Essay 17 – December 15, 2011

Teaching with Technology
Volume 2: The Stories Continue

Development for Student Success: An Undergraduate Online Course in Engineering

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Published by the
Learning Technology Consortium

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University of Notre Dame,
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http://ltcessays.wordpress.com

Background

E-learning at the University of Florida (UF) has sought to further improve the learning experience for students, facilitate the teaching process for faculty, and reduce costs of instruction. To achieve this, an enterprise program was instituted leading to a series of online course offerings for undergraduate students.

This program (Provost E-Learning Initiative, 2007 - 2011) (PELI) consisted of the production of high quality online courses designed to showcase best pedagogical practices and state of the art informa-

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Web-based, interactive applications, including Web 2.0 and social networking have become incredibly popular in the last few years. They are changing the way we exchange information and how we collaborate.

tion technology in education. Consistent with the values and mission of the Land Grant University this project aimed to increase the quality of learning and reduce the cost of instruction.

Courses chosen for development in the PELI program were selected through a Request for Proposal (RFP) process that sought to identify courses that would meet all or most of the following requirements:

- General education course open to all undergraduate students.
- Current or projected large enrollment numbers (minimum of 100 students over a three semester period).
- Gordon Rule requirement for mathematics or writing.
- Large student demand with insufficient course offerings.
- Commitment on the part of the instructors for course development, implementation and revision.

The PELI program outlined methodologies for course development based on research regarding factors that influence student success in undergraduate online courses. The major factor influencing success was identified as facilitation of interaction and participation (Salmon, 2005) with particular emphasis on 1) student-to-content, 2) student-to-instructor and 3) student-to-student. Best practices for undergraduate online course development were identified as: 1) the need for interactive course design, 2) consistent communication between student and instructor, 3) student accountability in assessments, 4) peer interaction geared towards critical thinking and, 5) community building. These best practices imposed requirements for instructional design and course delivery and were the basis of the design models developed for the PELI program.

Engineering Economy, EIN 4354 was one course selected for development in the PELI program. Prior to redesign, the course reached a full face-to-face capacity each semester averaging 306 students per year over a five year period. The Industrial and Systems Engineering Department proposed to reduce the cost of course delivery by offering the course fully online to remove the need for a physical classroom. Additionally, advanced modules from the course would replace or augment four similar engineering courses allowing an enrollment increase to 700 students annually.

The high current and potential student enrollment, cost reduction strategy, goals for student outcomes, and the commitment of faculty to participate in the redevelopment of the course for online learning made EIN 4354, Engineering Economy a clear candidate for the PELI program. The challenge would be to reach the PELI goals while ensuring quality instruction and avoiding common pitfalls in online courses targeted to undergraduate students.

Approach

The courses in the PELI program were developed in partnership with the faculty member and an Instructional Designer. The course structure for Engineering Economy focused on performance-based learning objectives. Lectures and activities were created based on the objectives and taught the course material. Varied assessments provided students with opportunities to show mastery of the learning objectives. Once the course architecture was completed, the challenges involved in distance education for undergraduate students had to be addressed. Challenges identified for the course are outlined in table 1.

For Students	For Faculty
Feeling of isolation leading to dropout (Fulford, Zhang, 1993)	High dropout rate (Graham, Anderson, 2005)
Time management skills (Chickering, Gamson, 1987)	Decreased student satisfaction
Reduced student collaboration (Chizmar, Walbert, Hurd, 1999)	Reduced student success rates
Limited opportunity for social and critical thinking skills acquisition (Collison, Haavind, Tinker, Elbaum, 2003)	Assessment validity
Limited interaction with instructors (Swan, 2002; Collison, Haavind, Tinker, Elbaum, 2003)	
Student accountability in assessments (Muirhead, 2005)	

Table 1: Challenges for Students and Faculty

Student-to-instructor and student-to-student interactions can diminish or have the perception of diminishing in a distance course leading to a

feeling of isolation on the part of the student. This feeling of isolation is often cited as a major factor in student dropout rate, success in the course, and perception of learning in undergraduate distance education. To address this challenge, the design team provided opportunities for student-to-student interactions through discussion boards and group-based projects. Five discussion board activities based upon current events provided an opportunity for peer collaboration. The discussions were graded on participation and comprised a small percentage of the overall grade.

