Evaluating Students' Performance in a New Course Sequence with Economic and Design Principles in the Undergraduate Engineering Curriculum

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ABSTRACT

This paper presents some of the results obtained from a four-year project conducted at the Georgia Institute of Technology and Virginia Polytechnic Institute. For this project, four engineering science courses were modified to include economic and design principles. The primary objective of this experiment was to investigate on how the integration of economic principles with design can effectively be used to teach engineering science courses in the undergraduate engineering curriculum.

Introduction

In 1991. the National Science Foundation funded a multiyear project involving five universities. The project, entitled "The Integration of Economics with Design in the Engineering Science Component of the Undergraduate Curriculum" primarily focused on how the integration of economic principles with design can effectively be used to teach engineering science courses in the undergraduate engineering curriculum. The project also investigated how a stronger design orientation can improve understanding of the economic and technical tradeoffs required in developing processes to transform resources into products

Four courses were initially proposed and subsequently developed during the first two years of the project. These courses included Introduction to Engineering Mechanics, Elements of Thermal Energy Sciences & Systems, Introduction to Electronics & Electromechanical Systems, and Engineering Economy. These courses were primarily developed at the Georgia Institute of Technology and Virginia Polytechnic Institute and two of them were beta tested at the University of Louisville in the academic year of 1994-1995 [1-5].

Review of results obtained from Georgia Institute of Technology's experiments

A total of 274 students at the Georgia Institute of Technology took part in the experiment. Table 1 illustrates the distribution of the participating students.

Table 1. Breakdown of participating students at Georgia Tech., Spring 1994

Course		Number of Students
ESM 2201	Introduction to Engineering Mechanics (Traditional Course)	60
ESM 4805	Introduction to Engineering Mechanics (Modified Course)	27
ME 3720	Elements of Thermal Energy Sciences& Systems (Traditional Course)	75
ME 4805	Elements of Thermal Energy Sciences& Systems (Modified Course)	30
EE 3710	Introduction to Electronics& Electromechanical Systems (Traditional Course)	49
EE 3825	Introduction to Electronics & E,lectromechanical Systems (Modified Course)	33

A pretest was designed and administered in the first week of the quarter. The objective of this pretest was to assess the students' preparation in the subject. Certain information was collected from all the students participating in this experiment. This information includes the following:

1. Gender
2. Major field of study
3. Class section
4. Level of study
5. Cumulative grade point average
6. Score on the SAT math examination
7. Score on the SAT verbal examination
8. Class percentile in high school
9. Score on the pretest
10. Score on the final examination

The data collected from courses listed in Table 1 were analyzed using the SAS software. In order to make this collected data more manageable, the gender, major, and level of study were classified into different groups.

1. Gender was divided into two classes (male and female).
2. Major was divided into classes (industrial engineering, other engineering, and nonengineering).
3. Level of study was divided into four classes (freshman, sophomore, junior, and senior).

The cumulative grade point average, SAT-math score, and SAT-verbal score were considered to be continuous independent variables.

Several procedures, including Correlation Analysis, General Linear Models, and Analysis of Covariance, were used to analyze the collected data. In the General Linear Model Procedure, the analysis was conducted using the final examination score as the dependent variable and the gender, class section, major, level of study, SAT-math score, SAT-verbal score, and grade point average as independent variables. All analyses were conducted at the 0.05 level of significance. The data from all six sections were pooled. It was found that the variable associated with class section was very dominant. The pooled data were then divided according to the three departments. Due to an insufficient amount of data, it was not possible to develop a statistically valid model for each department. It was further found that the design questions on the Electrical Engineering exams were far more challenging than the questions on the other exams.

A model was "then generated for the courses in the other two departments (ESM and ME). The results indicated that the level of study, high school grade point average, college grade point average, and five first-order interactions (class section major, SAT-math class section, CLGPA major, HSGPA level, and HSGPA CLGPA) significantly affected the scores on the final exams. The statistical analysis also indicated that the students in the new courses performed as well as the students in the traditional courses.

Review of results obtained from Virginia Polytechnic Institute's experiments

Four sections of the engineering economy course were taught at Virginia Polytechnic Institute during the Fall Semester 1994. A total of 459 students participated in these sections. Table 2 displays the breakdown of the participants in this experiment.

Table 2. Breakdown of participating students at Virginia Tech., Fall 1994

Section	Number of Students
ISE 2014-01	107
ISE 2014-02	145
ISE 2014-03	137
ISE 2014-04	70

The data collected from Virginia Polytechnic Institute was classified and analyzed using the same classification and statistical analysis techniques used for the Georgia Institute of Technology's experiments. The results indicated that at the 0.05 level of significance, the level, SAT-math score, and two interactions (level * major and level * CLGPA) significantly affected the scores on the final exams for all four sections. Analysis of the individual courses indicated the following:

1. There was a significant difference between the means of the two morning sections.
2. There was no significant difference between the means of the two afternoon sections.

The data from the morning sections and afternoon sections were pooled. The analyses were performed to compare the means of the final scores in the groups between the new and the old sections. The results indicated that there was no significant difference between the means of the morning and afternoon groups.

A comparison between the final scores of students who participated in the experiment in 1993 and 1994 was conducted. The results indicated that there was a significant difference between the means of the two mornings groups. A similar comparison was conducted between the afternoon sections 1993 and 1994. The results showed that there was a significant difference between the afternoon sections of these years.

Conclusions

This article reported some of the results obtained from data collected from an integrated core of the engineering science courses developed and conducted at Georgia Institute of Technology and Virginia Polytechnic Institute. The primary objective of this research was to investigate how design activity, fully integrated with economic principles, can be effective y uti lized to teach the engineering science component of the undergraduate curriculum. Several statistical procedures were used to compare the results obtained from these experiments. All experiments were carried out at 0.05 confidence level. The results indicated that the students in the new courses performed as well as the students in the traditional courses.

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