

Innovative Teaching Methods in Engineering Economy: Web Delivery, Excel Calculation, Teamwork Support

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Abstract

Advancing technology has affected both the classroom-learning environment, the methods of performing economic analysis and the expectations of employers. This paper describes an innovative course, delivering engineering economics training that integrates three new technologies: web delivery, spreadsheet calculations and team support.

- The classroom environment allows Web delivery. Web delivery provides both classroom support and the opportunity for students to receive distance education.
- Methods of performing economic calculations are utilizing spreadsheet calculations. Spreadsheets permit advance-teaching techniques allowing both improved understanding and a move toward required employment skills.
- Employers have expectations of teamwork competency. Teamwork provides an opportunity for peer support and exposure to a wider set of problem scenarios and learning outcomes.

A description is presented of the resources utilized, the delivery methods and the teaching techniques. A major feature of the course is the use of LearningSpace, a distance education package. Course development uses an action research approach; a discussion of the results of the development survey is provided. A major outcome of these changes is a shift in course attendance patterns and student work practices.

Introduction

Advancing technology has affected the classroom-learning environment, the methods of performing economic analysis and the expectations of employers. Internet technologies in the form of distance education software allow lectures to be provided and homework to be collected from remote locations. Many engineering classrooms are equipped with multimedia presentation technology that allow the instructor to present and the class to discuss a computer display drawn from the Internet. Spreadsheet software with financial functions provide the ability to develop and to utilize standardized calculation formats that are useful for analyzing, not just solving, engineering economy problems. Employers are requesting that engineers be competent, or at least conversant, with the software tools and solution methodologies that are in common use in industry. Many texts and courses are still using hand solution methodologies. This paper presents a look at an engineering economics course that integrates the use of web based distance education with spreadsheet technologies in a student team-structured environment.

Demographics

The course has been taught by the author during the spring and the fall semesters of 2000 at Oklahoma State University. The College of Engineering offers the course to engineers (88%) and technology students (12%). The students are predominately on campus Juniors but include Sophomores through PhDs. The average student age is 21 and includes several adult learners in their early 30's. The class size has been scheduled for a maximum of 65 students and the enrollment has averaged 57 students. The drop rate for the two semesters combined is 9%.

Resources

Resources required to support the course include (links are to the product's homepage):

- [Lotus LearningSpace](#)¹
- [Microsoft PowerPoint](#)²
- [Microsoft Excel](#)³
- Office computer hardware includes a PC with triple monitors connected to a LAN.
- Course room hardware consists of a PC connected to a video projector and the LAN.
- A teaching assistant 3/32-1/4 time with access to similar hardware and software.
- Text - [Engineering Economic Analysis](#)⁴
- Solution Manual - Engineering Economic Analysis
- [ExamView Pro](#)⁵

Innovation

The combination of software used in delivering the course materials, and the manner in which the students prepared and submitted their work, results in an innovative education delivery method for engineering economics. The following software contributes to this system (links are to Oklahoma State websites that demonstrate the use of the software):

- [LearningSpace at Oklahoma State University](#) (in particular see the tutorial)
Provides four main content delivery sections, the:
 - The Schedule provides both a roadmap and a schedule.
 - The MediaCenter contains the content that is used for the course assignments.
 - The CourseRoom allows discussions and team meetings, both public and private, and a place to submit and to retrieve assignments.
 - The Profiles section contains information about the students, so they may get to know each other. A private student portfolio is also available for the return of work comments and grades.

In addition, a fifth area is available for assessment and instructor grades.

- PowerPoint Presentation
Provides for the deliver of:
 - An outline of the content covered in the lecture.
 - Details of the definitions, the methods and the rules related to the content.
 - Excel slides, inserted as operable objects.

- Excel Spreadsheets
 - Provides for delivery of the following:
 - Instruction on the functions used in engineering economics.
 - Portrayals of the layout and utilization of spreadsheets as used in engineering economics.
 - Operable examples that allow for the exploration of economic functions and spreadsheets.
 - Graphs that provide added reinforcement on the underlying concepts in engineering economy.
 - And provides for the receipt of:
 - Student developed spreadsheet solutions to economic problems.

Teaming

The students form teams of two to four students. This is a self-select process with guidance provided on identifying a productive team member. Each team is responsible for developing and for submitting homework, and for completing a team test. The students quickly learn that they must review the work prior to submittal, as their grades are dependent on the quality of the work presented. This procedure has two benefits: it develops the teamwork habits that are required in industry and it provides the peer support that helps the students complete the work with improved understanding. The latter is especially beneficial when the students are working at a distance or when the class size is quite large. This assumes that the students really work as a team, sharing information and reviewing each other's work. If one student does all the work, or the work is parceled out, then both the student and the team may fail to achieve the ultimate goal.

