Interdisciplinary Journal of e-Skills and Lifelong Learning **Volume 12, 2016**

Cite as: Nugent, G., Kohmetscher, A., Namuth-Covert, D., Guretzky, J., Murphy, P., & Lee, D-K. (2016). Learning from online modules in diverse instructional contexts. *Interdisciplinary Journal of e-Skills and Life Long Learning, 12,* 113-121. Retrieved from http://www.informingscience.org/Publications/3511

Learning from Online Modules in Diverse Instructional Contexts

Gwen Nugent
University of Nebraska-Lincoln, Lincoln, NE, USA

gnugent@unl.edu

Amy Kohmetscher
The Ohio State University, Columbus, OH, USA

kohmetscher.1@osu.edu;

Deana Namuth-Covert
The Ohio State University, Columbus, OH, USA

namuth-covert.1@osu.edu

John Guretzky
University of Nebraska-Lincoln, Lincoln, NE, USA

jguretzky2@unl.edu

Patrick Murphy
Iowa State University, Ames, IA, USA

ptmurphy82@gmail.com

DoKyoung Lee
University of Illinois, Urbana, IL, USA

leedk@illinois.edu

Abstract

Learning objects originally developed for use in online learning environments can also be used to enhance face-to-face instruction. This study examined the learning impacts of online learning objects packaged into modules and used in different contexts for undergraduate education offered on campus at three institutions. A multi-case study approach was used, examining learning impacts across a variety of course subjects, course levels (introductory and advanced undergraduate), student levels (undergraduate and graduate), and instructional goals (i.e., replacement for lecture, remediation). A repeated measures design was used, with learning data collected prior to viewing the online module, after completion of the module, and at the end of the semester. The study provided a broad examination of ways that online modules are typically used in a college classroom, as well as measured learning effectiveness based on different instructional purpose and usage contexts. Results showed the effectiveness of the modules in serving as a substitute for classroom lecture, remediation of course prerequisite material, introduction to content with follow-up lab practice, and review for final exams. In each of these cases, the use of the modules resulted in significant learning increases, as well as retention of the learning until the end of the semester.

Keywords: Learning objects, online learning, instructional context, multimedia instruction, online modules.

Editor: Gila Kurtz
Submitted: December 30, 2015; Revised: April 19, May 19, 2016; Accepted: May 21, 2016

Introduction

Online learning objects (LOs) are small, stand-alone, mediated content resources that can be reused in multiple instructional contexts, serving as building blocks to develop lessons, modules, or courses. While the definitions of learning objects vary, a comprehensive review of the literature showed that there generally are three common characteristics: they are digital, they support learning, and they are reusable (Moisey & Ally, 2007). LOs supporting face-to-face classes can serve many purposes: as background/review covering prerequisite course knowledge; to replace a lecture; to support, reinforce, and complement classroom presentations; introduce content for follow-up practice; and to serve as a review for an exam. The capability of LOs to support a variety of instructional contexts helps meet educational needs of the growing diversity of students in both K–12 and college settings. These characteristics contribute to an LO's *utility*, which refers to an LO's expanded use beyond that of the initial intended audience or educational setting (Namuth, Fritz, King, & Boren, 2005). Learning objects may also be classified in terms of uses in different educational contexts with the goal of guiding selection and usage by potential users. Proposed classifications include presentation, practice, simulation, conceptual models, information, and contextual representation (Churchill, 2007).

Research has documented the instructional effectiveness of learning objects (Guy & Lownes-Jackson, 2012; Kay, 2014; Nugent, Soh, & Samal, 2006; Tallmadge & Chitester, 2010) but little is known about their learning impact when used to meet different instructional objectives and when used in different learning contexts. The purpose of this study was to explore the learning impacts of learning objects packaged into online modules and used in different learning contexts. The study used a multi-case study approach involving professors from different universities teaching different undergraduate agricultural science classes. This multi-case study approach allowed study of online modules used in a variety of instructional contexts, with different student populations, and with varying instructional purposes. The repeated measures design also allowed examination of the proximal and distal learning impacts.

