Using Digital Learning Objects to Improve Student Problem Solving Skills

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Introduction
Universities across the country are adopting new technologies to support the teaching mission. Much of this support is needed in the area of online education (McPherson and Nunest, 2008). It is estimated that in 2006, nearly 35% of all higher education institutions offered a complete online degree program and 20% of all U.S. students were enrolled in at least one online course (Bollinger and Wasilik, 2009). The rise of online education has been met with some resistance by faculty and administrators. Concerns over student and faculty interaction and the interaction of students to course material have always been an issue (Rabe-Hemp, et.al. 2009). Efforts have been made to address some of these concerns and one area of emphasis has been developing methods for conveying highly technical content to students at a distance. The evolution of technology has led to increased opportunities for teachers to share more technical educational materials with students.

Evolution to the Pen Based Technology
Efforts at the University of Tennessee at Martin to deliver online materials began in 2003 with the introduction of an online graduate program in agriculture. This program was delivered completely at a distance, with students rarely coming to campus. Over the years, faculty have experimented with different tools with hopes of more effectively delivering content. The most common tool used by faculty is Adobe Presenter, which is a plug-in for PowerPoint. This tool is very effective at delivering materials that are in a traditional lecture format using the instructor's voice. However, tools of this type do not allow instructors to develop dynamic mathematical problem solving examples for students without working out the problems in advance. An effective tool for demonstrating mathematical problems to students was needed. This need led faculty to use a Tablet PC along with a screen capture program to develop a pen-based solution

for demonstrating mathematical problems to students. The screen capture feature allowed faculty members to add their voice to create a dynamic digital learning object. The Tablet PC and screen capture combination worked well for developing step-by-step problem tutorials. Once the learning objects were created they were easily posted into a course management system for students to download and review. As technology changed, new options became available that did not require a Tablet PC and a screen capture technology. Several UTM faculty tested various digital pen products to determine if they were effective for developing mathematical tutorials that included the instructor voice. One of the products selected was the Livescribe Smart Pen developed by Livescribe. The pen was cost effective and allowed the instructors voice to annotate their notes as they were developed. The audio and written notes were synced together and produced a digital file that could be placed in a course management program. This tool did not require a separate screen capture program and had a low learning curve.

Data and Methods
The use of digital learning objects (DLO) has increased in recent years, as the cost of technology has declined. The objective of this study is to determine how effective pen based DLO are in increasing student problem solving skills. In order to understand the effectiveness of digital media on students, faculty willingness and perceptions of online teaching methods must be understood (Bollinger and Wasalik, 2009). In ~~the~~ summer 2010, University of Tennessee at Martin faculty were surveyed to determine their attitudes toward using a digital pen to develop learning objects (Burcham, et. al, 2010). Faculty found ~~that~~ the digital pen was useful for providing more points of contact between students and the content material. They also found the learning curve for this technology to be minimal. This initial survey revealed a need to determine if students are positively impacted through viewing the DLO in conjunction with typical classroom activities. To answer this question, student outcomes from two sections of an

introductory agricultural course were compared during the spring and fall semesters of 2010. Both sections contained similar student demographics with respect to major, GPA, and classification. Section 1 (n=28), was taught in the spring semester using a traditional classroom setting. Section 2 (n=29), was taught in the fall semester using the traditional classroom setting with an instructor-developed DLO. The DLO consisted of step-by-step mathematical problem solving examples. The examples included instructor hand written notes as well as voiced commentary. The objects were consistent with examples worked during class. The DLO was made available to students through the course management system and was available for the duration of the course. A survey was developed and administered to the fall 2010 class (section 2). The survey instrument asked for student perceptions of the DLO. Specifically, students were asked if they viewed the DLO and if they found it helpful or if they experienced any problems associated with it. The students completed the survey in conjunction with each hourly exam for the course. The survey was replicated three times during the semester. Finally, section 1 scores were compared to section 2 scores.

Results and Discussion

Faculty Perceptions

A survey was conducted by Burcham et. al in 2010 to determine faculty perceptions of using a digital pen to develop learning objects. Faculty members (n=27) from the University of Tennessee at Martin completed a questionnaire covering 17 specific questions on the usability of the digital pen. Results of the faculty surveys revealed that 84% of respondents indicated the learning objects created with a digital pen saved time when developing online course materials. This is very important for faculty members seeking to better use their limited resources. The addition of instructor voice and step-by-step problem solving made a better learning object for

students. The primary use cited by faculty of the digital pen was for math type problems and note taking. Over 58% of the digital pen usage was directly related to math and note taking. Graphing accounted for 29% of the usage. Another interesting finding from the survey was that faculty used the digital pen to develop materials for traditional undergraduate courses (59%). The survey also revealed that 41% of the faculty used DLO for online undergraduate courses. The pen can also be effectively used in a traditional class and not just for distance education. The majority of faculty surveyed did not receive direct feedback from students regarding their perceptions, but the faculty who did receive feedback had positive or strongly positive student responses.