Four projects were created to evaluate higher order learning objectives that required mastery of the subject matter as well as critical thinking skills. Three of the projects were geared towards groups and one focused on individual skills. The group projects required detailed understanding of spreadsheets and statistical analysis of data. Tutorials were created instructing students on how to utilize Google Spreadsheets for the projects. The Google spreadsheets were also helpful in fostering participation and collaboration within each group as students could easily peer-edit and evaluate their projects online. Rubrics provided clear information regarding assignment requirements as well as serving as a tool for the teaching assistants to use for grading.

A series of 22 quizzes were created to provide formative assessment and keep students moving through the course material. The quizzes were worth a total of 25% of the course grade, thus reducing the impetus to cheat by reducing the point value of each individual quiz. Quizzes were randomized with questions being drawn from a pool as well as being timed. Two higher stakes examinations (midterm and final) were worth 20% of the final grade and were required as an assessment methodology by the College of Engineering. The examinations were given on campus or at a proctor-based facility for additional test security. These examinations served as summative evaluations to determine retention of information and ensure understanding of course materials. However, the overall point value of the exams were kept low to prevent students from failing due to the pressure of high stakes evaluation while still being important to overall course success.

The Engineering Economy course was structured by modules that required students to perform specific tasks on a weekly basis. The course week consistently ran from Monday through Sunday throughout the semester and deadlines were 10:00pm on Friday for quizzes and 10:00pm on Sunday for all other activities, projects and discussions.

The methodologies utilized in the delivery of the Engineering Economy course were chosen to address the specific needs identified in research for undergraduate distance education students as outlined in Table 2.

Challenges	Delivery Method
Feeling of isolation leading to dropout	Discussion boards, group projects
Time management skills	Frequent and consistent deadlines
Reduced student collaboration	Group projects
Limited opportunity for social and critical thinking skills acquisition	Discussion boards, group projects
Student accountability in assessments and assessment security	Low-stakes assessments, group projects, proctored exams
Decreased instructor-to-student interaction	General course discussion board
Decreased student-to-student interaction	Discussion boards, group projects

Table 2: Challenges and Delivery Method

Results

The Engineering Economy course was evaluated based on the success of the course in the context of the PELI programs goals to reduce the cost of instruction while increasing the quality of learning. Evaluation data included enrollment numbers, student grades, and student evaluations.

The cost reduction strategy of the PELI program focused on reducing the need for physical classroom space, increasing student enrollment and course offerings, and when possible increasing the student-to-instructor ratio without reducing the quality of instruction. The online redesign of Engineering Economy proved to be successful in all of these points.

The face-to-face Engineering Economy course enrollment averaged 306 students per year over a five year period. After the launch of the redesigned online course, enrollment increased to an average of 386 students per year averaged over a 5 semester period as demonstrated in Table 3.

