AC 2011-1014: A LOOK INTO THE ENGINEERING ECONOMY CLASSROOM

Heather Nachtmann, University of Arkansas

Heather Nachtmann, Ph.D. received her Ph.D. in Industrial Engineering (IE) from the University of Pittsburgh in 2000. She is currently an Associate Professor of IE at the University of Arkansas and the John L. Imhoff Chair in Industrial Engineering. Dr. Nachtmann serves as the Director of the Mack Blackwell Rural Transportation Center. Her research includes cost estimation modeling, economic and efficiency analyses of transportation and healthcare systems, and engineering economy education. Dr. Nachtmann teaches in the areas of engineering economy and cost analysis. She serves as an Area Editor for The Engineering Economist journal.

Kim LaScola Needy, University of Arkansas

Kim LaScola Needy is Department Chair and 21st Century Professor of Industrial Engineering at the University of Arkansas. 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. Prior to her academic appointment, she gained significant industrial experience while working at PPG Industries and The Boeing Company. Her first faculty appointment was at the University of Pittsburgh. Dr. Needy's research interests include engineering management, engineering economic analysis, sustainable engineering, and integrated resource management. Results from her research are published in numerous scholarly journals including The Engineering Economist, the Engineering Management Journal, and the International Journal of Production Research. Dr. Needy is a member of ASEE, ASEM (Fellow status), APICS, IIE and SWE. She currently serves as ASEM Past-President and Program Co-Chair of the 31st Annual Conference. She is a licensed Professional Engineer in Kansas.

Emily M Evans, University of Arkansas

A Look into the Engineering Economy Classroom

Introduction

Over a decade ago, a survey was conducted that gathered data on how Engineering Economy was being taught across the United States[6]. Currently, research is being carried out so that a similar study can be recreated[5]. The motivation behind this investigation is to better understand how Engineering Economy education is changing over time. In order to update the survey, a recent literature search was conducted to identify the new and innovative ways faculty have been teaching Engineering Economy[2,3,4,7]. The literature review was presented in "A Look into the Engineering Economy Education Literature" at the 2010 ASEE conference[1]. Using the findings from the literature search, an updated survey was developed and administered to engineering faculty. A subset of the survey findings are presented in this paper. The overall goal of this research is to conduct a comprehensive study of current teaching practices with the intent of increasing the effectiveness of Engineering Economy education.

Survey: Development, Content, and Administration

The purpose of this survey is to collect information pertaining to Engineering Economy education across U.S. universities. The survey was developed using Qualtrics software, which provides capability to create surveys, distribute them via email, then record and analyze results. Utilizing membership lists from the Engineering Economy Divisions of the Institute of Industrial Engineers (IIE) and the American Society for Engineering Education (ASEE), a catalog of names and email addresses of current educators affiliated with Engineering Economy was compiled. At this time, seventy-five educators have responded to the survey. Of those seventy-five respondents, sixty-one of them exhibited the necessary qualifications for our survey sample. The necessary qualifications include teaching the first undergraduate Engineering Economy course offered in their department within the past three years and agreeing to participate in the fifteen minute survey.

The feedback from this sample of Engineering Economy (EE) instructors provides a look into how Engineering Economy is currently being taught in U.S. classrooms. The survey is comprised of questions that are both quantitative and qualitative in nature. The quantitative questions include those with multiple choice answers or data that was easy to measure, while the qualitative questions include those with open-ended responses. The survey questions are grouped into five sections pertaining to 1) Instruction, 2) Course Description, 3) Student Perception, 4) Course Material and Content, and 5) Teaching Methods. Presented in this paper are the major findings from the quantitative survey questions. See Figure 1 for a list of these questions. A forthcoming paper will report on the full survey results.

