AC 2008-173: ANALYSIS OF THE RESULTS OF A PILOT ENGINEERING AND ENGINEERING TECHNOLOGY STUDENT INVENTORY SURVEY

Andrew Vavreck, Pennsylvania State University-Altoona

Andrew N. Vavreck is Associate Professor of Engineering and Head of the Division of Business and Engineering at Penn State Altoona. He has earned degrees in Engineering Science (BS), Engineering Mechanics (MS) and Engineering Science and Mechanics (PhD), all from Penn State. His work experience includes engineering research and management at Johns Hopkins University Applied Physics Laboratory and the Applied Research Laboratory, Penn State. His research is in smart material (particularly magnetorheological fluid) design, application and control.

Irene Ferrara, Pennsylvania State University-Altoona

Irene Ferrara is the Coordinator of the Electro-Mechanical Engineering Technology program for the Altoona College of the Pennsylvania State University. She received her B.S. in Engineering Science from the Pennsylvania State University and her M.S. in Mechanics and Materials Science from Rutgers, The State University of New Jersey.

Rose Marra, University of Missouri

Rose M. Marra is an Associate Professor in the School of Information Science and Learning Technologies at the University of Missouri. She is PI of the NSF-funded Assessing Women and Men in Engineering (AWE) and Assessing Women In Student Environments (AWISE) projects. Her research interests include gender equity issues, the epistemological development of college students, and promoting meaningful learning in web-based environments.

Barbara Bogue, Pennsylvania State University

Barbara Bogue is an Associate Professor of Engineering Science and Mechanics and Women in Engineering at Penn State-University Park. She is Co-PI of the NSF Assessing Women and Men in Engineering (AWE) and Assessing Women in Student Environments (AWISE) and PI of SWE-AWE Projects. Her research interests are gender equity in STEM, recruitment and retention of women in engineering and career development.

Analysis of the Results of a Pilot Engineering and Engineering Technology Student Inventory Survey

Abstract

To further understand differences between students with engineering and engineering technology preferences, identify skills being developed in introductory engineering courses, and refine marketing efforts, Penn State Altoona undertook a survey of lower-division students in several courses in spring semester 2007. Two surveys, one directed to engineering students and the other to engineering technology students, collected demographic data, information on study habits and extracurricular activities, perceptions of progress made in critical program areas (e.g. understanding the non-technical aspects of an engineering career or solving an open-ended problem), level of expertise in certain skills, and descriptions of relationships with advisors and other faculty and staff. For engineering students planning to transfer to the Penn State University Park campus for upper-division work, the survey also asked questions about the transfer process, and two final open-ended questions asked what could be done to support the transfer process and better aid students in their engineering studies while at the Altoona campus. The transfer open-ended question was not included in the technology survey, and some of the program content questions differed between the two groups.

The paper presents the results of the survey, contrasting the two groups, discusses how the information will be used to improve advising and other support services, and identifies how the results will influence the evolution of introductory courses as well as the programs in general.

Introduction

In the past several years, engineering technology (ET) associate degree enrollments have declined across the twelve campuses offering such degrees in the Penn State system, a phenomenon also noted at other institutions.[1] A number of Penn State campuses offer baccalaureate engineering technology degrees that for many years were structured as 2+2 programs – students earned an associate degree in two years and then in their junior year entered the baccalaureate program to be completed in an additional two years. In general, baccalaureate enrollments have been relatively stable in comparison to associate programs. To increase upper division enrollments and programs, address and evolve engineering and ET programs to respond to market demand, and improve retention, Penn State has developed a strategy to evolve engineering technology programs in concert with engineering programs. The strategy includes a common first year engineering /ET introductory engineering design course, in which students from both communities learn about the other, in addition to acquiring basic skills in graphics, computer tools and design.[2]

The University of Missouri Columbia and Penn State University Park were funded in 2006 by the National Science Foundation Division of Human Resource Development for a project called GSE/RES Assessing Women in Student Environments (AWISE); Moving Assessment of

Women Studying Engineering into the Classroom.[3] The project addresses the national goal of increasing the number of women studying engineering by examining the impact of classroom experiences on women engineering students, and the experiences and barriers experienced by women engineering students who begin study at a campus offering only the first two years of an engineering baccalaureate degree. The AWISE study will enable comparative and cross-institutional assessments of core engineering curricular experiences (e.g. team interactions, student to student interactions) and campus experiences by developing instruments that measure both male and female student experience.

