Do First-Year Orientation Courses Alter Students Plans for Engineering Study?

Kerry Meyers
Youngstown State University, kmeyers@ysu.edu

***Abstract* - Many general First-Year Engineering Programs across the country offer students an engineering orientation type of course that is intended to help students determine which discipline of engineering is right for them. At an urban, public university in the Midwest, a study was conducted to assess the relative usefulness of this type of a course. At the start of the semester, students were asked to indicate which field of engineering they were considering, and then on a weekly basis students listened to a presentation on the engineering disciplines and were required to complete an on-line survey prior to the next week's lecture (in which they indicated their most current interest level). Student's interests in the different engineering disciplines were tracked over the course of the semester to assess relative changes in intended field of study, and it was found that 20% of students changed from their originally intended major, while 71% said that it affirmed their originally indicated / intended engineering discipline.**

Index Terms – First-Year Engineering, Major Selection, Orientation Course, Persistence.

BACKGROUND

Youngstown State University is an urban, public, research university in Northeast Ohio with a wide variety of higher education programs and majors serving ~13,000 undergraduate students, 86% of which come from within the state of Ohio. It is a very accessible school for students of diverse academic preparations and socioeconomic status. Specifically, it guarantees admission to any student earning a high-school degree or GED equivalent (although some programs, including engineering, do have restricted admissions). The STEM College is 72% male and 28% female and 15% minority student population. Most students in the STEM College are of traditional college age (80% less than 25 years old), are full time students (85%), and live off campus and commute (90% commute). The STEM College had a total enrollment in the fall of 2012 of 2,833 students, including 184 graduate and doctoral students, and 36 non-resident aliens.

The First-Year Engineering Program (which is part of the STEM College) had ~215 incoming students in the fall of 2012. Of those students, 84% were male, 16% female. In terms of race / ethnicity 86% were white, 14% underrepresented minorities. It is a general program such that all intended engineering disciplines take the same courses including:

(1) ENGR 1500 – Engineering Orientation – 1 Credit (fall)
(2) ENGR 1550 – Engineering Concepts – 2 Credits (fall)
(3) ENGR 1560 – Engineering Computing – 3 Credits (spring)

The Engineering Concepts and Computing courses are project based courses, while the engineering orientation class is a large lecture course that describes the engineering disciplines. These courses tend to be passive learning environments wherein attendance (often in a large lecture hall setting) is the primary grade determinate. On a weekly basis there is different engineering discipline presentation to the students, with the hope that at the end of the semester they know a bit about every discipline and have a clear path for themselves. This approach is well-intended by administrators, and is a way to present standard information on engineering disciplines on a large scale, but does it make a difference for students? There is often resistance from students who claim they already know which discipline they would like to pursue, are any of them swayed by what they hear in these presentations? Such a program exists at a medium-sized, Midwestern, urban, public institution, and we sought to assess how many students were influenced by this approach.

INTRODUCTION

Engineering educators are tasked with changing traditional ways of educating engineers and broadening the exposure of K-12 students to engineering careers, requirements, and opportunities [1]. With the wide range of research citing the need to transform traditional lecture courses into more interactive and responsive environments [2-5], many colleges and universities have begun transforming their engineering curricula. YSU has also begun this transition to support smaller class sizes focused on active learning strategies rooted in project based learning. Active learning strategies have been reported to improve the long term retention of average students in engineering [6]. Further, cooperative, project-based learning experiences grounded in a broader societal context have been recognized as positive

influences for all students, including underrepresented groups such as women and minorities [7-9].

With so much emphasis on small classes and active learning strategies is there any place for the traditional lecture based approaches? At Youngstown State University, we sought to offer both methods – using a large, lecture based approach to convey "standard information" about the five engineering disciplines available in conjunction with a separate course that engages students in active, project based experiences. This is a reality for many large state schools, and does have the advantage of being an economically feasible way to reach students. The benefits of project based learning are well established, so we sought to understand the benefits for a lecture format course as well.

METHODS

The data collected from students was primarily quantitative; however, open ended qualitative responses to survey items provide richer feedback and greater understanding of the results. Each week there were 10 questions, which are outlined in Table 1. Responses were collected using BlackBoard which was the course tool used for administration of all classroom documents and grading for the course. Responses were not anonymous; however, students were told that they would receive credit for completing each question on the survey (10 points per question) and not based on their response.