Student Perceptions

Results from the section 2 class revealed that student perceptions are overall positive for the digital learning objects. Assignments compared to the section 1 class reveal that students who access the online problem tutorials have improved understanding of the material. This finding was supported through improved assignment scores and quiz scores for the semester. The following are results from the survey and the exam scores from section 2 with the DLO.
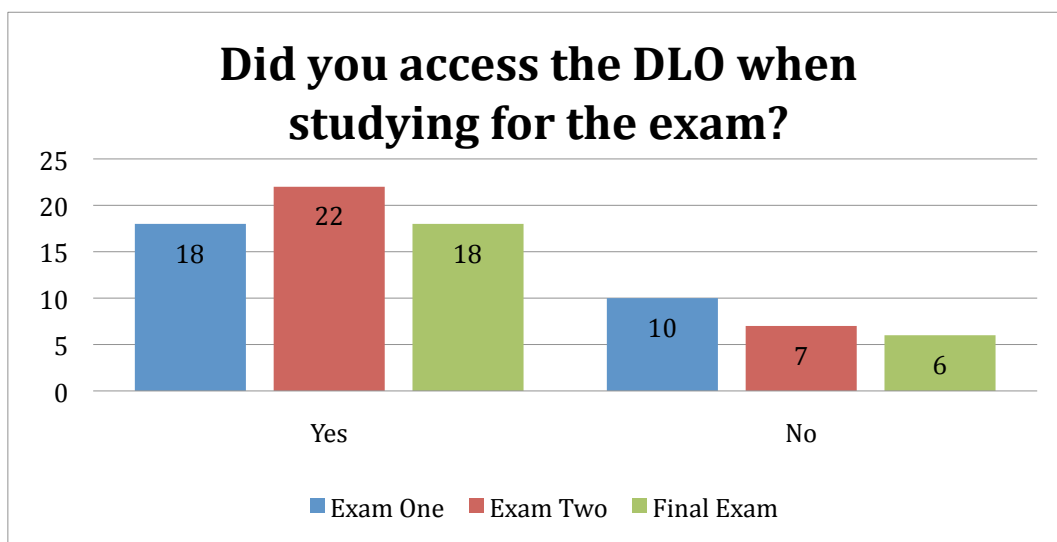
Figure 1. Student Access of DLO Prior to Exams (Section 2)

Figure 1 summarizes student participation in accessing the DLO when preparing for exams. The students accessed the DLO in the greatest numbers for the second exam and the least for the final exam. This finding was peculiar. It was expected that student access would increase as students progressed through the course. A possible explanation was that students felt that the DLO was not as helpful on the earlier exams, resulting in students abandoning the DLO as a study tool.
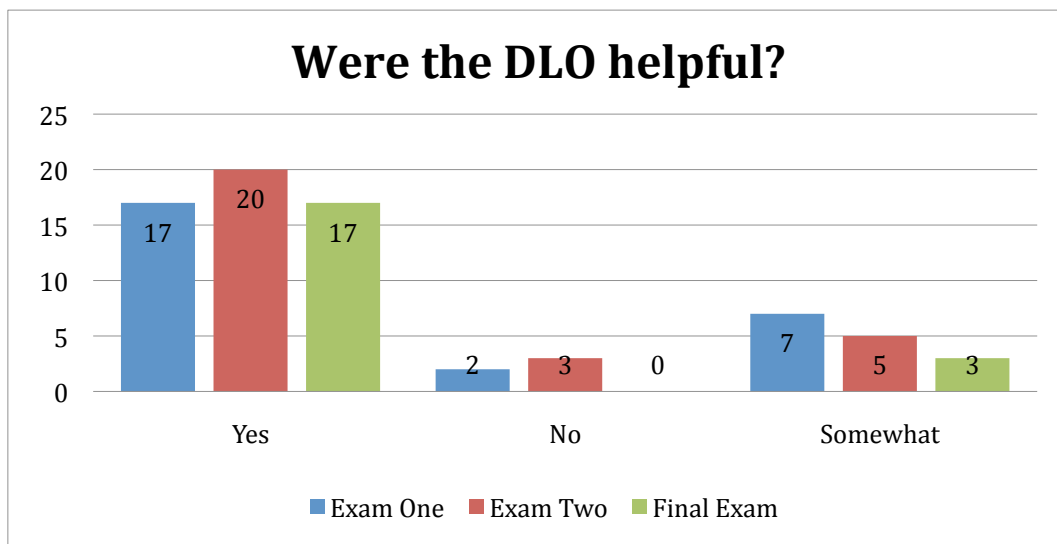