Instructor
What is the highest degree you obtained?
What is your academic rank?
What is the discipline of your primary appointment?
How many years have you been an educator at the college level?
How many years of experience do you have teaching Engineering Economy?
Check all of the areas below that you have Engineering Economy experience in:
Do graduate students ever take full responsibility for teaching the Engineering Economy course in your department?
Approximately what percent of the time do graduate students take full responsibility for teaching this course?
What is the highest degree that your department awards?
Course Description
How many offerings of the Engineering Economy course are taught in your department each year?
What is the average number of students in each offering of your Engineering Economy course?
Is your Engineering Economy course a Semester or Quarterly course?
How many credits is your Engineering Economy course worth?
In your department's recommended plan of study, what year is your Engineering Economy course taken?
Are there any prerequisite courses for your Engineering Economy course?
In addition to your Engineering Economy course, are there other courses in the Engineering Economy field available to students within your department?
Student Perspective
In general, do your students believe that Engineering Economy is an important course at the time the course is taken?
In general, do your students believe that Engineering Economy is an important course three years after the course is taken?
Course Material and Content
Do you require a textbook in your Engineering Economy course?
Please check all of the supplemental materials you use in your Engineering Economy course:
Please check all of the ways below that indicate how you incorporate real world information into your Engineering Economy course:
Does the Fundamentals of Engineering Exam impact how you teach your Engineering Economy course?
Teaching Methods
Do you incorporate student teams (formal or informal) into your Engineering Economy course?
Please check all types of questions you ask on you exams:
Please check all types of technology that you incorporate in your Engineering Economy course:
Please check all of the following teaching methods that you use in your Engineering Economy course:

Figure 1: Quantitative Survey Questions.

Survey Results for Instruction

The survey results from the Instruction section give an indication of who is teaching the Engineering Economy course across U.S. classrooms. According to the participants' responses to the highest degree they have obtained, 16% have a MS degree, and 84% have a Ph.D. degree. The academic rankings of survey respondents can be seen in Figure 2. The greatest percentage of EE instructors fall into the Full Professor rank, which reinforces the importance of this class in the curriculum. It should also be noted that several faculty members at the Distinguished Professor rank are still actively engaged in the teaching of Engineering Economy.

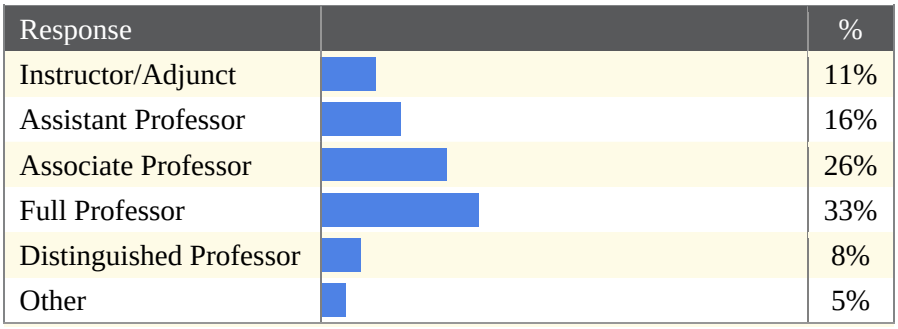


Figure 2: Faculty Rank

The surveyed EE instructors are from a large variety of engineering disciplines. Figure 3 lists the primary appointment of the respondents.

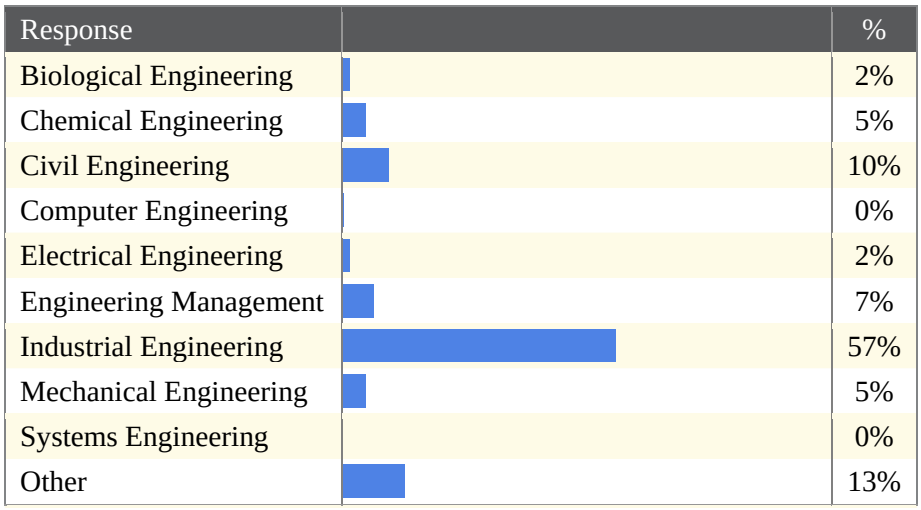


Figure 3: Faculty Department

While the EE instructors range from new to experienced, the majority (66%) of respondents have been teaching at a college level for over 15 years. Figure 4 shows the breakdown of years of experience for respondent pool.