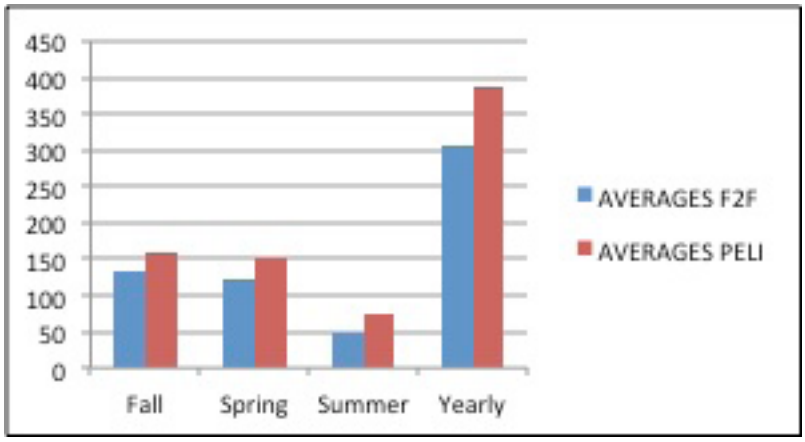

Table 3. Average Yearly Enrollment in EIN 4345, Engineering Economy

The revenue generated by the increased enrollment was estimated by the weighted cost of delivery per Student Credit Hour as determined by the University of Florida Responsibility Center Management Operating Manual (RCM). The revenue generated due to the increase in enrollment in the Engineering Economy course is estimated at $88,449/year. The release of the face-to-face classroom for use by another department or course was also determined by the RCM at a savings of $4,860/year for the release of the square footage of space occupied by the course. The number of teaching assistants necessary to support the course was reduced by one at a cost savings of $28,830 per year.

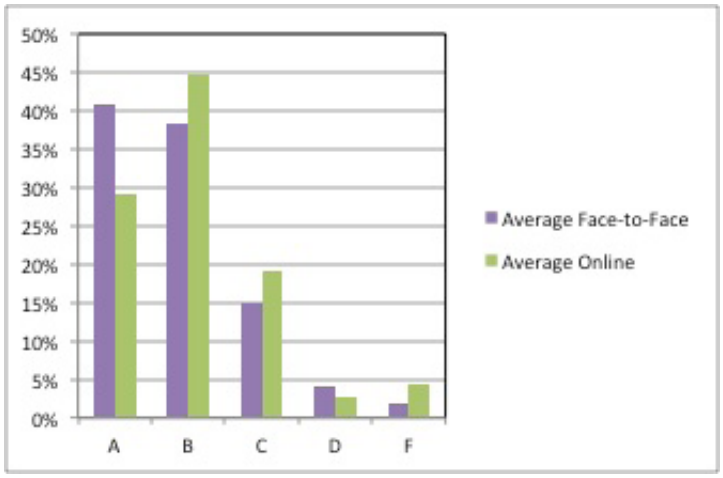

Table 4. Face-to-Face vs. Online Grade Distribution Comparison

The total cost savings of the course was determined by the value of the yearly average number of increased student credit hour dollars ($88,449) added to the average yearly cost savings of one teaching assistant ($28,830), and the average yearly value of the release of one large lecture hall for use by another course ($4,860). This number was then subtracted by the yearly cost of the learning management system which was calculated at $1,930 for the 386 average student enrollment in the online course. The cost of proctored examinations was not factored into the cost savings as both the face-to-face and online versions of the course used the same method and facility. The total cost savings of the Engineering Economy course is estimated at $119,489 dollars per year. It is important to note, however, that the financial impact of the students taking the Engineering Economy course in lieu of another course were not calculated.

The second major goal of the PELI initiative was to improve the quality of learning for the student. This was determined by comparing overall student performance data of five years prior to the course redesign and the five semesters of the online course. Table 4 shows that grade distribution changed in the online course with a decrease in A and D grades and an increase in B, C, and F grades. The historical grade distribution of the face-to-face course had a rate of 94% passing and 6% failing while the online course grade distribution had a rate of 93% passing and 7% failing. Overall the distribution of passing grades versus failing grades when comparing the face-to-face and online course has remained well within a standard deviation of 1%.

Quality of learning was also determined by comparing student responses to surveys in comparison with the key challenges outlined for success in the undergraduate online course. The survey results showed a high level of student satisfaction in the course with specific areas identified for improvement. Areas of success were identified as a 60% or greater positive response rate. Table 5 below shows a brief summary of student survey results taken from online course supporting student satisfaction within these identified challenges.

