Engineering Economy: Current Teaching Practices

Heather Nachtmann, Kim LaScola Needy/ Jerome Lavelle/ Ted Eschenbach
University of Pittsburgh/ Kansas State University/ University of Alaska Anchorage

Abstract

A two-part survey was conducted in 1995 and 1997 in order to examine the teaching practices of engineering economy educators. The first survey was sent to the mailing lists of the Council of Industrial Engineering Academic Department Heads and the Engineering Economy Division of the American Society for Engineering Education. The first survey yielded 45 useable responses. Twenty-eight of the respondents also participated in the second survey. In total, the survey participants teach 165 sessions of engineering economy on average each year to over 10,000 students. A statistical analysis was performed on the data to examine the effect of the instructor's discipline and class size on teaching methods. Detailed findings have been previously reported. [6,9,10] The purposes of this paper are to discuss existing teaching practices in engineering economy as uncovered by our two-part survey and to suggest methods of improvement based on relevant literature.

Introduction

Based on the authors' work in surveying engineering economics instructors, three central issues emerge as a semester's plan is being developed: "Am I attempting to cover too much material?", "Am I lecturing from a single text?" and "Am I encouraging active learning in my classroom?" In this paper we will address each of these questions and attempt to provide a perspective from the pedagogy survey work done and detailed previously.

Content: How much is too much?

The average engineering economy class is covering 14 chapters of material. Engineering economy educators should evaluate whether too much material is being covered too quickly in their courses. The question that instructors should ask themselves is whether students can effectively learn, apply and master the course material being planned. Is the engineering economy student better served by mastering a higher fraction of fewer topics or a lesser fraction of more topics? Wankat [11] explains that "content tyranny exists when the need to cover material rather than to encourage student learning dominates educator's teaching and testing styles".

Avoid relying solely on the "textbook lecture"

Eighty-nine percent of the engineering economy courses examined in this research use a single text. Only 44% of respondents supplement the single text with other materials such as personal notes, articles or cases. Six of the respondents supplement their textbooks with case studies. On average, case studies only account for 2% of the final grade. This small percentage may signify a lack of importance being placed on case studies in engineering economy education.

Chinowsky and Robinson [1] discuss the importance of the case study approach to engineering education. These authors state that an important contrast between engineering education and the engineering profession is the use of over-simplified examples within the classroom. Perhaps increasing the use of case studies and the weight of importance being placed on them may help to lessen the gap between the education and profession of engineering.

It is encouraging that 58% of respondents utilize projects in their engineering economy courses. However, the importance of project work is not reflected in the final grade percentage weight (8%). Projects provide students with the opportunities to explore in depth a topic of their choice and to work on communication skills. [12] Wankat and Oreovicz, in their book, Teaching Engineering, [12] suggest that class projects should account for 25% of the final course grade. Engineering economy educators may need to evaluate whether the importance and prevalence of project work in the "real world" are being stressed in the classroom.

An additional concern in average final grade weights is that 75% of the final grade consists of an individual student's performance on exams and quizzes. While groups are being utilized by 44% of the respondents, students are being evaluated primarily on their individual performances in the course. Current trends in engineering education encourage students to work together in a cooperative learning environment where they work in groups to maximize learning and mimic processes used in engineering practice. [8, 2]

Recently, engineering education researchers have expressed the need to integrate research and education. [3, 5] Less than half (46%) of the respondents are conducting research in the field of engineering economy. Eighty-five percent of these faculty members are currently integrating their work into the classroom. This positive finding demonstrates a successful integration between research and education among the respondents who are actively conducting engineering economy research.

Active Teaching, Active Learning

More than 82% of the respondents are incorporating "new" teaching methods to encourage active learning in their classroom. Sixty-four percent are incorporating more than one method. In active learning, active signifies that students do not simply listen and watch but participate through discussing, questioning, arguing, brainstorming, or reflecting. [4] Johnson, et al., [8] recommend group problem solving, turn-to-your neighbor exercises, and periodically turning questions back to the class to keep students actively engaged intellectually. These teaching methods are being utilized in 54%, 25% and 18% of the respondents' courses respectively. Five-minute quizzes are being used in 46% of the responding courses. This type of assessment is useful to the instructor to determine what the students are learning and can help to focus students' attention and help them to reflect on the class period. [8]

Seventy-six percent of the respondents are utilizing spreadsheets in their courses. Fifty percent of the faculty respondents have the students build their own spreadsheets. Student-made spreadsheet assignments can promote an active learning environment, provide a focus on the "process" of engineering analysis and problem solving and remove the mundaneness and

roteness of traditional approaches. [7] It is encouraging that half of the respondents are promoting active learning by incorporating student-made spreadsheet coursework in their classes.

Future Trends

Johnson, et al., [8] state "The real challenge in college teaching is not covering the material for the students; it's uncovering the material with the students". Engineering economy educators need to be aware of the current trends in engineering education, looking at which of these methods have been proven effective and assess which methods work best for them and their students. Forty-seven percent of the respondents are currently involved in reworking how engineering economy is being taught with 5% of them planning to incorporate more active learning techniques. A detailed discussion of these results will be presented at the 1999 American Society for Engineering Education Annual Conference in Charlotte, North Carolina.

