

## Study of Prior Exposure to Engineering Economy at The Citadel

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### Abstract

As a requirement for graduation, Civil and Electrical 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. A background knowledge probe (pre-test) was developed based on key concepts in engineering economy. The pre-test was administered at the beginning of the course to measure student's prior engineering economy knowledge and to identify student misconceptions at the beginning of the term. This study examines the pre-test data from sections of Engineering Economy taught in summers 2017/2018 and fall 2018 at The Citadel.

### Keywords

Concept Inventory, Pre-test, Engineering Economy

### Literature Review

Concept inventories (CIs) are a key component in evaluating student learning and assessing how well students have mastered concepts of a course. The assessment process begins at the start of course, when students are given a background knowledge probe, such as a pre-test. The pre-test provides a baseline that is vital to assess a student's mastery of course concepts when utilizing another knowledge probe at the end of the course, a post-test. Significant research has been published on concept inventories for a multitude of courses and disciplines (reference papers). Specific to engineering, courses such as Statics, Dynamics, and Thermodynamics are widely defined and researched CIs<sup>1-6</sup>. CIs for engineering economy are not widely used in student learning. Bursic<sup>1</sup> has one research application in engineering economy in which she developed and assessed learning through a CI of 17 multiple choice and three numeric response questions. The scarcity of engineering economy concept inventories highlights the minimal value placed on engineering economy in engineering programs. A survey by Nachtmann, et al.<sup>7</sup> highlights 57% of economy courses are taught by industrial engineering professors, with instructors of all other branches of engineering never exceeding 10%. The premise that students will be better equipped to make advantageous financial decisions, both in their professional endeavors and in their personal undertakings after taking an engineering economy course, was investigated by Ulstad, et al. The results of the Ulstad<sup>8</sup> study were inconclusive on the gains in financial decision making after taking the course. Engineering Education should better prepare engineering students to make informed economic decisions. Further, a better picture of prior economics knowledge will help determine effective course preparation and structure for engineering economics. This paper studies students' prior exposure to engineering economy when entering a required course on the subject.

### Institutional Context

Engineering Economy is required of students in both the Civil and Electrical Engineering programs at The Citadel. Students in the evening program may only take Engineering Economy during one of the two summer terms. Students taking Engineering Economy in the day program usually take the course during the fall semester, but may also register for the course in the summer.

Summer sections of Engineering Economy primarily have Electrical and Civil Engineering evening students, but may also have day students. Evening students may be employed full-time or part-time and students who normally attend school in the day program may also have summer jobs. Finally, students may have been taking courses at The Citadel for two or more years and other students may be students in a 2+2 program who are taking Engineering Economy as their initial course at The Citadel.

### Assessment Measure

A six-question pre-test was developed based upon the key concepts in engineering economy course (see Table 1). The pre-tests were administered to measure students' prior geotechnical knowledge and to identify student misconceptions at the beginning of the semester. It is important to note that the pre-test did not count toward the course grade.

Table 1. The short-answer questions on the pre- and post-test

Question 1	How do time and interest affect money?
Question 2	What is the meaning of the rate of return?
Question 3	What is the difference between APR and APY?
Question 4	What evaluation method is used to select between public sector alternatives with unequal lives?
Question 5	What is capitalized cost?
Question 6	What is the difference between tax depreciation and book depreciation?

### Results and Discussion

Figure 1 illustrates the mean score (in percentage) for each question and analyzes students' performance on each question on the pre-test. The pre-test means for Questions 1, 2, 3, 4, 5, and 6 range from 71% to 97%, 32% to 71%, 2% to 31%, 0 to 4.5%, 0 to 7%, and 0 to 12%, respectively. Student's high pre-test performance on certain questions suggests that they are sufficiently able to apply their prior knowledge to certain aspects of Engineering Economy. Student performance (at below 50% level) on Questions 3-6 of the pre-test is an extremely poor performance, indicating little to no prior experience with these concepts. The strongest score on the pre-test was Question 1 (time value money), which is an important theme in the Engineering

Economy course that the students successfully mastered. Student’s high pre-test performance on Question 1 suggests that they are sufficiently able to apply their prior knowledge to certain aspects of Engineering Economy. The weakest scores on the pre-test were Question 3 (difference between Annual Percentage Rate and Annual Percentage Yield); Question 4 (evaluation method used to select between public sector alternatives with unequal lives); Question 5 (concept of capitalized cost); and Question 6 (difference between tax and book depreciation). The pre-test standard deviation for each question is shown in Figure 2 and ranges from 0 to 95%. The pre-test standard deviation for Questions 1, 2, 3, 4, 5, and 6 range from 19% to 30%, 39% to 44%, 11% to 95%, 0 to 21%, 0 to 26%, and 0 to 32%, respectively.

