge	Chronic disease management
Mechanics of writing	Mathematics (2 projects)	Travel claims	Nursing process
Learning theories	*Our planet earth*	Sales techniques	Transport nursing
Instructional design (2 projects)	Understanding free trade	NATO operations planning process	
Music theory		*Fire fighters breathing apparatus*	
Anatomy and physiology		Student loans	
Child development		Using Dreamweaver	
2 new learning objects	3 new learning objects	2 new learning objects	1 new learning object
7 used existing learning objects	3 used existing learning objects	6 used existing learning objects	3 used existing learning objects

Note. Topics in italics indicate new learning objects.

- MERLOT (http://www.merlot.ca) learning repository.
- Portal for Online Objects in Learning (POOL) (http://www.edusplash.net)—a resource developed by Simon Fraser University.
- Campus Alberta Repository of Education Objects (CAREO) (http://careo.ucalgary.ca).
- Learn Alberta (http://www.learnalberta.ca—Use login "guest" and password "guest" to access). This site was identified as an excellent source of learning objects for K–12.
- University of Wisconsin's Online Resource Center (http://www.wisc-online.com).
- Good examples of learning objects on literature were noted at the Web site http://vccslitonline.cc.va.us.
- The Web site http://telus2learn.com was identified as containing "great LOs related to the K–12 Alberta curriculum. The nice part is that this site was developed by a group of teachers."

- The Owl & Mouse Educational Software site (http://www.yourchildlearns.com/owlmouse.htm) was identified as a source of individual interactive activities that could be integrated into lessons.

Online resources. Online resources were another facilitating factor identified in the analysis of conference postings and essay assignments. These were recommended Web sites containing information to assist with learning object design and development. For example, URLs that provided direction in the following areas were identified:

- How to use Dreamweaver.
- How to assess literacy levels of textual materials.

Several resources were cited as good resources providing information on how to develop learning objects themselves. Some of these resources are listed here:

- One useful informational resource was "The Instructional Use of Learning objects" (http://www.reusability.org).
- Another resource, "Learning Objects 101: A Primer for Neophytes" (http://online.bcit.ca/sidebars/02november/inside-out-1.htm), by Glenn Millar (a former MDE student), was identified by numerous students as a practical guide for constructing learning objects.
- For the development of technical skills, W3Schools (http://www.w3schools.com) was identified as an excellent source of free online tutorials for technical training (e.g., use of html, xhtml, cascading style sheets).

Evaluation assistance. Another facilitating factor was the availability of resources to assist with the evaluation of learning objects to determine their suitability for use. The peer evaluation component of repositories, such as the MERLOT repository, was identified as an asset in this regard. So too was the Learning Object Analysis Sheet (http://www.alivetek.com/learningobjects); several students reported that they used this tool to assess various learning objects to determine which one(s) to use in their instructional unit.

Barriers

Far more categories of barriers than facilitating factors were identified. The analysis revealed numerous barriers to the development and use of learning objects. These barriers were wide-ranging, involving nine major categories. These categories are presented in the following sections.

Definitional. The initial barrier that most students faced was to determine a precise definition for the term *learning object.* The plethora of associated terms—knowledge object, educational object, information object, and so forth—made students wonder if they were on the right track in developing or using something that would truly meet the requirements of a learning object.

Moreover, the variation among definitions and the variety of critical characteristics of what constituted a learning object created great debate. The requirement for metadata or a digital format was questioned. Are learning objects found only in repositories, or may they be found in other sources? Is metadata a requirement for something to be considered a learning object? Is digital format a requirement? As one student pointed out in the computer conference, "a book online is a learning object, whereas a book in a library is not." The excerpted entries from their learning journals included in students' essay assignments confirmed the confusion that nearly all of the students experienced in this regard. Still another student remarked in an analysis of the learning journal entries, "I was becoming increasingly concerned that the two learning objects I intended to use to develop my unit on *** were not actually LOs. They were not tagged with metadata. I had not found them in a repository, but in a website."