Methods

Description of Modules

Learning objects packaged into online modules were developed as part of a USDA grant (Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-304111) designed to expand academic and outreach curricula in the broad areas of agronomy and biofuel. The modules contained stand-alone content and appropriate assignments and included a combination of video, animations, graphics, text, and quizzes. The videos could be narrated PowerPoints, tours/demonstrations of field techniques, demonstrations of calculations, or links to YouTube resources. The modules were designed to promote learner control of the navigation and viewing of the material. Students could freely move between pages, and watch, pause, and rewind the video components. Students could also click on designated terms and access a glossary. There were also links to external content. These strategies took advantage of the capabilities of online instruction to prompt active student response, which has been shown to result in greater mastery of material (Freeman et al., 2014; Nugent et al., 2009). Strategies also are forms of learner control of the lesson, which has been shown to be important to effectiveness (Windle, McCormick, Dandrea, & Wharrad, 2011).

The modules were developed following an instructional design process that included a) development of learning objectives; b) collaborating with content experts to refine objectives and write content; c) development of learning objects such as videos, graphics, written e-lessons, and quizzes; d) internal review by content experts and revision; e) public release of learning objects to students and public; and f) final revision based on evaluation data. Modules were developed using Adobe Flash Animation, Camtasia, and Moodle (LMS).

Study Design

Because the goal was to examine the effectiveness of the digital materials in a variety of learning contexts, a case study approach was used, examining learning impacts across a variety of course subjects, course levels (introductory and advanced undergraduate), student levels (graduate, undergraduate), and instructional goals (i.e., replacement for lecture, remediation). The case study approach provides a broad examination of ways that a module of packaged LOs is typically used in a college classroom, as well as evidence of the learning effectiveness based on different instructional purposes and usage contexts.

Each of the case studies followed a design using quantitative methods to assess the learning at various course time points. All cases used measures of proximal learning evidenced by assessment given immediately after completing the module, as well as distal learning as measured by course final exams. Learning data was collected at baseline (beginning of course, prior to introduction of module), post module (after students had completed the online module), and the end of the semester (final exam). This repeated measures design allowed examination of the immediate impact of the digital modules (from baseline to post-module), as well as the retention of learning to the end of the semester (from post-module to end of course).

Case Study One: Online Module as Primary Learning Material and Remediation

This case study compared the learning impact of a module intended as primary learning material in a 200 level university course (introductory level) versus use as remediation and refresher for prerequisite content for a more advanced class. The study involved use of a single module, "Perennial Grass Growth and Development," (http://passel.unl.edu/communities/index.php?idinformationmodule=1130447263&idcollectionmodule=1130274200) used by two different professors at two different universities. The first professor used the module as a substitute for a single lecture in a 200 level undergraduate soil science class. Students in this class (n = 68) represented a mix of sophomores (25%), juniors (45%), and seniors (30%). The majority were carrying a GPA of 3.0–3.4. Most were male (91%), and classified themselves as agronomy majors (52%). Eighty-five percent of the students reported that the course was required for their major.

The second professor, located at a different university, used the same module of learning objects to provide remediation and background material for a 400 level soil science class (advanced level). The demographics for this class (n = 13) represented it upper level status, with 46% graduate students, 31% seniors, and 23% juniors. The gender split was 69% male and 31% female. Majors were varied, with typical majors being bioenergy and biological engineering.

Both professors used the same assessment consisting of 11 multiple choice questions that covered material presented in the module. They also followed the same data collection protocol, with the same quiz given at the beginning of the school year (baseline), after viewing the LOs (post-LO), and end of course (final exam). This sequence of assessments allowed for a repeated measures design with three data collection points.

