Learning Objects: Resources for Instruction

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OBJECTIVE: Upon completion of this article, the reader will be able to describe learning objects (LOs) and discuss their use in clinical laboratory sciences instruction.

DESIGN: Through a questionnaire, educators evaluated clinical laboratory sciences-related LOs for accessibility, usability and instructional qualities.

SETTING: LOs were presented on a password-accessed website. Evaluations were completed on the website.

PARTICIPANTS: Nine educators participated in the evaluation.

INTERVENTIONS: The LOs were made available to participants for use in their own instructional material.

MAIN OUTCOME MEASURE(S): The evaluation measured educators' interest in and perceived usefulness of LOs in clinical laboratory sciences curriculum.

RESULTS: On a scale of one to five with one equal to poor and five equal to excellent, participants rated LOs as accessible (4.68) and usable (4.61). Ninety-eight percent stated that they would use LOs in their curriculum. Fifty-seven percent stated that they could attribute improved learning performance on student exposure to LOs.

CONCLUSION: LOs are useful, relevant, and time-saving resources to clinical laboratory sciences instruction.

ABBREVIATIONS: CLS = clinical laboratory sciences; LO = learning object.

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INDEX TERMS: instruction; Internet; teaching.

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Focus Continuing Education Credit: *see pages 191 to 192 for learning objectives, test questions, and application form.*

Learning objects (LOs) are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science. LOs are instructional components that can be reused in different learning contexts to communicate material that is jointly used in the presentation of many topics.[1,2] These elements can be delivered over the Internet, and accessed by a number of individuals simultaneously.[1] LOs often represent autonomous, fundamental concepts presented by most instructors. Through joint preparation and review, creators standardize the content element while reducing instructional preparation time. Individuality is retained by the instructor through the choice of context in which the LO is used.

Key to the development of LOs is the ability to name and easily retrieve the object. Although all LOs have certain

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properties, it is their differences that aid in categorization. Several taxonomies may be used to differentiate LO types. Bloom provides a system of differentiating statements by cognitive levels.[3] Proponents of LOs suggest a system of differentiating LOs on the basis of the instructional design, technology, and interactivity of the object:

- Fundamental – a JPEG of a hand playing a chord on a piano keyboard
- Combined-closed – a video of a hand playing a chord on a piano keyboard with accompanying audio
- Generative-presentation – a chord identification problem
- Generative-instructional – instructs and provides practice for any type of procedure[1]

Properties that add to ease of use for LOs include consistent use of terminology, use of comprehensible formats, absence of references to other LOs, uniformity of grammar and tone, consistency of language level and the use of searchable keywords. Content management of LOs is aided by the use of a metatag, or descriptive information about the LO.[4] Metatags facilitate storing, searching, and retrieval of content by technological databases.

Traditional instructional media, such as an overhead or videotape, may be used by one instructor at one time. LOs may be used by thousands of instructors and students at one time. Instructors may collaborate on the creation of LOs for increased standardization and time savings. Such object-orientation is grounded in instructional theory. Reigeluth and Nelson suggest that when teachers organize instructional materials, they break the content down into fundamental components.[5] They reassemble the components to support their own context. Burns and Parlett describe expert performance as the process of disintegration of complex performances into progressively simpler performance units.[6] It is a natural step to apply this expert performance to the creation of digital technology. In this model, instructors do not have to develop their own instructional components. Instead they can use objects developed by others, bypassing the step of breaking down lessons to repackage in their own lesson format. This allows for increased speed and efficiency of instructional development and decreased faculty preparation time. Merrill applies an algorithmic model of computing to instruction, in which knowledge is represented by data and instructional strategies are represented as algorithms.[7]

The use of LOs applies the learning theory of constructivism. Constructivism describes learning as an active process of constructing rather than acquiring knowledge, and it describes instruction as a process of facilitating that construction. Constructivists propose that the learner individually interprets experience from a knowledge base that permits reference, reuse, and reconfiguration of knowledge objects. They suggest that the same knowledge objects can be configured into different types of instructional formats including presentation, practice, and learner evaluation.[8] Central to the theory of constructivism is the belief that learners perceive knowledge objects differently, based on their own set of experiences.[9]

LEARNING OBJECTS FOR CLS INSTRUCTION

In clinical laboratory sciences (CLS), the body of knowledge expected of CLS graduates has been defined on a national level.[10] Given that the contents of curricula across CLS programs are comparable, high-quality, easily accessible, digital multimedia that can be incorporated into CLS program materials and lessons could be advantageous for CLS educators. Although the idea of sharing resources seems reasonable, design for effective implementation in a variety of settings can make the task seem overwhelming. The variety of models that exist in CLS education creates a challenge for collaborative efforts among programs. Course scheduling becomes difficult for programs interested in sharing courses and faculty resources. For example, in a one year CLS hospital-based program, specific course content may be integrated into the clinical preceptorship time or presented in short seminars, whereas a two year university program may teach this content in specific courses. Additionally, with the decrease in CLS programs,[11] an effort to provide more educational opportunities for students through distance learning is being made. A major difficulty in providing education has been the lack of quality educational materials that are easily shareable. In a review of electronic educational materials available to CLS programs, very little can be found in a format that is easily identifiable and transferable between programs. Limited image collections on DVD and CD are available from a few textbook publishers and professional associations. These collections are not user friendly for faculty teaching courses, have not been appropriately cataloged for easy faculty accessibility, and are not readily available to students without additional expense. Existing materials are primarily embedded in platform specific course delivery systems, are course specific, and are not readily sharable.