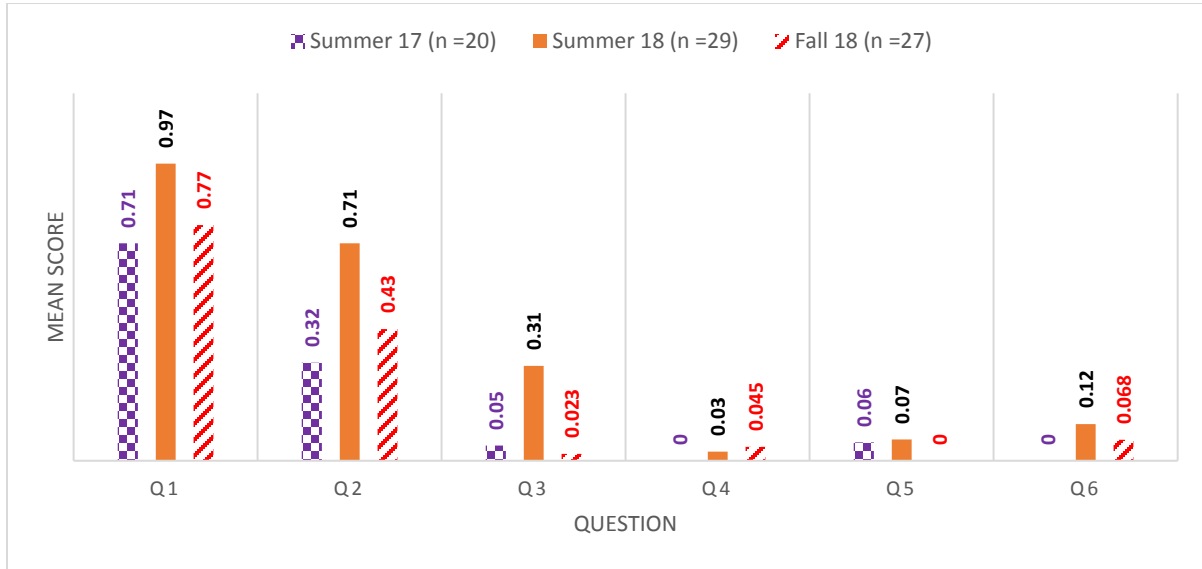


Figure 1. Mean score for each question on the pre-test

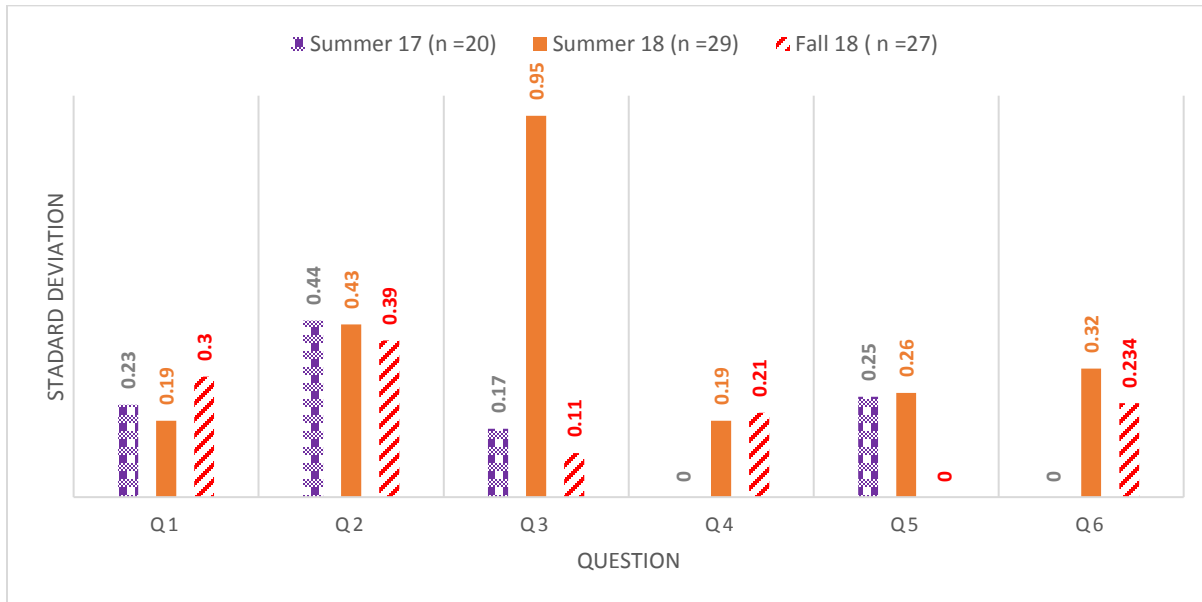


Figure 2. Standard deviation of each pre-test question

## Conclusions

This study assessed the amount of exposure engineering majors have to Engineering Economy prior to this course. The following conclusions can be made based on the study results:

- Students are entering Engineering Economy course with little prior knowledge. The low performance on several of the pre-test questions is not surprising, as students are not expected to have wide exposure to these concepts prior to completing a course in Engineering Economy.
- The results show that 82% of the students were able to answer very loosely how time and interest affect money, but were unable to correctly answer any other question consistently regarding rate of return, capitalized cost, or depreciation.

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