For the purposes of this study, Ally's (2004) definition of a learning object was adopted—"a digital resource that can be re-used to achieve a specific learning outcome" (87)—as students were created new learning objects or used existing learning objects in the development of instructional materials designed to produce a learning outcome. For pedagogical reasons, the definition proposed by Sicilia and García (2003) was considered too restrictive due to its requirement for metadata. The rationale for this determination was based on two primary reasons: (1) metadata was not a requirement for the learning objects students developed, as the focus of the course was on the application of instructional principles and students were not provided with instruction on how to develop metadata for their learning objects; and (2) without this requirement, a broader array of potential learning objects were available to students for repurposing into their instruc-

tional materials. However, had this requirement been present, students would have been advised to complete the metadata as the learning object was being developed, as Hamel and Ryan-Jones (2002) recommend.

Work involved and skill deficits. The process of developing learning objects was not an easy one, as evidenced by a review of students' postings in the computer conference and essay assignments. A common theme was the amount of work involved in creating a learning object or using learning objects in the design of flexible instructional materials. One student commented, "Although it is somewhat 'easier' to reuse something that exists, rather than building it from the ground up, the exercise of repurposing the learning object can be challenging. It is similar to some of the home renovation shows. The contractors comment that it would have been easier to level the house and start over rather than incorporating an addition into the current structure."

Another prevalent theme in the postings and journal entries was the difficulty students were experiencing in the application of instructional design principles to the development of their learning objects. All of the students had been introduced to instructional design theories and concepts in a prerequisite course, but few had previously applied the instructional design process even though many students had extensive experience in educational settings. Many comments were also made about the difficulty of translating classroom techniques to online learning. Other more specific instructional design skills were also mentioned, such as how to accommodate learning styles. Still another barrier was "limited technological prowess," as one student termed it.

Another theme was the difficulty that many students experienced in moving from classroom-based instruction to that of individualized self-instructional materials. The attempt to translate in-class teaching techniques to the online environment was clearly a stretch for many students as evidenced by the postings they made in the computer conference. However, over time, students appeared to realize the unique benefits of online learning. Indeed, as one student commented about the debate waging over how to translate in-class teaching to learning object design, "[faculty] infer that they would like their online students to have the same opportunity as their face-to-face students, I want my face-to-face students to have the same opportunity as my online students."

Although it can be argued that the skills required for developing new learning objects differ from those required for repurposing existing objects or aggregating them into a learning module, there are nonetheless common

skills as well. Both require the application of instructional design principles, such as identifying learning outcomes, determining an appropriate instructional strategy based on the cognitive level of the learning outcomes, incorporating interaction to promote active learning, and ensuring that suitable and adequate assessment is in place. Primarily the additional skills required for the development of new learning objects involved technical skills related to Web page design and programming.

Structure of repositories. Some students reported difficulty navigating the repositories and locating learning objects within it. For instance, MERLOT was described as a "maze." Another found the visual organization and layout to be cluttered and busy. Broken links were noted as a difficulty in accessing learning objects.

Lack of learning objects in some disciplines. Another barrier identified was a lack of learning objects in certain disciplines or for some objectives. Although it was acknowledged that learning objects are new and the development of repositories is in its infancy, the willingness to use learning objects in developing instructional materials was hampered by this factor. Time and resources are required to stock repositories with a sufficient inventory of learning objects in less popular areas.

Quality of learning objects in repositories. Lack of visual design quality was identified as a barrier affecting the use of learning objects. Poor formatting was noted; for example, one student said, "Some of these materials looked like they were created with an old typewriter and a Gestetner," but further noted, "Taking the time to input and correct errors will pay off for someone in the long run."

Lack of instructional content was another barrier cited. One student noted, "In surveying many websites, there is little content associated with the look and feel of instruction." Another noted that some learning objects are "flashy, but don't teach." One student advised the following:

> When searching for a learning object for the unit on ****, it was easy to be lured by LOs that were flashy, colorful and visually appealing. The issue that arose was trying to keep the LO in perspective and remembering that learning was the goal in choosing an appropriate learning object. A learning object that is cool and fun may have little instructional value, and so it is important to keep the learning objective at the forefront when choosing a LO.

Granularity. The size of the learning object was identified as a concern. Students noted that some learning objects were extremely small, for example, a photo or table of figures. On the other hand, some were so large that they could not easily be integrated into a lesson. With regard to the size of the objects they were developing, students were not sure what constituted a "medium level" of granularity. More precise definition is required in this area.