Challenges	Survey Question	% Response	
		True	False
Feeling of isolation leading to dropout	I felt connected to the students in this course.	**65%**	35%
	I considered dropping this course while taking it via e-Learning due to lack of interaction with other students and the instructor.	7%	**93%**
Time management skills	The weekly discussion, quiz, and assignment due dates helped me stay on task with my responsibilities in the course.	**93%**	7%
	I had difficulties keeping up with the weekly discussion, quiz, and assignment due dates.	30%	**70%**
Limited opportunity for social and critical thinking skills acquisition	This course challenged me to think about and more fully explore the topics discussed, beyond the stated lecture topics.	**80%**	20%
Decreased student-to-instructor interaction	I was able to easily communicate with the EIN4354 instructor.	**90%**	10%
	The EIN4354 instructor responded back to my emails and discussion board posts within an appropriate amount of time.	**96%**	4%

Table 5. Positive Student Satisfaction with Course Challenges

Table 6 below identifies areas of dissatisfaction. Areas of needed improvement were identified as those with a 40% or greater negative response rate within the stated challenges.

Challenges	Survey Question	% Response	
		True	False
Feeling of isolation leading to dropout	I felt connected to the instructor of this course.	54%	**46%**
Reduced student collaboration	I established strong, collaborative relationships with the students in this course.	40%	**60%**
	I had difficulties connecting and collaborating with the students in this course.	**46%**	54%
Decreased student-to-student interaction	I think taking this course via e-Learning provided me with the same level of academic interaction with my fellow students that I would have had in a face-to-face course.	59%	**41%**

Table 6. Student Dissatisfaction with Course Challenges

Although student surveys showed areas of needed improvement in regards to student-student interaction and instructor presence, overall student satisfaction with the course was positive.

Recommendations

One of the two major goals of the Provost E-Learning Initiative was to reduce the cost of instruction in high-demand courses at the University of Florida. When utilizing online courses as a methodology for reducing the cost of instruction it is important to consider the cost of the learning management system in comparison with the cost of the face-to-face classroom. In the case of Engineering Economy, when comparing the cost of the learning management system ($1,930) and its support to the cost of the physical classroom ($4,860), it is evident that the online course was indeed less costly than the face-to-face course. The additional increased revenue created by the online course was generated by increasing student enrollment and reducing the number of teaching assistants.

This fact brings into sharp relief the second goal of the PELI initiative – to improve the quality of learning. Notably in the Engineering Economy course, the issues of isolation and reduced collaboration were identified as areas of needed improvement. The reduction of a teaching assistant and increase in enrollment may have contributed to a perception of decreased interaction and collaboration. Additionally, issues related to the learning management system, such as the robustness of wiki, blog, and discussion board tools affected the design of collaborative activities within the course.

Future goals for the Engineering Economy course include conducting more research on assessment security within the online course quizzes and improving the quality of the course in the areas identified by student evaluations. In addressing these areas, care must be taken not to increase the burden of work that currently falls on both the students and the instructor. Activities that encourage students to collaborate on ungraded homework activities, increased peer-review activities, and short instructor video responses to questions with an external tool such as VoiceThread may increase communication and collaboration and reduce isolation.

Overall, student surveys reflected a positive reaction to the design of the class and specifically within the identified challenges of isolation, time management, social and critical thinking skills acquisition, and student-to-instructor communication. Another future goal for the Engineering Economy course is to add modules in order to easily meet the needs of different engineering programs. This would ultimately allow the course to replace a total of four existing courses that are teaching similar materials and increase enrollment to a projected 700 students annually. These goals will ensure that the Engineering Economy Course continues to save money while maintaining quality education.

(Author bio, continued from page 1)

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Original release – December 15, 2011

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Acknowledgement

The editors wish to extend special thanks to Carrie Bishop and Melissa Gay of the Center for Teaching and Learning at the University of Georgia for their editorial assistance with this essay.

The Learning Technology Consortium

The LTC began in 1998 as a partnership of institutions with similar instructional goals, strong technology and faculty support programs, and an interest in collaboration around teaching and learning with technology. The members are:

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