Results

A split plot analysis with time as the within variable and course as the between showed no significant time by course interaction ($\Lambda = .96$, $F(2,72) = 1.68$, $p = .19$). However, the main effect for time was significant ($\Lambda = .35$, $F(2,72) = 67.12$, $p < .0001$, partial $\eta^2 = .65$), documenting changes in learning across the three time points. In order to isolate specific changes between time points, one-way within subjects ANOVAs were run, followed up by pairwise comparisons. Results showed significant increases in both courses from pre- to post-module—200 level class: $t(63) = 13.03$, $p < .0001$, $d = 1.60$; 400 level class: $t(12) = 4.99$, $p < .0001$, $d = 1.38$, and a nonsignificant change (slight decrease) from post-LO to final 200 level class: $t(63) = 1.13$, $p = .26$; 400 level class: $t(11) = 1.43$, $p = .18$). Figure 1 shows the pattern of results for the two classes.

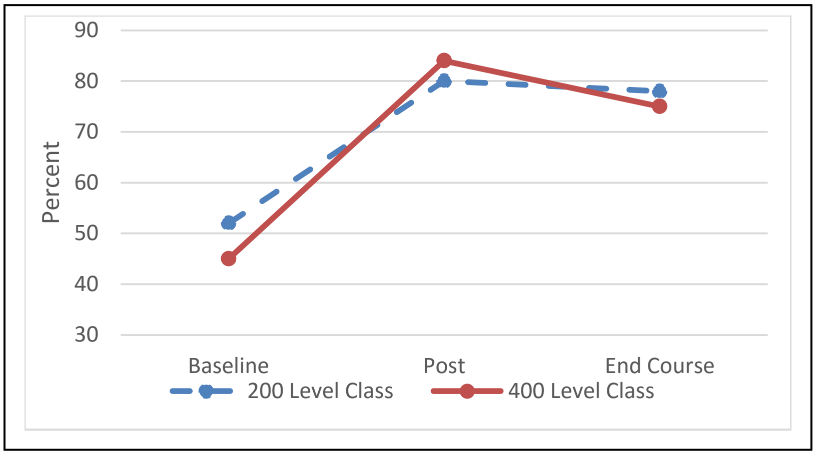

Figure 1: LO learning impacts in two classes. Percent represents the score or % of assessment questions answered correctly.

Discussion

The results provide clear evidence that the module had a similar learning impact, despite differences in its intended purpose for the two classes. Because the baseline results (pre-module) for the two classes were similar, it appears that, in general, students in the 400 level class did *not* have more content knowledge than the lower level course at the beginning of the course, as was expected. Thus, the module appeared to serve the same purpose in both classes—as primary learning material. It is important to note that results from both classes showed a significant increase in learning as a result of viewing the module, followed by a stabilization or retention of the learning. The use at two different universities with two different courses provides greater generalizability of results regarding the effectiveness of learning objects in increasing student learning and promoting learning retention.

Case Study Two: Module Used with Follow-Up Lab Practice

Case study 2 involved use of a different module focusing on "Establishment of Switchgrass and Other Perennial Grass Stands" (http://passel.unl.edu/communities/index.php?idinformationmodule=1130447188&idcollectionmodule=1130274200). The material required application of knowledge through the use of specific formulas and calculations to determine amount of seeds needed, percent germination, etc. The study examined a) the learning impact from viewing the packaged learning objects, b) the value-added learning impact of participating in a lab with practice with the content and needed calculations, and c) the retention effect to the end of the semester. A major area of inquiry was looking at the singular effect of the module and the combined effect of the module with additional lab practice.