Figure 2. Student Responses to Perceived Helpfulness of DLO

The majority of students revealed the DLO was helpful in preparing for exams (figure 2). The second exam had the highest positive response with 20 students saying that the DLO was helpful. Only 5 total students responded that the DLO was not helpful, with no students having negative responses for the final exam. It is important to remember that the material for this course is progressive in knowledge. Students utilize skills learned for the first exam on all remaining exams. It was surprising to find that the number of positive responses did not increase as the semester progressed. The findings did indicate the majority of students viewed the DLO positively, and it can be a useful teaching tool.
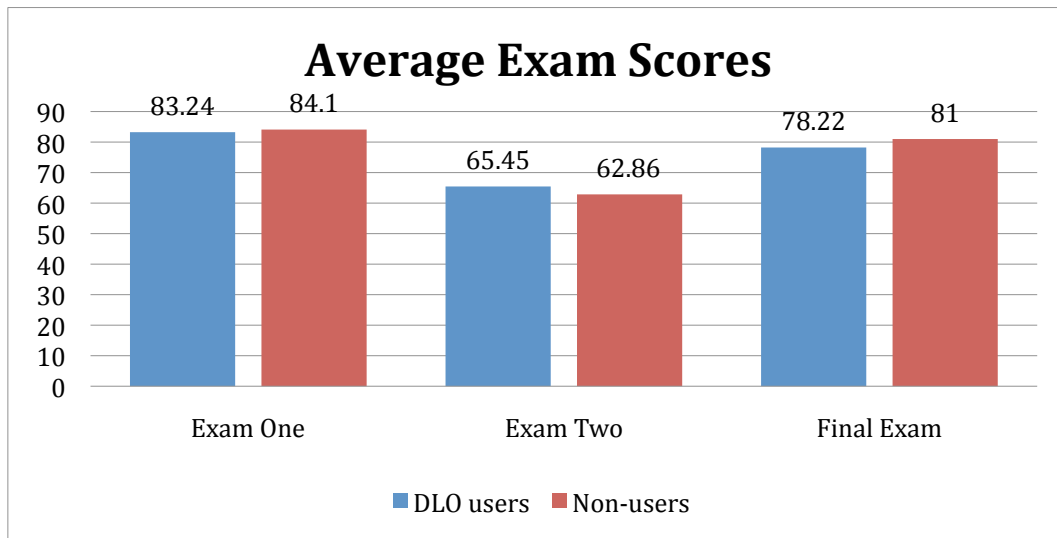
Figure 3. Average Exam Scores Comparing DLO Users vs Non-DLO Users

One measure of effectiveness of any teaching tool is how it impacts student's performance on exams and assignments. Figure 3 illustrates the average exam scores for students that used DLO versus those that did not. None of the comparisons were statistically significant when evaluated using a two-sample t-test with equal variances.
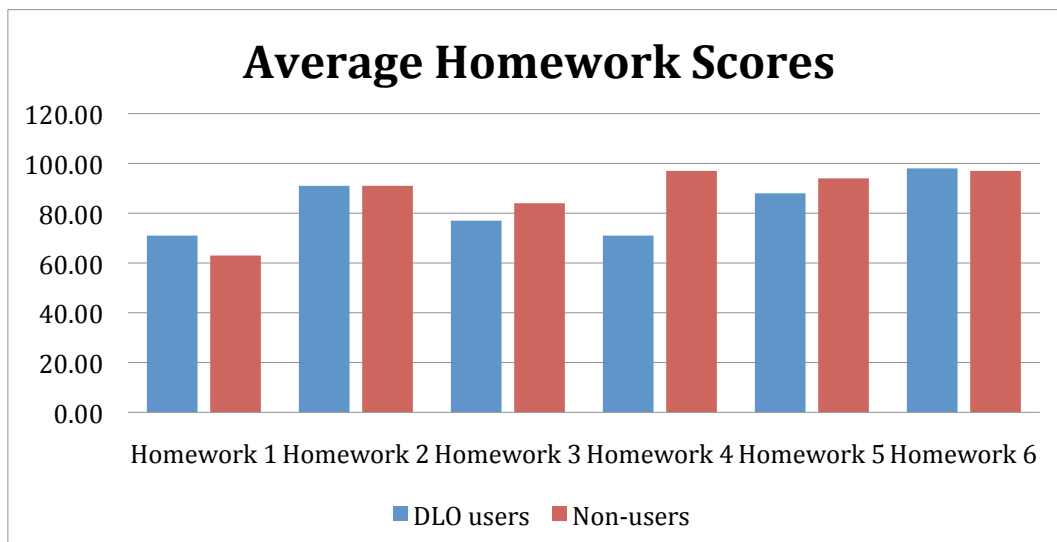
Figure 4. Average Assignment Scores for DLO Users vs Non-DLO Users

