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Instructional Strategies Used in an Engineering Economy Course

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Instructional Strategies used in Engineering Economy

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Abstract

As a requirement for graduation, Civil, Construction, Electrical and Computer Engineering majors at The Citadel must take an Engineering Economy course in their junior year. The course focuses on basic principles of engineering economy as applied to the economic analysis of the costs of construction and operation of various engineering works. This Work-in-Progress paper describes the instructional strategies for Engineering Economy for two different methods of instruction (i.e., real world application problems/case-based and direct instruction using textbook problems).

Keywords

Engineering Economy

Background and Literature Review

Engineering majors in their first two years of their education are generally taught methods and are not exposed to the applications of these methods until later in their education. Unfortunately, it is difficult to motivate students when they do not see how their work applies to the real world [1]. To maximize student learning, it is essential to develop ways to promote student motivation and engagement[2-3]. Motivated students strive to make the most of their education by acquiring new information and using it to further their knowledge [2-4]. To increase the value that students place on a task, it is helpful to relate it to their interests [2-6]. If students can work on a topic that has meaning or relevance to them, they are more likely to see the value and become more motivated [3,7]. One way to increase students' motivation is to provide them with assignments that focus on real-world applications. Focusing on real-world problems helps students see the actual applications of the theories learned in class [2-6]. The real-life examples and case studies help students see their classroom material come to life [2-4].

Engineering Economy Course at The Citadel

At The Citadel, Civil, Construction, Electrical and Computer Engineering majors are required to take an Engineering Economy course in the first semester of junior year. Engineering Economy is a two-credit course that meets for 2 hours (twice a week for 50 minutes each) The main topics of the course include Time Value of Money and application of Present worth (P), Future worth (F), Annual worth (A) and Gradient (G) factors; calculating nominal and effective interest rates; calculating Capitalized Cost and Equivalent Uniform Annual Worth for alternatives comparison; calculating rate of return for alternatives comparison, using Minimum Attractive Rate of Return as a basis; calculating Benefit Cost Ratio for alternatives comparison, including associated ethical considerations; performing breakeven analysis; and depreciation calculations using

Straight Line, Double Declining Balance and Modified Accelerated Cost Recovery System methods.

Real World Problems/Case-based Instruction

One instructor (instructor X) at The Citadel uses just-in-time[8] and case-based teaching methods which begin with questions to be answered or case studies to be analyzed. The instructor uses web-based pre-class reading responses[8] to motivate students to prepare for class. Students are required to respond to one or two open-ended questions (i.e., what is the difference between APR and APY? What is capitalized cost?) prior to the lesson. Before each lesson, the instructor examines student responses, and he develops in-class activities to meet their actual needs[8]. At the end of each lesson, the instructor uses the One-Minute paper[9] to monitor student learning and address students' misconceptions and preconceptions. He asks students to write a concise summary of the concepts, write an exam question related to the key concepts, or answer a big-picture question from the material that was presented in the current lesson in 60 seconds.

Textbooks problems are typically well-defined, have only one solution method, and provide all information necessary for a solution. Instead of using traditional textbook problems such as: "Find the monthly payment for loan of $247,200 which are occurring for 15 years. Assume 6% annual rate of interest". The instructor uses real world examples such as the following example: In December of 2021, Uncle Mort purchased a $309,000 house in Town of Goose Creek, South Carolina with a 20% down payment and financed the balance at an APR of 6% for 15 years.

(a) How much money does Uncle Mort need on the closing day [including the down payment, origination fee, processing fee, underwriting fee, appraisal fee, credit report fee, survey, and title fee]? For part a, assume reasonable values for the closing cost items listed above.
(b) Determine the total amount of money Uncle Mort pays each month to the bank (which includes principals, interest, property tax, property insurance). For part b, assume reasonable values for the property taxes and homeowner's insurance premium.
(c) Uncle Mort plans to apply for a home equity loan for renovating the master bathroom and kitchen. How much equity will he have in December 2028?
(d) Uncle Mort is interested to know how much of his first and second monthly payment goes toward the interest paid to the bank.
(e) Write a short memo to Uncle Mort and explain to him how you solve parts a through d.

The instructor also employs case study. The following are two sample case studies used in engineering economy course:

Uncle Mort's rent or buy dilemma: Uncle Mort can rent the house for $2000 per month. If he plans to live in the house for five years. Use present worth analysis to decide which alternative he should choose (be sure to show the cash flow diagram for each alternative and state all assumptions). Produce a report that includes, at a minimum, a brief *d*escription of the concepts learned and recommendations. The report should be prepared in a business letter format. Keep the letter brief but be sure to use an appropriate writing style and include all analyses in an attachment.

Locate a spot in your house that you believe to be wasting energy and determine if you can

develop an economic project to reduce the waste. Be sure to consider the following: What is the current process? How much is the current energy usage? Why is it inefficient? What should be installed or replaced, and how much energy will it use? How much would it cost to purchase and install the proposed equipment? How much are the maintenance costs? What will go better or worse than you think and the resulting financial implications[10]? Produce a brief report that includes your analyses and recommendations. The report should be prepared in a business letter format. Also be sure to use an appropriate writing style and include all analyses in an attachment.

Textbook-Directed Instruction with Business Case and Stock Market Activities

Similarly, through the traditional textbook-directed instruction, students taking the Engineering Economy course are exposed to real-world problems through class quizzes, class work, homework assignments, team projects and exams to demonstrate proficiency. To support the textbook concepts and example problems, another instructor (instructor Y) at the Citadel engages students with a business case team project that utilizes many of the concepts in the examples and problems covered in class and homework assignments. Additionally, a stock market activity is assigned students at the beginning of the semester where students select a stock and follow its daily trading volume throughout the semester to understand market conditions and effects on stock price.

Both the Case-based methods and traditional Textbook-Directed methods can be used to demonstrate ABET outcomes [11].

- ABET Criteria: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
    - Case-based method: cases are complex problems requiring identification, formulation, and engineering topics covered on the FE exam.
- ABET Criteria: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
    - Case Method: students need to describe the economic, environmental, and societal context of a case.
- ABET Criteria: An ability to communicate effectively with a range of audiences.
    - Case-based Method: Case study reports require effective written/verbal communication.

Research Next Steps

As this research continues, quantitative and qualitative data will be collected from course sections taught by both instructor X and instructor Y in the form of graded assessment, evaluation of ABET outcomes and student surveys. It is anticipated that the analysis of the data collected would give meaningful insight into the effectiveness of the methods used by either instructor. This data-driven contrast and comparison of the two course instructional methods used would be a valuable resource, not only to both instructors, but to all others who would be teaching Engineering Economy in the future.

Conclusions

Preparing the students for engineering economic evaluations to complement real world applications is an important outcome and achieved through the methods of instructions discussed in this paper. The application of the team projects continues to reinforce the basics of engineering economy and education of the students.

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