Response		%
>5		11%
5-9		16%
10-14		7%
15+		66%

Figure 4: Years of Experience Teaching at College Level

Additionally, the greatest percentage (41%) of EE instructors have been teaching Engineering Economy for more than 15 years as depicted in Figure 5.

Response		%
>5		25%
5-9		18%
10-14		16%
15+		41%

Figure 5: Years of Experience Teaching Engineering Economy

Figure 6 displays the experience held by EE instructors. Essentially all of the respondents (98%) have completed undergraduate coursework in Engineering Economy. A majority (62%) have additionally completed graduate coursework. Almost half of the EE instructors (48%) have actual consulting experience in the field. More than a third of EE instructors (39%) have research experience in Engineering Economy. A wide variety of Engineering Economy experiences, including theoretical and especially practical, help to increase the dynamics in the classroom. Overall, this sample has a diverse spread among experiences.

Response		%
Undergraduate coursework		98%
Graduate coursework		62%
Research		39%
Consulting		48%

Figure 6: Areas of Engineering Economy Experience

According to the data collected, 27% of institutions have graduate students teaching in the classroom in some capacity as shown in Figure 7. The percentage of time the graduate students teach varies greatly between institutions. Of the schools that do allow graduate students to teach, the average amount of time is 27%, with a minimum amount time of 3%, and a maximum time of 70%.

Figure 7: Percentage of Graduate Students Teaching

Figure 8 displays the highest degree awarded at the survey participant's institution and shows that the majority of EE instructors teach at Ph.D. granting institutions.

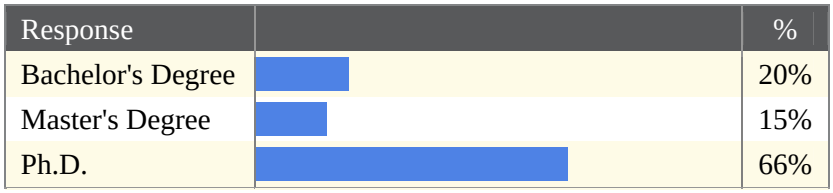


Figure 8: Highest Degree Awarded by Institution

Survey Results for Course Description

The Course Description section seeks to determine how the Engineering Economy classroom is organized and administered at various institutions. According to the survey results, the number of offerings of the class is anywhere from 1 to 15 times per year, with an average offering of approximately 3 times per year. Within each of these offerings, the number of students can vary anywhere from 8 to 600, with an average number of approximately 73 students.

Figure 9 displays the percentage of institutions that operate on semester and quarterly schedules with the vast majority operating on a semester calendar.

Figure 9: Semester and Quarterly Courses

Figure 10 displays the credit hours given for the Engineering Economy course. More than three quarters of classes (81%) are worth three credit hours, with no classes being awarded more than four credit hours.

Response		%
1		3%
2		10%
3		81%
4		5%
5+		0%

Figure 10: Credit Hours for Course

According to the results of the survey, more than half (59%) of respondents place their Engineering Economy class in the third year of their plan of study, and no institutions planning for the course to be taken during the first or fifth years of study. Figure 11 displays the full results.

Response		%
1st year		0%
2nd year		22%
3rd year		59%
4th year		19%
5th year+		0%

Figure 11: Year in Plan of Study

It is almost evenly split between whether or not the first undergraduate Engineering Economy course has any prerequisite course(s), with 53% of respondents stating that their course does have prerequisites and 47% saying it does not. Additionally, nearly a third of the EE instructors (32%) state that their department offers other courses in the Engineering Economy field.

Survey Results for Student Perception

The Student section asks the EE instructors to assume a student mindset to answer questions about the significance of Engineering Economy. From the student's point of view, they were asked if Engineering Economy is an important course both at the time the course is taken and three years after it is taken. In both time frames, the majority of EE instructors answered "Yes" with a greater appreciation after three years. Figures 12 and 13 present the full results.

Response		%
Yes		53%
No		30%
Do not know		18%

Figure 12: Importance while Taking Course

Response		%
Yes		70%
No		2%
Do not know		28%

Figure 13: Importance Three Years after Course

Survey Results for Course Content and Material

This section provides information on how Engineering Economy classes are taught and what materials are being used. According to survey results, 96% of EE instructors require a textbook. In addition to nearly all students utilizing a textbook, Figure 14 displays the types of supplemental material that EE instructors are providing to their students.