As part of the AWISE project, research is being conducted at Penn State University's main campus in three departments and its satellite campuses. To help fulfill the goals of AWISE and support the evolution of engineering programs, a survey of student experiences in engineering and engineering technology was undertaken at Penn State's campus in Altoona, Pennsylvania. Penn State Altoona is one of nineteen satellite campuses in the Pennsylvania State University system, which maintains its administrative and research hub at the University Park campus. The Altoona campus is located approximately 45 miles southwest of University Park, and is the geographically closest of the satellite campuses in the Penn State system. With 150 acres and more than 20 buildings, Penn State Altoona offers approximately 4000 students the opportunity to complete 20 baccalaureate and eight associate degree programs ranging from Arts and Humanities to Engineering. In Engineering Technology, two associate degree programs are offered, in Mechanical Engineering Technology and Electrical Engineering Technology. In addition, one baccalaureate degree program in Electro-Mechanical Engineering Technology is available at the campus. Approximately thirty students graduate each year with a BSEMET degree (Bachelor of Science in Electro-Mechanical Engineering Technology). In the twelve years since the inception of the BSEMET program, approximately 300 students have earned the degree.

In addition to the many degree programs that can be completed at Penn State Altoona, the campus also offers the first two years of over 180 Penn State majors, including thirteen in the College of Engineering. Engineering students then complete their degree programs at the University Park campus or another Penn State location offering that degree program.

Methodology

Separate surveys were administered on-line during Spring Semester 2007 to engineering students intending to transfer to the University Park campus for completion of their baccalaureate degrees and to engineering technology students. The surveys differed in questions about campus transfers and some program outcomes. Students were sent e-mail requests and where possible were asked in class to go online to complete the survey. Students were informed that if they completed the survey they would be entered in a drawing for a small incentive. Of a total of 114 technology students to which requests to complete the survey were sent, 26 were completed (22.8%). Of 193 engineering students, 38 were completed (19.7%).

While the surveys administered to the two different groups (engineering and ET) did contain a few different questions, both referred to "engineering" degrees and programs, which was not expected to confuse the engineering technology students, since they are in the college of engineering, and refer to themselves and are referred to (during their pursuit of a degree and after) nearly always as "engineers."

Results

Demographic and academic related survey results are shown in Table 1. Technology students are more likely to be employed, white, male and living off-campus. Involvement with engineering societies is likely higher among technology students because they spend all four years at the campus, and upperclassmen have more ability to contribute to student chapter projects and other activities. In addition, engineering students preparing to transfer to University park are not as integrated in general with the campus "engineering community." The relative complexities of curricular and employment choices for students in the engineering technology program may explain why ET report seeking advice from other faculty more often than from their academic advisor. Faculty members teaching in the ET program have extensive industrial as well as academic experience, and students may be seeking them out as good references for the "real world" And how to make the best of their program to get prepared for it. Another factor in selecting faculty other than advisors for advice may simply be that students in the small ET community at the campus self-select faculty for help who are known to be good advisors.

Table 1: Selected Demographic and Academic Factors

	Engineering	Engineering Technology
Male	82.5%	100%
White American	82.1%	96.2%
Master's or Above Highest Degree Expected	64.9%	50.0%
Currently Employed	41%	76.9%
Current GPA	3.14	3.28
Living On Campus	33.3%	7.7%
Study 6-10 Hours/Week	29.7%	28%
Involved in an Engineering Society	8.1%	28%
Go Primarily To Assigned Academic Advisor for Advice	80%	36%

The survey also included questions on students' self-report of knowledge acquisition and perceptions about engineering. Tables 2 through 4 compare responses from engineering and engineering technology students. Probabilities are on the differences between the average ratings for each group for each question.

The data demonstrate that the ET students are more aware of what they will be doing in industry as well as the process and tools they have at their disposal (Table 2); that the ET students feel better prepared to solve real problems, to dissect problems into approachable parts, and to present those problems clearly in both oral and written form (Table 3); and that ET students are more confident and empowered because of their experience at Penn State Altoona (Table 4).

The only areas where the engineering students appear to believe they are as well prepared (as ET students believe they are) is either for the non-technical aspects of problem solving or for group situations (with a few exceptions).