Metatagging and cataloguing in repositories. One of the major reasons for developing learning objects is their ability to be reused (Sicilia and García 2003). Proper tagging or cataloguing is required for learners, instructors, and instructional designers to easily locate and retrieve learning objects from the repositories in which they are housed. Although there are many implementations of the IEEE LOM standard, there is no consensus on the content of metadata or the form in which it should be represented. When students in this study raised questions about which system of metatagging was best to use, they were advised to use CanCore due to its ease of use and also because CanCore was the format used in the ADLIB learning object repository.

Despite encouragement to the class to complete the metadata for their learning objects (this was an optional activity), only one student developed metadata for her learning object. She attempted to enter the learning object and metadata into the learning object repository but was not able to log on properly or download the learning object. Unfortunately, none of the learning objects designed in the course were entered into a learning object repository—a significant loss of learning excellence!

Copyright and intellectual property. Copyright was a frequently mentioned concern. Some students noted that because they were working on a course assignment, copyright was not so important ("fair dealing for the purpose of research or private study"). However, if they were going to use their learning materials beyond the course, copyright would have to be addressed. Other related concerns were deep linking (i.e., linking to a part of a Web site beyond the home page) and ownership of the materials. Two students commented that their learning objects were to be used only in their organizations and therefore were not public property.

Attitudinal barriers. Attitudinal barriers was the final category of factors identified from the analysis of conference postings and essay assignments. Based on this analysis, factors tended to fall in two areas. One was a

reluctance or unwillingness to share—a sort of proprietary feeling or possessiveness on the part of the author. For example, as one student noted, "In my heart of hearts I want to share and collaborate. But the skeptic in me makes me wonder who is making money off me?" The second appeared to be a lack of confidence. For example, some expressed concern that no one would find his or her learning object useful; others were embarrassed over the quality of the learning object they had created, feeling it was not refined enough to be put into the repository. This observation is further supported by the fact that when students were given the opportunity to enter their learning object into ADLIB, the learning object repository at Athabasca University, none of them did so.

Nonetheless, the benefit of using learning objects was clearly evident in students' postings and essay assignments. One student commented on the reusability of learning objects, providing a rationale for developing a video-based learning object as follows: "[Building a learning object is] like buying a pair of shoes you can wear to many functions. … Using the basic economic principle of economies of scale, the more use that you can get out of an object, the more that you are willing to spend to develop or buy it."

Similarly, the value of learning objects was clearly understood and appreciated by the class in general, as evidenced by one student who summed up the future of learning objects as follows:

> The vision is bold, exciting, and daunting. It implies collaboration rather than competition and a pooling and sharing of common knowledge and learning tools for the benefit of learners and societies. Rather than isolated educators creating and recreating content, these individuals and learners can come to a central hub where like-minded colleagues build and maintain LOs that facilitate learning. In a world where nations have limited resources yet have entire populations requiring life-long education and training, this translates into an accessible, cost effective, and efficient use of learning resources.

Conclusions and Recommendations

This study explored the experience of student educators in their attempts to develop or use learning objects within the context of a graduate-level course on instructional design. Factors were identified that supported or facilitated the development and use of learning objects, as well as factors that tended to hinder or inhibit their use. To promote the successful develop-

ment and use of learning objects, facilitating factors need to be supported and sustained and barriers reduced or overcome.

The approach of looking at barriers and facilitating factors has its derivation in the behavioral sciences and Lewin's (1951) Force Field model. This theory postulates that people function in a relative equilibrium, in a balance between positive and negative forces. Removing negative forces, instead of or in addition to adding positive forces, can help promote change. In terms of promoting change, therefore, further consideration of the barriers and facilitating factors identified in this study shows that factors can be categorized into three separate categories:

1. Organizational factors—those within the context of educational institutions, such as factors pertaining to professional development and faculty support, as well as the creation of an organizational culture that promotes the development and use of learning objects.
2. Learning object-related factors—those pertaining to learning objects themselves and the structure of repositories.
3. Theoretical factors—those pertaining to theory-related factors that affected learning object development and use.