Because LOs are visual in nature, they could be an asset for the development of lesson structure in distance learning, computer-assisted, and traditional classroom environments.

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The use of CLS LOs may reduce the preparation time for lectures, examinations, and remediation materials, freeing instructors to focus on other tasks. This article will discuss the results of a survey of CLS and microbiology faculty members who have reviewed a series of newly created LOs for accuracy, clarity, interactivity, and durability. Data from these reviews will guide final preparation of each LO for distribution.

MATERIALS AND METHODS

The University of Texas Medical Branch CLS Program partnering with the University of Nebraska Medical Center CLS Program received a Fund for Improvement for Postsecondary Education grant to create LOs for CLS and disseminate them via an online repository. The CLS repository is currently focused on microbiology and immunology. Partners in the project divided instructional material into autonomous content. Content was deemed appropriate for development of LOs if it could be used in a variety of presentations and it was visual in nature. The instructional content includes biochemical reactions, organism identification and panel selection, and gram stain quality control. These LOs were created, maintained, and stored for use as resources for lectures, reviews, or tests that may be used individually or with other LOs to create interactive content. They include a combination of drawings, still photographs, animations, videos, audio clips, and text components. The partners in the CLS project have chosen to differentiate LOs in a modification of the Wiley system:[1]

- Level 1 LOs display simple graphics. A photo of a gram-negative bacillus or an agar plate showing *Escherichia coli* colonies are examples of Level 1 LOs.
- Level 2 LOs consist of an animation or video clip showing a specific mechanism. A positive oxidase test with text describing the procedure is an example of a Level 2 LO.
- Level 3 LOs provide instruction and practice requiring student interaction. A Level 3 LO might be an animation requiring the student to drag and drop agar plates in the correct incubation environment or an exercise requiring interpretation of a biochemical panel, in which the student must add specific reagents. This level includes one to two objectives and a short unit of instruction including the interactive component.

Partners in the CLS project prepared and categorized LOs. Learning objects were categorized by several partners to maintain inter-rater reliability.[12] Reviewers were recruited through Internet-based list serves and presentations at professional conferences. Nine educators evaluated 105 LOs. Not all evaluators evaluated all LOs. Reviewers accessed the project via a website, http://webcls.utmb.edu/lo/, and obtained a user identification and password. Through the descriptive terminology of the storage database, reviewers chose LOs, which could be downloaded to the reviewer's electronic storage. After examining the LO, the reviewer completed an online

Table 1. Results of the evaluation survey

Question/Evaluation	Result
Rate the learning object (LO) for	
Accessibility	4.68*
Usability	4.61*
Instructional qualities	4.55*
Overall evaluation	4.33*
Using the LO saved time	yes, 90%
Time saved by using the LO	1 hour
Areas in which time was saved†	Lesson or course development Student learning
Gain in learning attributed to LO	yes, 57%
Performance gain attributed to LO†	Improved performance on assessment of didactic content, content comprehension and competency
Will use LOs again	yes, 98%

*Average of rating responses to all LOs, rating scale 1 through 5 where 1 = poor and 5 = excellent
† Subjective evaluation by individual reviewers

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questionnaire. Each LO was reviewed separately. Reviewers were rewarded with free use of these LOs. The evaluation questions are indicated in Table 1.

RESULTS

Evaluation ratings and comments were stored within the website database and accessed as cumulative data. Table 1 shows the results of the survey. Average responses were computed on the basis of responses to all LOs.

DISCUSSION

LOs offer the ability to share resources. They are fundamental elements of a model for content creation and distribution.[13] The survey results show that LOs are useful and accessible elements of high quality technology. Fifty-seven percent of the educators stated they could attribute some aspect of increase in learning to student exposure to LOs. Several educators stated they were not able to determine this factor because they had not yet evaluated their students.

Anecdotally, reviewers suggested that the partners needed to develop LOs in more commonly used formats to ease LO downloading. Instructions for downloading programs for viewing and using the LOs must accompany each LO that relies upon the program. The project will continue to develop LOs for the CLS repository and encourage submission of LOs to the Internet repository by other educators.

LOs provide fundamental knowledge through technology-based, searchable resources. However, knowledge is not enough; the educator's goal is to engender student understanding. Only with understanding will the student have the ability to think and act flexibly while using that knowledge.[14] LOs provide elements of knowledge; educators facilitate understanding. Shared resources providing the knowledge component allow educators the time and flexibility to accomplish understanding more readily and in a variety of educational settings.

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