Response		%
Personal class notes		89%
Newspaper articles		61%
Research papers		29%
Cases		64%
Other		25%
None		4%

Figure 14: Supplemental Materials

Figure 15 shows the ways EE instructors are incorporating real world information into their course. Real world situations are helpful for students to relate what they are learning in class to practical situations. According to the results, the entire faculty sample integrates real world information somewhere within their course.

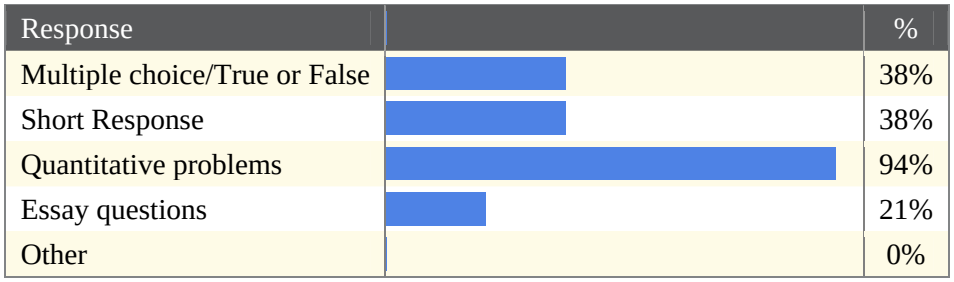
Response		%
Lectures		100%
Readings		50%
Assignments		77%
Other		20%
I do not incorporate real world information into my course		0%

Figure 15: Outlets for Real World Information

Lastly, the participants were asked if the Fundamentals of Engineering Exam impacts the way they teach their Engineering Economy course. The majority (54%) responded that it did indeed affect the way they taught their course.

Survey Results for Teaching Methods

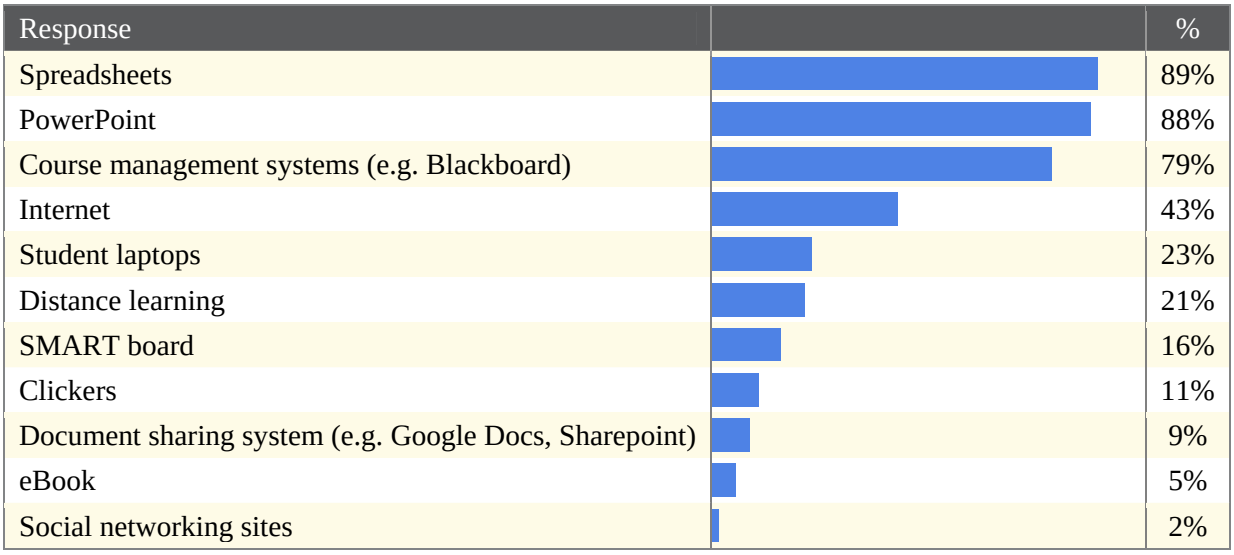
The Teaching Methods section asks questions related to the EE instructor's unique teaching style and how they administer their Engineering Economy course. According to the results, a majority (57%) of EE instructors incorporate teams into their course, be it study groups, partnered assignments, etc. Looking into student performance assessment, Figure 16 displays the types of questions that the EE instructors ask on their exams.



