Course Strategy: Executing High-Enrollment Engineering Economics Online

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Instructional Environment

This course strategy relates to a two-credit undergraduate engineering economics course at Missouri University of Science and Technology delivered by the Department of Engineering Management and Systems Engineering. The course is a required component of the curriculum for mechanical engineering majors, and may be completed at any time in the program. The course is also a required core course for engineering management majors, where students typically complete engineering economics in their second year of study. Further, students from other engineering departments often choose to complete the course, making for a varied student population. In addition to students from a mix of majors and class standing, the course also reaches students who are away from campus on co-op or internship terms and cooperative degree program students studying at a partner campus. The course is managed by a sole instructor, and is regularly offered each fall and winter semester, as well as an abbreviated summer semester. Typical enrollments of 300 students each semester in fall and winter, and 50 students each summer are expected. No regular teaching assistant or grading support is utilized, though campus-based tutoring is available to students three days per week.

Delivery Method

The course strategy has been developed over many semesters, through iterative design-based research macrocycles. The course initially evolved from a traditional classroom lecture into a hybrid/buffet delivery, incorporating the positive aspects of both online and face-to-face elements. After refining this approach over many semesters and developing high quality digital support resources, the course advanced to fully online delivery several years ago. The online course is delivered through the campus learning management system, Canvas, with author-generated and publisher-provided learning resources integrated directly into the learning management system. Extensive introductory and orienting content is presented to students at the beginning of the course - before they encounter any engineering economics material - to ensure students are comfortable and prepared to work in the online environment.

Approach to Instruction and Technology

The general approach to the course involves introduction of the fundamentals of time value of money using both equations and tables, aided by extensive use of cash flow diagrams. This "by hand" approach is most appropriate when students are first introduced to the concepts, as it promotes visualization of cash flows and intuition about calculations. Further, in parallel, simple spreadsheet financial functions are introduced as a third solution approach to foundational

calculations. Once students have developed strong conceptual understanding of the basic principles, analysis moves progressively to greater spreadsheet use. Some topics, such as sensitivity analysis, rely almost exclusively on spreadsheet analysis.

The online course is organized into modules by topic, with one module presented each week of the standard 14 week semester. Each module offers a structured learning path to guide the student progressively through the learning resources provided. Providing an abundance of learning resources is valuable to the student, but can be highly overwhelming.   Students may be uncertain how to best use the resources or which features and topics are important. The structured assignments in each module guide students to specific resources, and encourage them to interact with the material in a natural progression. Each module contains the following assignments/elements:

Reading Review: Students are prompted to read specific sections of the digital or print text, and then answer multiple-choice questions related to the text concepts.

Lessons: Students are prompted to view mini-lecture videos that present fundamental topics and simple examples, and may take notes on fill-in forms as they view.

Examples: Students are presented videos that demonstrate the solution to a characteristic example problem solved using equations, tables and spreadsheet functions.

Practice: Students are assigned math-based problems, and offered structured support as they practice the problem-solving processes demonstrated in the text and examples. Support may include a video solution of the problem or a tutorial that outlines the problem-solving steps, along with answers and solutions displayed after two attempts are made.

Homework: Students are presented problems with limited support to test their knowledge of the problem-solving processes. Problems are algorithmic so each student sees different values.

In the progression of each module, Reading Reviews begin by introducing the text and encouraging mastery of terminology and concepts. Lessons present the fundamental topics in video form. Examples encourage students to view a problem-solving process and model it in a similar assigned problem. Practice encourages more problem-solving—the key to success in the course—and offers abundant student support. Finally, Homework requires students to apply the problem-solving skills to new scenarios. When presented sequentially, the assignments guide students through concepts and problem-solving in a progressive fashion.

Topics Covered

Specific learning objectives are associated with each module. General module topics include: interest & cash flows, time value of money calculations for various cash flow patterns, compounding and effective interest rates, personal finance, present worth, future worth, annual worth, payback period, discounted payback period, capitalized worth, benefit cost ratio, rate of return, depreciation, corporate taxes, inflation, break even, sensitivity analysis, and risk.

Assessment

Overall course grades are determined by weighted categories, with Reading Review (5%), Practice (15%), Homework (30%), and Exams (50%). Reading Review, Practice and Homework assignments are all submitted through the learning management system and are graded automatically by the publisher-provided system. Three Exams are administered in a proctored environment, involving questions that require students to demonstrate the steps of their problem solving. Exams are graded manually by the instructor with partial credit and written feedback.

Rationale for the Approach

As previously noted, the online delivery approach evolved over many semesters. Incremental course changes were informed by design-based research study of student perceptions, learning outcomes, and success measures. Advancements in educational technology and availability of quality digital content facilitated the shift to fully online delivery. However, most importantly, student demand was the primary factor influencing delivery mode. In the early stages of transition from lecture to hybrid/buffet delivery, student preference for increased digital learning was pronounced. When given the choice of a buffet of learning options, students chose to access digital resources over attending live lectures, with no deterioration in learning outcomes or success measures. Further, a significant shift in student accountability was noted. Rather than students feeling frustrated that they could not "get it" from lecture, they became empowered owners of their learning – accessing resources that best suited their learning preferences and seeking assistance when needed. A key factor in the success of hybrid/blended delivery, and now online, is abundant support resources. When students need help, they can choose from: regularly scheduled online office hours with their instructor, by appointment virtual office hours, email and/or text communication with rapid response times, a collaborative online Q&A platform, and/or face-to-face tutoring. Learning management system data allows the instructor to identify and connect with at-risk students early in the semester, linking students with the support resources they prefer.

Lessons Learned

Significant time and resources were dedicated to the design and development of the online course strategy detailed here. Without the expertise of instructional design and educational technology professionals, the transition from lecture to online delivery may have been disastrous. Learning from the experts in the areas of teaching and technology, and listening to the student perspective, have proven invaluable in this journey to online.