Integrating Research into the Cost Engineering Classroom

Heather Nachtmann
University of Arkansas

Abstract

This paper is based on the author’s positive experience of integrating research into the classroom at two levels of engineering education, graduate and freshman. Several integrative teaching and research activities were conducted in a graduate Cost Estimation Models course. These activities included article reviews, presentation of current faculty research, and student research projects. The freshman level course, Industrial Cost Analysis, introduced students to various research activities including literature reviews and preparation of research presentations and reports. A brief overview of the relevant literature in this area is presented in this paper. Various methods and suggestions based upon these integrative classroom experiences are discussed.

Introduction

Engineering education researchers have recognized the importance of integrating research and education. The results of a recent survey of engineering economy educators show that eighty-five percent of respondents who are conducting research in the field of engineering economy incorporate this research into their classrooms. These engineering economy educators have recognized the importance and benefit of doing this and are actively responding to the need to integrate research and teaching.

The current movement toward integrating research into the engineering economy classroom can benefit both the students and the professor. The integration of faculty research into the classroom has several potential benefits including:
- reduces class preparation time,
- extends traditional textbook material,
- stimulates interest in the classroom,
- motivates creativity, and
- provides real world applications of classroom concepts.

Keeping up with recent research developments enhances the intellectual content of the course and helps to keep the course content current.

Graduate Course

The graduate course, Cost Estimation Models, was developed and taught during the Fall 2000 semester. The course was delivered to 14 students onsite in the classroom and 15 distance students offsite via videotape. The general format of the course was lecture coupled with active learning exercises and discussions.
In addition to traditional manufacturing and parametric cost estimation, the primary course topics were data collection & management, learning curves, activity based costing, cost reviews, and risk and uncertainty.

The primary objective of the course was to provide an in-depth overview of cost estimation techniques and methodologies with an emphasis in manufacturing. This was accomplished through detailed analysis of the cost estimation development process and various cost estimation models. A secondary objective was to further develop the students’ research interests and abilities. This objective was achieved by incorporating several research activities into the course. These activities are discussed next.

Article review

Each student was assigned an article that was relevant to the course. The articles were reviewed by the students and presented orally to the class and instructor. In addition to providing a thorough overview of the article, the students were asked to address the following questions:

- what research was done,
- how was it presented,
- did the results support the premise of the article,
- was the argument convincing, or did more or better work need to be done, and
- how much of a contribution to the field does it make.

This required the students to critique the article in addition to performing an in-depth review. It is important for students to understand that the quality of the publication, qualifications of the authors, depth of analysis, and presentation and validity of the results should be assessed. In addition to providing them with experience in reviewing published articles, the article review helps them to critique their own research.

For the most part, relevant articles were assigned to students based on their professional and research interests. Students were also given the option of selecting their own articles. Articles were assigned and presented in accordance with the current course topic. For example, Cooper and Kaplan’s 1998 paper, “The Promise and Peril of Integrated Cost Systems” and Harrison and Sullivan’s 1996 paper, “Activity-Based Accounting for Improved Product Costing” were assigned to supplement the Indirect Cost Estimation – Activity Based Costing portion of the course. When Data Collection and Management was covered in the course, students presented “The Organization of an Estimating Department” by Dysert and Elliott and “A Strategy for the Development of a Cost Estimating Database” by Gearney. Selecting articles to supplement course topics was a worthwhile process as many of these papers contributed to the author’s own research.

In an anonymous course survey, all of the student respondents felt that the article review added to their classroom experience and recommended its inclusion in future course offerings. Specified benefits were as follows:

- provided public speaking experience,
- gave further understanding of course topics, and
- provided additional in-depth information that was not covered in the course.
Proposal

A take home exam was assigned that required students to write a proposal to a potential client requesting funding for a proposed cost estimation system. The take home exam asked the students to evaluate the current cost estimation system, make recommendations based upon the course knowledge base, project potential development and implementation problems, and estimate the cost of implementing the system. The proposals were primarily assessed in the following areas:

• depth of analysis,
• feasibility of recommendations,
• assessment of potential problems,
• validity of estimated system cost, and
• writing quality.

Student performance on these proposals exceeded the instructor’s expectations. This exam allowed the students to synthesize course content, be creative, develop their written communication skills, and obtain experience in proposal writing, which are all important research skills.

Project

The students completed an open-ended term project on a course-related topic of their choice. The projects were completed individually or in small groups. Each project consisted of a written report describing the problem area, analysis, results, and recommendations. A literature search and review primarily consisting of refereed publications was undertaken and written up in each report. Each project was also presented orally to the class.

Students were asked to select a project that focused on a real problem in their work, research, or personal life. An additional option was to provide a more in-depth look at one of the course topics or investigate an area of cost estimation that was not covered in course. The majority of the students opted to research a real world problem facing them at work or home. A sample of the selected project topics were:

• cost estimation of home remodeling,
• cost estimation for the residential conversion of a Wall Street office building,
• cost estimation of starting a web business,
• cost estimation of a wheelchair accessible van, and
• activity based costing at Fort Knox, Kentucky.