When comparing the results of the DLO on assignment grades (figure 4), the results were similar to the findings for the exam scores. Student results were inconsistent across the different assignments. All of the assignments were compared using a two-sample t-test with either equal or unequal variances. None of the assignments were statistically significant when comparing DLO users versus non-users. Of course the exam scores are influenced by the assignments as well. As students complete assignments that are reflective of exam material, one would expect the exam scores to improve. An area of future study will be to look at how the assignments and exam material are connected. There may be issues with the frequency of DLO postings and the number of assignments completed between exams.
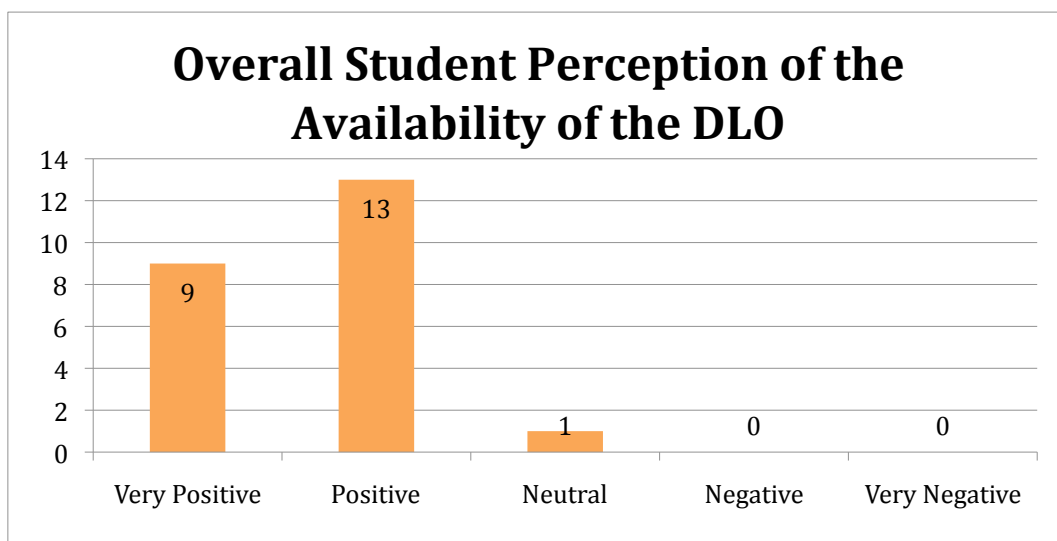

Figure 5: Overall Student Perception of DLO (Section 2)

At the conclusion of the course, students were asked to give an overall opinion of the DLO given a 5 point scale ranging from very positive to very negative (figure 5). The results showed that 22 respondents found the DLO to be either very positive or positive. Only one student had neutral feelings towards the DLO. Since exam scores did not reveal that the DLO resulted in better performance for all students, the results can only state how the students perceived the DLO and its usefulness. Overall, student perceptions of the DLO were positive, but they did not show

improvements in overall student performance in the class for exams and assignments. As with

most tools designed to increase student performance, there is no guarantee of success. In the

end, it is still up to the individual student to work hard and be prepared for the class. Instructors

can provide all the materials for students to succeed except the drive to be successful.

A final question for the student survey was an open-ended question dealing with problems

encountered with the DLO. The responses to this question are listed in Figure 6 and reveal

similar issues among the students. Common problems found among students had to do with the

technology, not the DLO themselves. Internet server issues and course management software

problems were addressed throughout the semester. These problems are common to any

educational software or course management used for traditional and online courses. Overall, the

negative impacts with the DLO were limited.