Bibliography

[1] Chinowsky, Paul S., and Jeffrey Robinson, "Enhancing Civil Engineering Education," Journal of Engineering Education, vol. 86, no. 1, January, 1994, pp. 45-49.

[2] Davidson, Cliff, and Susan Ambrose, The New Professional Handbook: A Guide To Teaching And Research In Engineering And Science, 1994.

[3] Denton, Denice D., "Engineering Education For The 21st Century: Challenge And Opportunities," Journal of Engineering Education, vol. 87, no. 1, January, 1998, pp. 19-21.

[4] Felder, Rich M. and Linda K. Silverman, "Learning And Teaching Styles In Engineering Education," Engineering Education, vol. 78, no. 7, April, 1988, pp. 674-681.

[5] Hartman, Joseph C., "Suggestions For Teaching Engineering Economy At The Undergraduate Level," to appear in The Engineering Economist.

[6] Lavelle, Jerome P., "Engineering Economy: A Survey Of Current Teaching Practices," American Society for Engineering Education Annual Conference Proceedings, 1996.

[7] Lavelle, Jerome P., "Enhancing Engineering Economy Concepts With Computer Spreadsheets," The Engineering Economist, vol. 41, no. 4, 1996, pp. 381-386.

[8] Johnson, David W., Roger T. Johnson and Karl A. Smith, Active Learning: Cooperation In The College Classroom, Interaction Book Company, 1991.

[9] Lavelle, Jerome P., Kim L. Needy, Heather N. Umphred, "Engineering Economy – A Follow-up Analysis Of Current Teaching Practices," American Society for Engineering Education Annual Conference Proceedings, 1997.

[10] Needy, Kim L., Jerome P. Lavelle, Heather Nachtmann, and Ted G. Eschenbach, "An Empirical Analysis Of Engineering Economy Pedagogy," under review The Engineering Economist.

[11] Wankat, Phillip C., and Frank S. Oreovicz, "Content Tyranny," ASEE Prism, October, 1998, p. 15.

[12] Wankat, Phillip C., and Frank S. Oreovicz, Teaching Engineering, McGraw-Hill, Inc., New York, 1993.

HEATHER NACHTMANN
Heather Nachtmann is currently an industrial engineering Ph. D. candidate at the University of Pittsburgh where she also received her B.S. and M.S. in Industrial Engineering. Her research interests include activity-based costing, fuzzy set theory, engineering valuation and engineering education. She is a student member of IIE, ASEE and AACE International.

KIM LASCOLA NEEDY
Kim LaScola Needy is an Assistant Professor of Industrial Engineering at the University of Pittsburgh. She received her B.S. and M.S. degrees in Industrial Engineering from the University of Pittsburgh, and her Ph.D. in Industrial Engineering from Wichita State University. She has obtained nine years of industrial experience at PPG Industries and The Boeing Company. Her research interests include Activity Based Costing, TQM, Engineering Management, and Integrated Resource Management. Dr. Needy is a member of ASEE, ASEM, APICS, IEEE, IIE, SME and SWE. She is a licensed P.E. in Kansas.

JEROME P. LAVELLE
Jerome P. Lavelle is an Assistant Professor in the Department of Industrial and Manufacturing Systems Engineering at Kansas State University. Dr. Lavelle received his Ph.D. in Industrial Engineering at North Carolina State University and previously worked at AT&T Bell Labs. He is the past director of the engineering economy divisions of both ASEE and IIE. He is co-author of *Engineering Economic Analysis, 7th Edition* (with Donald G. Newnan) published in 1998. His teaching/research interests are in the areas of Engineering Economy, Cost Analysis, Engineering Management and Total Quality Management.

TED G. ESCHENBACH
Ted G. Eschenbach, P.E. holds the B.S. in mathematics from Purdue University, and the M.S. in operations research and the Ph.D. in industrial engineering from Stanford University. He has taught at the University of Alaska Anchorage since 1975. On sabbaticals he has worked for the U.S. GAO, and taught at the Naval Postgraduate School and the University of Missouri-Rolla (as the Robert Koplar Professor of Engineering Management). He is the founding and current editor of the *Engineering Management Journal*. He is working on the 2nd edition of *Engineering Economy: Applying Theory to Practice*.

Teaching is a cycle of reflective practice. This book encourages you to think of reflective practice as cyclical (Figure 2). Re-flective practice begins with who you are, your identity, and life history, and extends. Figure 1. Cycle of Experience (Kolb, 1984).Â this knowledge to the meaning of teaching and teaching practices, to stories about teaching, to values and what is happening in education and the world. You have already generated a wealth of experience and knowledge, and the challenge is to help you focus this into the process of becoming a technology teacher.Â Whether we are learning to teach design, engineering, technology, or ICT, there are fundamental commonalties. Engineering Economics in Civil Engineering, also known generally as engineering economics, or alternatively engineering economy, is a subset of economics, more specifically, microeconomics. It is defined as a "guide for the economic selection among technically feasible alternatives for the purpose of a rational allocation of scarce resources."Â It publishes "...original research, current practice, and teaching involving problems of capital investment."[9].