Projects provide students with the opportunities to further explore a course topic(s) of their choice and to improve written and oral communication skills. The first benefit was validated by several of the students who responded that they enjoyed being able to apply what they had learned that was of particular interest to them. Another student stated that the opportunity to think creatively was the primary benefit to him. All of the students that participated in the course survey felt that the project added to their overall learning experience and recommended that the project be included in future course offerings with the exception of one student. This student felt that future project topics should be assigned and that the project itself should be more structured.
While the overall performance on the term projects was satisfactory, the students’ performance on the literature reviews was not. After discussing this unsatisfactory performance with other members of the departmental faculty, it was determined that the literature review process should be more strongly emphasized throughout the graduate and undergraduate program. This motivated the inclusion of a literature review in the freshman course discussed later in this paper.

**Research presentation**

The author presented a conference paper that was relevant to the class prior to presenting it at the 2000 American Society of Engineering Management conference. To introduce the presentation, an explanation of the professional society and annual conference was provided to the class. This allowed the class to observe a professional conference presentation and the instructor to practice!

**Professional societies and publications**

Ongoing discussion of the professional societies in the area of cost estimation was conducted throughout the semester. Recent editions of societal publications were circulated throughout the course. The AACE (American Association of Cost Engineers) International and the Institute of Industrial Engineering societies provided complementary copies of their publications (Cost Engineering and The Engineering Economist respectively) for distribution to the students in the course.

**Freshman Level Course**

The freshman level course, Industrial Cost Analysis, was offered in the Spring 2001 semester. The class was made up of 66 undergraduate students, primarily in their first year of industrial engineering. The goal of the course was to introduce the field of cost analysis to future industrial engineers. The course was delivered via an active learning lecture/discussion and a problem-solving laboratory. The primary course topics were basic financial accounting, cost behavior, cost management systems, product costing, decision making, and budgeting.

**Literature review**

The students were teamed in small groups and required to conduct a literature search and review. A presentation and tutorial by a research librarian was made to the class and along with a hands-on tour of the library. This introduced the students to the literature search and review process and provided a basis for their term projects.

**Project**

Each group was required to conduct a term project involving the aforementioned literature review, cost analysis, and presentation of results. Completion of the project involved a formal written report and an oral team presentation to the class. Sections of the project report were collected on interim due dates throughout the semester in order to facilitate effective time management. Each interim write-up was evaluated and feedback was provided to the teams.
encouraging them to make revisions for their final reports, which were due at the end of the semester. Each group selected a public company headquartered in Arkansas. The primary project requirements were as follows:

- perform an economic analysis of the state of Arkansas,
- analyze the economics of the industry in which their company operates,
- analyze the financial aspects of their selected company,
- propose a project that their company should be working on based on the findings of the financial analysis, and
- estimate what the cost and benefits of the project would be.

The projects provided the students with experience in open-ended problem solving, technical report writing, team building skills, and public speaking.

**Cases**

In addition to traditional homework assignments, the students completed mini case studies on the primary topics in the course. The importance of the case study approach to engineering education has been recognized as a method to overcome the use of over-simplified examples within the classroom. Introducing students to research-based case studies allows them to appreciate real world applications of the course content.

**Research discussions**

Discussion of the instructor’s related research was provided throughout the course, along with the relevant work of other researchers. This exposed the class to ongoing research that is related to the course.

**Summary**

This paper discusses several techniques for incorporating research into the cost engineering classroom at both the graduate and undergraduate levels. The graduate course, *Cost Estimation Models*, included an article review and presentation, written proposal, term project, instructor research presentation, and overview of professional societies and publications. All of these techniques were viewed favorable by the students in the course and recommended for use in future course offerings.

The freshman course, *Industrial Cost Analysis*, introduced students to literature reviews, projects, case studies, and research presentations. At the University of Arkansas, students come into the industrial engineering program as freshman. They are primarily taking calculus, science, and computer classes. As part of a departmental effort to improve retention, two industrial engineering courses were developed and offered in the first year of the program with the purpose of having industrial engineering faculty instructing students every semester. The *Industrial Cost Analysis* course is the second of these courses and is offered in the spring semesters. The content of the course is appropriate for lower level engineering students and allows for the introduction of many engineering concepts that they will encounter later in the industrial engineering curriculum. The Spring 2001 offering was the first attempt at integrating research into the course.
Incorporating research into lower level undergraduate engineering courses can facilitate a life-long learning process, which is emphasized in today’s engineering programs. In the 2000-2001 criteria for accrediting engineering programs as defined by the Accreditation Board of Engineering and Technology (ABET), one of the program outcomes is that engineering graduates must have a recognition of the need for, and an ability to engage in life-long learning.

The integrative research/teaching techniques discussed in this paper are not limited to cost engineering courses and can be effectively utilized other types of engineering courses. All of these techniques are recommended by the author and surveyed students and will be included in future course offerings. Incorporating research into the classroom benefits both the students and instructor and enhances the teaching/learning environment.

Bibliography


HEATHER NACHTMANN
Heather Nachtmann is an Assistant Professor of Industrial Engineering at the University of Arkansas. She received her Ph.D. in Industrial Engineering from the University of Pittsburgh. Her research interests include economic decision analysis, heuristic optimization, engineering valuation, and supply chain management. She is a member of AACE International, ASEE, ASEM, IIE, INFORMS, and SWE.