The module was used in the same 200 level undergraduate soil science class from study 1, but in a different semester. This module replaced what the instructor typically presented in a lecture and was followed up with a lab where students had direct practice using the formulas and making the appropriate calculations. The learning was measured through presentation of a planting scenario that required calculations. The assessment was given at three time points: following student viewing of the LOs (a non-graded multiple choice quiz in the module itself), following the lab (a fill-in-the-blank graded quiz), and on the final exam. The multiple choice format for the first administration of the quiz was necessary to allow presentation and grading of the quiz within the module itself. However, the content was the same across the two instruments. Because of the extensive calculations involved, no pre-test was given. It was believed that students would not be able to successfully answer the questions, resulting in guessing, or would become frustrated, with possible impact on their course attitudes. Thus, the proximal learning impact of the module cannot be definitively determined. In order to maintain consistent data collection points across the case studies, we estimated a baseline score based on the expectation that students could have been expected to score around 25% by chance as shown in Figure 2.

Results

A one-way within subjects ANOVA was conducted, with time as the within subject variable. Results showed a significant effect for time ($\Lambda = .69$, $F(2,39) = 8.98$, $p < .001$, partial $\eta^2 = .32$). This main effect was followed up by pairwise dependent t-tests, showing a significant increase from post-viewing to post-lab ($t(42) = 4.39$, $p < .0001$, $d = .68$) and a nonsignificant increase from post-lab to post-final exam ($t(40) = .10$, $p = .92$). Figure 2 shows the pattern of learning effects.

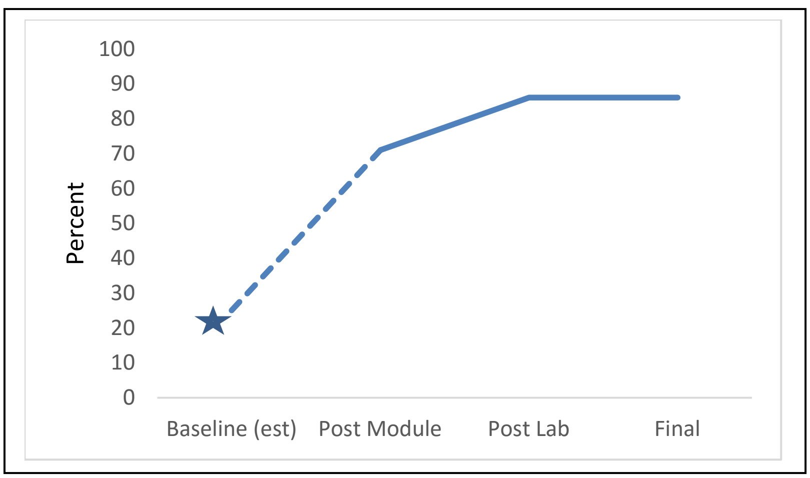

Figure 2. Learning impacts for LO module supplemented with lab-based practice in a single course (n = 50).

Discussion

Given the projected baseline score of around 25%, the 70% average score following module viewing represents considerable learning. Of major interest, however, is the additional gain realized through lab practice. Results suggest the value of LO module as introduction to material, but that full learning impacts may not be realized until students have time to practice and apply what they have learned. This practice effect may be most important for the type of learning material presented in this particular module, which focused on the use of formulas and calculations to solve problems as opposed to presentation of basic information or concepts. It is also possible that the practice components could be incorporated into the learning object package itself, reducing the need for follow-up lab practice and providing additional opportunities for active learning on the part of the learner. It is also important that, similar to results in case study 1, the learning realized from the additional practice stabilized and was retained throughout the semester.

Case Study Three: Module as Reinforcement and Review

Case study 3 extended the research on the effectiveness of learning object modules by examining their use as both reinforcement for previously learned material and review for the final exam. The module was used in a 200 level (introductory undergraduate), crop production equipment class ($n = 42$) with a mixture of sophomores (51%), juniors (21%), seniors (14%), and freshmen (2%). Seventy percent were majoring in Agricultural Systems Management and 79% were taking the course as a requirement for their major. The majority (44%) reported their GPA as between 2.5 and 2.9. All students in this course were male.