Within the context of educational organizations, much can be done to facilitate the development and use of learning objects. Barriers pertaining to lack of time and skill deficits need to be addressed. Professional development to support the enhancement of knowledge and skills relating to the development and use of learning objects is required. Providing educators with appropriate development tools and resources will also facilitate the development and use of learning objects.

In addition to providing training and tools, organizations should provide recognition for learning object development. Recognition of learning objects development as a valid academic achievement is required. Educators involved in the development of learning objects appear to be experiencing similar difficulties to those involved in the development of distance courses, in which faculty are often not recognized for course development in performance assessment and promotion. Learning objects are even less understood and are even more likely to be unrecognized. Greater recognition of learning object development as a legitimate academic activity would facilitate the production of learning objects and assist with populating repositories.

Factors pertaining to learning objects and learning object repositories need to be addressed. Better ways of identifying superior learning objects

are required. Peer review and methods of evaluating learning objects are needed. Although the students in this study identified existing evaluation-related resources as a facilitating factor, more are needed in this area.

The instructional design of learning objects is also a consideration. Pedagogically sound learning strategies, in which learning is the outcome, should provide underpinnings to support the development and use of learning objects. It is important to develop sound instructional design models for teachers and instructors who do not have the instructional design training to develop quality learning objects.

Lack of consensus on how to tag or catalogue learning objects is another problem to be addressed. Several systems for tagging learning objects have been proposed. Most conform to the IEEE LOM standard (IEEE 2002); however, the system proposed by the IMS Global Consortium (http://www.imsglobal.org) provides a larger, more comprehensive collection of specifications. One of the simplest systems is the CanCore profiling system, which consists of eight main categories, fifteen subcategories, and thirty-six elements. CanCore is a subset of the IEEE LOM standard (which includes seventy-six data elements) and is easier to implement, making it more suitable for educators (Friesen, Roberts, and Fisher 2002).

Ideally, there should be one agreed-on standard for metadata and the fields to be specified. Moreover, to complete the specified fields in a consistent manner, a dictionary or lexicon of terms is required to describe the content of the learning object. Such standardization of descriptors will help to alleviate difficulty in locating appropriate learning objects to integrate into instructional materials. More involvement of educators in the development and revision of learning objects standards is also required as they are familiar with the learning process and are the ones using the learning objects when developing instruction and interacting with learners.

Finally, repositories themselves need to be designed to be user friendly and organized with the neophyte user in mind. Finding and accessing learning objects should not interfere with the instructional design process. It is important that educators use their time and energy developing instructional materials rather than locating learning objects. Moreover, when users experience difficulty using a repository, it may result in frustration and reduce their motivation to access and incorporate learning objects in their future instructional activities.

The third category of barriers affecting the development and use of learning objects relates to the discipline itself. The abundance of definitions, some of them so broad as to be unusable, creates confusion. The plethora of terms—learning object, knowledge object, information object,

instructional object, course work object—reflects the need for a more precise definition of learning object. This lack of definitional precision and of theoretical groundwork is perhaps the most pressing problem facing the development and use of learning objects.

Recommendations for Further Research

Further research is required into the issues affecting the development and use of learning objects as well as the processes involved in creating quality learning objects. Based on the findings of this study, the research described in the following is recommended:

1. The relatively small sample size of this study (twenty-seven subjects) is recognized as a limitation. Further research with a greater number of participants would serve to confirm the findings of this study.
2. This study used two sources of data: essays discussing students' experience developing and using learning objects and a transcript of the postings and comments in a conference discussion. Further studies using additional sources of data (e.g., learning journals, interviews) would be useful to determine if additional or different themes may emerge as well as to provide triangulation of the themes identified in this study.
3. This study involved both the development of new learning objects and the retrofitting of existing learning objects into an instructional unit. Further studies should examine these areas individually to determine the specific processes and skills required for each area.
4. Additional areas for further research were also suggested in students' comments. For example, students noted that examples of high-quality learning objects facilitated their process of developing and using learning objects. Determining the characteristics of these exemplars would be worthy of study. Similarly, determining the characteristics of helpful resources for evaluating learning objects is also an area requiring further investigation.
5. Further research using Lewin's (1951) Force Field theory and focusing on change is encouraged, as this theoretical framework may provide a promising perspective for studying ways of promoting learning object development and use.

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