One could argue that this is just because the engineering students in the sample must be in their first two years, while ET students may be juniors and seniors, and simply would have had more course work and experience. The engineering technology survey respondents were: 23.1% freshmen, 11.5% sophomores, 26.9% juniors, 30.8 % seniors, and 7.7% other. Even if 65% are upper division responses and 35% are not, the difference is still substantial, but a definitive answer to how substantial, and in what ways as a function of semester standing, must wait for a larger data set and the ensuing analysis.

Table 2: Answers to Question "What progress have you made as a result of your engineering related course work at your campus in each of the areas below?"

	Program	None (1)	Slight (2)	Moderate (3)	A Great Deal (4)	Rating Average
***Understanding what engineers do in industry. (t= 4.185, *p*<.001)	Engineering	5.4%	32.4%	**43.2%**	18.9%	2.76
	Engineering Technology	0.0%	4.0%	36.0%	**60.0%**	3.56
Understanding the non-technical aspects of an engineering career (e.g. economic, political, ethical, and/or social issues).	Engineering	5.4%	**45.9%**	43.2%	5.4%	2.49
	Engineering Technology	4.0%	28.0%	**52.0%**	16.0%	2.80
***Knowledge and understanding the **language** of design in engineering. (t= 4.210, *p*<.001)	Engineering	5.4%	29.7%	**51.4%**	13.5%	2.73
	Engineering Technology	0.0%	8.0%	32.0%	**60.0%**	3.52
***Knowledge and understanding the **process** of design in engineering. (t= 3.764, *p*<.001)	Engineering	5.4%	29.7%	**48.6%**	16.2%	2.76
	Engineering Technology	0.0%	8.0%	36.0%	**56.0%**	3.48

* $p < .05$
** $p < .01$
*** $p < .001$

Table 3: Responses to “Using the following scale, choose the rating that best reflects how well prepared you feel in each for the items below as a result of completing engineering related course work (e.g. math, science, EDSGN 100).”

	Program	Not At All Prepared	Slightly Prepared	Moderately Prepared	Very Well Prepared	Rating Average
***Design a process, component of a system or a product. (t= 3.704, *p*<.001)	Engineering	8.1%	27.0%	**51.4%**	13.5%	2.70
	Engineering Technology	0.0%	4.0%	**52.0%**	44.0%	3.40
**Solve an open-ended problem (that is, one for which no single right answer exists). (t= 2.699, *p*<.01)	Engineering	0.0%	21.6%	**54.1%**	24.3%	3.03
	Engineering Technology	0.0%	4.0%	44.0%	**52.0%**	3.48
Apply an abstract concept or idea to a real problem or situation.	Engineering	5.4%	16.2%	**56.8%**	21.6%	2.95
	Engineering Technology	4.0%	12.0%	**48.0%**	36.0%	3.16
*Clearly describe a problem orally. (t= 2.485, *p*<.05)	Engineering	0.0%	29.7%	**45.9%**	24.3%	2.95
	Engineering Technology	0.0%	8.0%	44.0%	**48.0%**	3.40
*Clearly describe a problem in writing. (t= 2.033, *p*<.05)	Engineering	0.0%	27.0%	**59.5%**	13.5%	2.86
	Engineering Technology	0.0%	12.0%	**56.0%**	32.0%	3.20
*Identify the tasks needed to	Engineering	0.0%	27.8%	**52.8%**	19.4%	2.92

solve an open-ended problem. (t= 2.540, *p*<.05)	Engineering Technology	0.0%	8.0%	**48.0%**	44.0%	3.36
**Visualize what the product of a design project might look like. (t= 2.683, *p*<.01)	Engineering	8.1%	18.9%	**40.5%**	32.4%	2.97
	Engineering Technology	0.0%	0.0%	48.0%	**52.0%**	3.52
*Weigh the pros and cons of possible solutions to a problem. (t= 2.485, *p*<.05)	Engineering	2.7%	21.6%	**54.1%**	21.6%	2.95
	Engineering Technology	0.0%	8.0%	44.0%	**48.0%**	3.40
Figure out what changes are needed in prototypes so that the final engineering project meets design specifications.	Engineering	10.8%	29.7%	**35.1%**	24.3%	2.73
	Engineering Technology	0.0%	8.0%	**72.0%**	20.0%	3.12
Develop ways to resolve conflict and reach agreement in a group.	Engineering	8.1%	21.6%	**40.5%**	29.7%	2.92
	Engineering Technology	4.0%	8.0%	**44.0%**	**44.0%**	3.28
Make sure that all group members have the opportunity to contribute to group activities and outcomes.	Engineering	2.8%	19.4%	**44.4%**	33.3%	3.08
	Engineering Technology	0.0%	16.0%	**44.0%**	40.0%	3.24
**Organize information relevant to a	Engineering	2.7%	18.9%	**54.1%**	24.3%	3.00