The module, which dealt with harvesting perennial grasses for bioenergy, contained content which an estimated 60–70% of the class had been exposed to in previous courses. The module was assigned as a replacement for two days of lecture. It was followed by a 15-item multiple choice exam the following week. The graded post-exams were returned with no feedback. The link to the module was also sent out prior to the final exam as a source of review. The data collection followed a similar pattern to previous studies: baseline, post-module, and as part of the final exam. As a result of student feedback, the module has since been split into two: 1) "Field Operations for Harvesting Herbaceous Bioenergy Crops: Mowing and Conditioning" and 2) "Field Operations for Harvesting Herbaceous Bioenergy Crops: Raking and Merging" (http://passel.unl.edu/communities/index.php?idinformationmodule=1130447261&idcollectionmodule=1130274200).

Results

A one-way within subjects ANOVA was conducted, with time as the within subject variable. Results showed a significant effect for time ($\Lambda = .39$, $F(2,35) = 26.98$, $p < .0001$, partial $\eta^2 = .61$). This main effect was followed up by pairwise dependent t-tests, showing a significant increase from pre- to post-LO ($t(36) = 3.73$, $p < .001$, $d = .61$), and a significant increase from post-LO to final exam ($t(36) = 4.37$, $p < .0001$, $d = .72$). Figure 3 shows the pattern of learning effects.

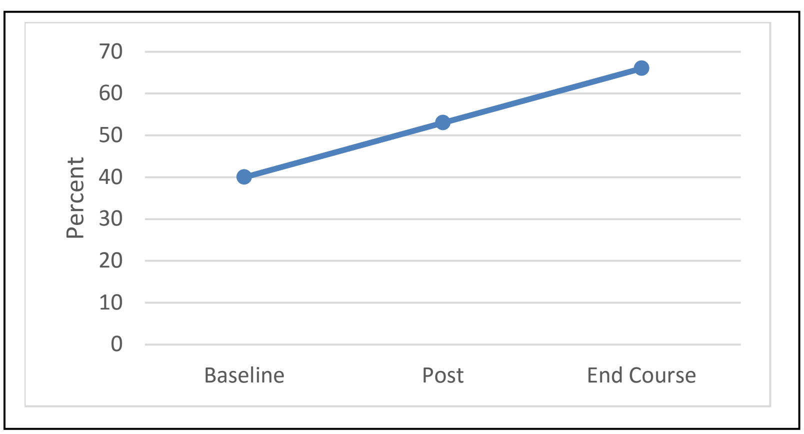

Figure 3. Learning impacts for LO module as reinforcement and review.

Discussion

In contrast to the pattern of results from the previous two studies, this study resulted in a linear trajectory, with no levelling off of learning impacts. As with the previous studies, the module had significant learning impact, but that initial impact was accentuated by its use as review for questions on the final exam. This result could be attributed to a dosage effect because students viewed the module twice. It is also possible that completing all course content allowed students to more effectively understand and integrate the specific module content when it was reviewed at the end of the course.

Overall Discussion

This paper provides insight into the effectiveness of LO modules used in different instructional contexts for on campus academic courses to meet diverse instructional goals. The three study cases (representing four separate courses) were deliberately selected to examine different uses of LO modules: a) substitute for classroom lecture, b) remediation for course prerequisite material, c) introduction to content with follow-up lab practice, and d) review for final exams. In each of these cases, the use of the module resulted in significant learning increases.

All cases involved measures of proximal learning evidenced by scores on an assessment given immediately or within a few days after completing module, as well as distal learning as measured by course final exams. The first study showed the learning effectiveness of the module as measured through comparisons between baseline scores and scores from the exam administered following student usage of the module. This study also demonstrated learning retention as shown by scores on the final exam. In short, the learning did not decay but was retained through the end of the semester. The second and third studies suggest ways in how this initial learning impact of the module can be further extended. Follow-up reinforcement of the content through practice further increased learning, as did the opportunity to reuse the learning object module as review for the final exam. It is also important that, similar to results in case study 1, case study 2 showed that the learning realized from additional practice stabilized and was retained throughout the semester.