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1. The first time I accessed it; it sent me to the main server's online catalog of everything anyone had posted. The runoff example also has no voice. I don't know it is supposed to, but the other example's voice worked fine.
2. Sometimes had to go to it a couple of times before it carried me to the problem.
3. I clicked on the link and it took me to the website but not directly to the problem specified.
4. When we clicked the link for the example problems, the page will not open. We get an Internet error page. We can right click on the link, click opens a new window, and it opens a live scribe page, but it isn't your example problems. Sometimes we can close and open again and it works but not all the time.
5. There were several times when I could not access Blackboard or Echo.
6. At first I had problems when opening the live scribe link, but usually seems to work.

Figure 6. Student Responses to Problems Accessing the DLO
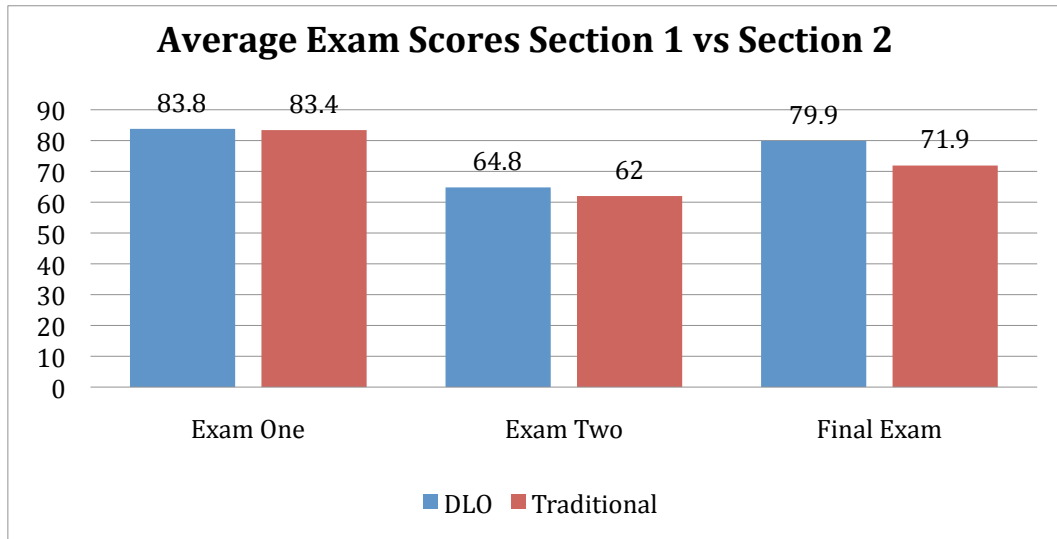
Figure 7. Exam Score Comparison of Traditional Class vs DLO Enhanced Course

A comparison of the DLO enhanced course and the traditional class was compiled based on exam scores (figure 7). Both sections had the exact same exams and material presented to the students. The only variation was that the DLO was introduced for section 2. Both classes had access to instructor notes and the same textbook. The averages from both sections were compared statistically using a two-sample t-test with equal variances. Results from the t-tests indicated that only the final exam scores are significantly different. This could indicate that exposure to the DLO over the course of the entire semester may have a positive impact on the final exam test scores. Results found that the DLO enhanced course achieved a higher average exam score for all three exams. Of course this does not prove that the DLO are the sole reason for the increase. There are many factors that impact student performance such as individual student preparation and other environmental factors that influence student behavior. Since the student demographics were similar for both sections, and the exam materials were the same it is reasonable to assume that performance would increase if you add additional study aids for students, such as DLO.

Final Thoughts

The results from this study were surprising. It was assumed that student performance would be greater for all aspects of the DLO enhanced course as compared to the traditional course. Again, faculty cannot guarantee student success simply by developing better teaching materials. They can help with student outcomes, but the student is still responsible for putting in the necessary effort to be successful. The authors feel the use of DLO with instructor voice has great potential for faculty seeking to supplement traditional classroom teaching. As a result of the ease of development, low cost, and student outcomes from the DLO, this technology has great potential for faculty teaching math intensive courses like agricultural economics and engineering. A potential growth area for this technology is the ever-increasing distance education options for universities. The digital pen can be very effective for someone developing materials for an online course or seeking to supplement traditional classroom teaching methods.

References

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