problem solving activity (e.g. writing reports, sharing research with other group members, etc.) so that it is easily understandable to others. (t = 3.276, *p*<.01)	Engineering Technology	0.0%	0.0%	44.0%	**56.0%**	3.56
Use drafting and/or computer design software to illustrate ideas and/or develop engineering designs.	Engineering	Not Asked	Not Asked	Not Asked	Not Asked	Not Asked
	Engineering Technology	0.0%	4.0%	32.0%	**64.0%**	3.60

* $p < .05$
** $p < .01$
*** $p < .001$

Table 4: Responses to the Statement "As a result of taking courses at your campus:"

	Prog.	Decreased Greatly	Decreased Somewhat	Not Changed	Increased Somewhat	Increased Greatly	Rating Average
**Your confidence that majoring in engineering was the right choice for you ... (t= 2.725, *p*<.01)	ENGR	0.0%	5.4%	32.4%	**43.2%**	18.9%	3.76
	ET	0.0%	0.0%	16.0%	36.0%	**48.0%**	4.32
Your motivation to become an engineer has ...	ENGR	0.0%	2.7%	18.9%	**54.1%**	24.3%	4.00
	ET	0.0%	0.0%	20.0%	36.0%	**44.0%**	4.24
*The likelihood you will continue in an engineering program has ... (t= 2.128, *p*<.05)	ENGR	0.0%	2.7%	32.4%	29.7%	**35.1%**	3.97
	ET	0.0%	0.0%	16.0%	24.0%	**60.0%**	4.44
Your motivation to complete an engineering degree at Penn State has ...	ENGR	2.7%	5.4%	21.6%	29.7%	**40.5%**	4.00
	ET	0.0%	0.0%	20.0%	16.0%	**64.0%**	4.44

* $p < .05$
** $p < .01$
*** $p < .001$

Conclusion and Future Work

Some part of the differences between the groups, especially in skills and experiences areas, may be due to the average lower semester standing of engineering students in the survey, but the small sample size makes more detailed correlation difficult. The differences between the two groups are likely rooted in the courses that are in the ET programs from the first semester on that allow them to have lab experiences and do meaningful analysis in an engineering sense. ET students aren't just learning the abstract theory; they are applying it on a daily basis. The faculty believes that the students in the ET program are much more aware of what it means to be an engineer. ET students are more confident and happier with their choice of major because they are part of a more coherent community at the campus, in which they are connected to the faculty and other students.

Some results were likely not semester standing dependent, though, and indicated interesting differences between the student groups that will help chart the course for curricular development, program organization, advising and recruitment and retention efforts. For instance, the significantly different percentage working while attending school between the groups has led to the scheduling of several new night sections of EDSGN 100 for Fall 2008. The significant number of technology students expecting to go on to a master’s degree or beyond will require redoubling efforts to prepare BSEMET students better for graduate work. Since the engineering students took the survey late in their introductory engineering course (EDSGN 100), their lower self-rating on industry familiarity and non-technical aspects will require further examination of the content of that course as well as the delivery of the freshman seminar.

In Fall Semester 2007, data was taken from nine sections of EDSGN 100 (as many as 180 students) and a more concerted effort was undertaken to survey technology students. The larger data set should permit a future deeper analysis of the experiences of the two groups at the campus.

Bibliography

1. Science and Engineering Indicators, http://www.nsf.gov/statistics/seind06, Last Accessed January 15, 2008.
2. Ferrara, Irene and Andrew Vavreck, Analysis of the retention of students and possible recruitment into technology in a common first-year course for engineering and engineering technology students, ASEE Annual Conference and Exposition, 2007.
3. Assessing Women in Engineering, http://www.engr.psu.edu/awe, Last Accessed January 15, 2008.