Instruction

Delivery of the material, as originally structured, was as a classroom lecture of thirty, 75-minute sessions. During the first semester, a slowly decreasing attendance rate throughout the early part of the semester was noticed. Exploration of this issue indicated that many of the on campus students were electing to study the material at their own convenience. During the second semester, this information was shared with the students early on and attendance dropped immediately to approximately one-third of enrollment. Following this enrollment slowly increased to about fifty percent. Those students attending class attended consistently, and no difference was noted in the average test scores of those attending from those not attending.

Testing

Testing is accomplished by utilizing both a team test and an individual test. The team tests are offered over the Internet. The team tests are problem based, requiring solution and submittal in spreadsheet format using economic functions. The first and second team tests are based on problems similar to the homework problems; the third team test is a case study that integrates principles from across the course materials. The individual tests are offered in a course room environment and are based on the materials presented on the overheads, in the homework problems and on the team tests. The individual tests are in a true-false and multiple-choice format that requires both a conceptual understanding and an analytical analysis of the course

material. This testing method was driven by a combination of class size, the availability of a computer course room of adequate size, the instructor's schedule and teaching assistant resource issues.

Course development

The strategy was to first select a text that utilized spreadsheet and economic functions as an instructional and as a solution mechanism. Since a text that followed this format, in a pure sense, was not available, a text that was making the shift to this format was chosen. The text selected was [Engineering Economic Analysis](#). During the first semester, the text was followed in constructing the instructional materials; the book examples were developed as spreadsheet examples. During the second semester, additional examples were added based on the text's end of chapter questions and an automatic test development system was instituted using [ExamView Pro](#). ExamView pro was chosen because the software can automatically prepare Web based tests. Web based individual testing may be the next step in course development, but will only occur in a proctored setting or if students are widely separated geographically.

Student assessment

In individual private discussions with a number of students concerning the course, the students generally reported the following:

- Benefits
 - Scheduling of instruction time at a time compatible with their needs provides an improved learning experience.
 - The availability of operating spreadsheets as examples reduces questions and facilitates developing solutions.
- Costs
 - Working in teams can involve more work if the team members do not schedule and control their time.
 - The individual student needs to learn to use the Internet efficiently and in some cases to upgrade their hardware.
 - For a few students using spreadsheets seems to be a struggle.

Instructor assessment

As the instructor, I observed the following:

- Benefits
 - Using economic functions and spreadsheets provides a method for explaining concepts more effectively and efficiently.
 - Developing a new approach to delivering training materials is very enjoyable.
 - The instructional delivery time requirements can be greatly reduced.
 - More material can be covered than in a traditional approach
- Disadvantages
 - Preparation of the materials can be time consuming.

- Training the students to utilize the technology is at first frustrating and time consuming.
- Some students see the delivery method as a means of reducing their personal involvement.

Improvements

A goal for future semesters will be to refine and to integrate the instruction materials and examples in a more cohesive manner. Necessary improvements include:

- Bloom's taxonomy integrated into the course structure.
- The subject matter presented in smaller increments.
- A review of materials presented:
 - Is an understanding of functional notation and interest factors still relevant?
 - Is an understanding of interest formulas still relevant and if so to what extent?
- Modeling of learning outcomes demonstrated at the beginning of a section.
- Selecting and providing hot links to issues that may impact a particular problem.
- Relating identified outcomes to the learning methods used by students when developing solutions.
- Developing and providing test modules that allow for on-line student practice.

Conclusion

Using this innovative teaching method in an engineering economics class works well. Students learn engineering economics while using a method that provides the advantage of approximating the work environment they will experience after graduation: using spreadsheets to solve economic problems, working in teams, using the internet to collect and distribute information.

Bibliographic Information

¹ URL: <http://www.lotus.com/home.nsf/welcome/learnspace>, LearningSpace Website Homepage.

² URL: <http://www.microsoft.com/office/powerpoint/>, Microsoft Office – Microsoft PowerPoint.

³ URL: <http://www.microsoft.com/office/excel/>, Microsoft Office – Microsoft Excel.

⁴ URL: <http://www.engrpress.com/isbn/1576450538.html>, Newnan, Donald G., Lavelle, Jerome P. & Eschenbach, Ted G. *Engineering Economic Analysis*, 8th Ed. Austin Texas: Engineering Press, (2000).

⁵ URL: <http://www.examview.com/>, Welcome to ExamView Pro.

Biographical Information

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