All of the case studies described in this paper were in the curricular area of plant and soil science, limiting the generalization of study results to other subject areas. Nevertheless, results extend previous research on learning objects by documenting the more distal retention effect, which is an important educational goal. While we acknowledge that numerous factors promote retention, it is important that all four examples across the three case studies showed retention effects. This study also identified conditions under which learning can be further increased following initial viewing of LOs, including additional practice and review and reuse of the LOs.

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Biographies

Dr. Gwen Nugent is Research Professor of the Center for Research on Children, Youth, Families, and Schools at the University of Nebraska-Lincoln. Dr. Nugent coordinates development and research projects focusing on the impact of technology to improve student learning and teacher competencies, with special emphasis on multimedia instruction and on-line assessment. She has over 30 years' experience in the design, production, and evaluation of mediated instruction, and has served as project manager for over 300 multimedia projects designed in a variety of subject areas and for a variety of audiences. The majority of these projects are distributed nationally and internationally, and many have won national awards for their educational impact and effectiveness.

Ms. Amy Kohmetscher is an Instructional Development Specialist at The Ohio State University – Agricultural Technical Institute. She collaborates with faculty and IT specialists at OSU and nationally to develop instructional content for online delivery, designing instructional media to promote student and adult learning. She assists with evaluation and assessment of learning objects created.

Dr. Deana Namuth-Covert is currently a Professor and Director of Online Education and Outreach at The Ohio State University – Agricultural Technical Institute and College of Food, Agricultural and Environmental Sciences. She has 16 years of experience leading online STEM programs, some federally funded. She also teaches plant science classes/trainings, has advised online students and researches best practices. Her responsibilities include working closely with OSU faculty and staff to provide organizational direction in the prioritization, development and maintenance of course modules which serve both academic students and extension clientele. Her work also involves the creation, use and evaluation of learning object repositories.

Dr. John Guretzky is an Associate Professor and Grassland Systems Ecologist in the Dept. of Agronomy and Horticulture at the University of Nebraska-Lincoln (UNL). His research focuses on impacts of fire, grazing, and seeding on range and pastureland plant communities. He teaches courses in Forage Crop and Pasture Management and Forage Evaluation. His goal is to improve student understanding about the role of forages and grasslands in sustainable agriculture. Before joining UNL, John served as a Research Agronomist at the Samuel Roberts Noble Foundation in Ardmore, OK, from 2006 to 2009 and Postdoctoral Assistant with the U.S. Army Corps of Engineers Construction Engineering Research Laboratory in Champaign, IL from 2003 to 2006.

Dr. Patrick Murphy is currently the Education Co-Director for Cenusa Bioenergy in the Bioeconomy Institute at Iowa State University. His responsibilities include overall direction of Cenusa university education program which includes an online bioenergy curriculum, summer undergraduate internship program and graduate student webinar series and preparation of technical content for the bioenergy curriculum. In addition to his role at Iowa State University, he operates a research and engineering consulting firm serving the grain, feed and bioprocessing industries. He holds a doctorate in Agricultural Engineering and Biorenewables Resources and Technology from Iowa State University.

Dr. DoKyoung "D.K." Lee is an Associate Professor of Biomass and Bioenergy Crop Production and Extension Agronomist in the Department of Crop Sciences at the University of Illinois. He is a production agronomist with the broad range of research and educational background in the area of crop production, perennial grasses, soil science, and international agriculture and expertise in dedicated energy crop production. Currently, he is serving as the primary investigator of several biomass feedstock researches including CRP Management for Sustainable Biomass Feedstock Production as a part of the U.S.DOE & Sun Grant Regional Feedstock Partnership and Sustainable Biomass Feedstock Production-Dedicated Energy Crops funded by USDA, NIFA.