Response	%
Multiple choice/True or False	38%
Short Response	38%
Quantitative problems	94%
Essay questions	21%
Other	0%

Figure 16: Types of Questions on Exams

Figure 17 shows the types of instructional technology that is being used in the Engineering Economy classroom. Spreadsheets, PowerPoint, and Course management systems rank highest among selections.



Response	%
Spreadsheets	89%
PowerPoint	88%
Course management systems (e.g. Blackboard)	79%
Internet	43%
Student laptops	23%
Distance learning	21%
SMART board	16%
Clickers	11%
Document sharing system (e.g. Google Docs, Sharepoint)	9%
eBook	5%
Social networking sites	2%

Figure 17: Technology Used in Classroom

Lastly, Figure 18 displays the percentage of EE instructors who use teaching methods beyond strictly lecturing, the most popular being turning questions back to the class.

Response		%
Turn question back to the class		50%
Group problem solving		38%
Cold calling (polling class)		32%
Turn-to-your-neighbor exercises		32%
5-minute quizzes		29%
Student advisory groups		5%
Group test taking		2%

Figure 18: Teaching Methods Used in Classroom

Conclusions and Future Work

Overall, the survey results presented here provide a look into the Engineering Economy classroom. For many of the topics surveyed, it is clear that there are new pedagogical methods being introduced into the classroom. Below is a summary of the survey findings:

- 41% of EE instructors are Full Professor rank or higher.
- 66% of EE instructors have been teaching at a college level for over 15 years, and 41% have been teaching Engineering Economy for more than 15 years.
- 48% of EE instructors have Engineering Economy consulting experience, and 39% have Engineering Economy research experience.
- The average EE class size is 73 students, and the maximum is 600.
- 85% of EE courses are taught on a semester schedule.
- 81% of EE courses are worth three credit hours
- The majority of respondents (59%) place their Engineering Economy class in the third year of their plan of study.
- According to faculty, 53% of students think Engineering Economy is an important course while they are taking it, and 70% of students think it is an important course three years after they have taken it.
- 96% of EE instructors require a textbook for their EE course.
- 89% of EE instructors provide personal class notes as supplemental material in addition to textbooks.
- 94% of EE instructors ask quantitative problems on their exams.
- 89% of EE instructors use spreadsheets, 88% use PowerPoint, and 79% use course management systems (e.g. Blackboard).
- In addition to lecturing, more than half of EE instructors are using active learning techniques.

Future work will be performed to further analyze the quantitative data and study the qualitative results. Survey results will be segmented by instructor-type and analyzed to explore differences among various instructor types. In addition, a longitudinal analysis will be performed to compare these findings with the previous survey conducted over 10 year ago to investigate how EE education has changed over time.

Acknowledgements

We are grateful to our Engineering Economy Division colleagues from IIE and ASEE who took the time to complete our survey and share how Engineering Economy is being taught today across the United States.

Bibliography

1. Evans, E., Nachtmann, H., & Needy, K. L., "A Look Into the Engineering Economy Education Literature," American Society for Engineering Education Annual Conference Proceedings, 2010. Louisville, KY.
2. Hartman, J. C., "Suggestions For Teaching Engineering Economy at the Undergraduate Level," The Engineering Economist, Vol. 44, No. 1, 1999, pp. 110-125.
3. Lavelle, J. P., "Enhancing Engineering Economy Concepts With Computer Spreadsheets," The Engineering Economist, Vol. 41, No. 4, 1996, pp. 381-386.
4. Merino, D. N., "Impact of ABET 2000 on Teaching Engineering Economics: What Subjects Define Economic Literacy for Engineers?," American Society for Engineering Education Annual Conference Proceedings, Session 1639.
5. Nachtmann, H., Needy, K. L., Lavelle, J. P., & Eschenbach, T. G., "How Do Engineering Managers Teach Engineering Economy?" American Society for Engineering Management Proceedings, 2008. West Point, NY.
6. Needy, K. L., Nachtmann, H., Lavelle, J. P., & Eschenbach, T. G. (2000). "An Empirical Analysis of Engineering Economy Pedagogy," The Engineering Economist, 45 (1), 74-92.
7. Olson, R. T., "Comparison of the Impact of Pre- and Post-Lecture Quizzes in Student Learning in an Engineering Economy Course," American Society for Engineering Education Annual Conference Proceedings, 2005.