TABLE I
WEEKLY SURVEY QUESTIONS & RESPONSE CHOICES

	Question	Answer Choices
1	Did the presentation this week increase your background knowledge of _____ Engineering? (Civil, Chemical, Electrical, Industrial, or Mechanical)	Very Much Somewhat Not Much
2	Considering all of the 5 engineering departments at YSU– indicate your interest level in each of them (you can have multiple disciplines that you are interested / disinterested in). What is your current interest level in Civil Engineering?	Very Interested Interested Neutral Not Particularly Interested Disinterested
3	What is your current interest level in Chemical Engineering?	
4	What is your current interest level in Electrical Engineering?	
5	What is your current interest level in Industrial Engineering?	
6	What is your current interest level in Mechanical Engineering?	
7	Considering lecture from this past week, what was the most useful/helpful thing that you learned?	Free Response
8	Considering lecture from this past week, was there anything that you wish had been discussed that was not?	
9	Please comment on how the lecture this week influenced your thoughts on selecting an engineering discipline (did this affirm what you had previously thought, or did it change / dissuade you from your prior interests?).	
10	Are there any issues or concerns that the First-Year Engineering Program Faculty should be aware of? Or is there anything you would like to tell us?	

The data from Likert scale questions (1-6) for all 215 students enrolled in the course for each of the 15 weeks was tabulated using Excel to obtain basic statistical information such as mean, median, and standard deviation. Note that higher numbers represented more positive / favorable responses from the participant. Additionally, the free responses were reviewed by course personnel, the department chairmen, and any additional presenters from the engineering discipline that presented in a given week. Some of the key responses that helped to explain the quantitative results are shared in this paper for deeper understanding through triangulation of both methods.

RESULTS / DISCUSSION

Student responses to the first-survey question as to whether the presentation for a given week increased their knowledge of that engineering discipline was positive, indicating that students found value in the presentations. Table 2 outlines the average score of all students for each of the weeks that engineering departments were presenting.

TABLE 2
INCREASED KNOWLEDGE OF ENGINEERING DISCIPLINE?

Semester Week	Engineering Program	Increased knowledge Average (out of 3)
3	Civil	2.58
4	Civil	2.31
5	Chemical	2.32
6	Chemical	2.43
7	Electrical	2.45
8	Electrical	2.65
9	Industrial	2.55
10	Industrial	2.46
11	Mechanical	2.55
12	Mechanical	2.53
	Overall Average	2.48

The next 5 questions (2-6) were asked each week, to gauge interest level week to week and see if it related to when the presentations were given for each department. Table 3 summarizes these results, specifically – the overall average for each of the 5 disciplines was calculated and compared to the average interest level expressed during the two sessions when faculty members from those departments were presenting in the class. In every case, the average during the 2 weeks the departments presented were higher than the overall semester average (on a 5 point scale).

TABLE 3
INTEREST IN ENGINEERING DISCIPLINES

Week #	Interest in Program	Civil	Chemical	Electrical	Industrial	Mechanical
3	Mean	**3.73**	3.02	3.41	3.14	3.99
4	Mean	**3.89**	2.95	3.42	3.16	4.00
5	Mean	3.57	**2.97**	3.39	3.13	4.01
6	Mean	3.59	**3.10**	3.48	3.13	3.95
7	Mean	3.56	2.97	**3.54**	3.13	3.99
8	Mean	3.40	2.80	**3.73**	2.96	3.96
9	Mean	3.37	3.62	3.12	**3.95**	3.95
10	Mean	3.40	2.75	3.50	**3.17**	4.00
11	Mean	3.38	2.71	3.40	2.98	**4.01**
12	Mean	3.41	2.69	3.35	3.02	**4.11**
Overall Average		**3.53**	**2.96**	**3.43**	**3.18**	**4.00**
Average for the weeks that Program Presenated		**3.81**	**3.03**	**3.63**	**3.56**	**4.06**

Finally, students gave feedback in an open-ended format to indicate the things that were most and least helpful to them. Question seven on the survey each week related to what they wished they had heard. For the most part, students said the information they wanted to hear was covered adequately, but each week a number of students would mention things about pay or professional opportunities:

Pay that could be expected for being a chemical engineer.

I wish we would have talked more about the different jobs that apply to chemical engineering, rather than the procedures that people are taking part in.

Students were also asked about what they enjoyed most about the lecture of the week (question eight on the survey), and several students mentioned a greater understanding the types of jobs a particular engineering discipline might be involved with:

I learned Mechanical engineering is not just working with machines, it also involved in analyzing product mistakes by setting damage tests.

I learned that there are a lot of different fields in electrical engineering and I also learned a lot about engineering in the military which was very interesting as well.

The departmental presentations are especially useful for teaching students about the "less mainstream" engineering disciplines such as Industrial Engineering. Many of the comments indicated that students really did not know what Industrial Engineering was at all:

I didn't know what industrial engineering was all about at first.

I'd learned that the industrial engineering is more involved in manufacturing specially electric and mechanical companies such as GE and GM. I also have knowledge about what industrial engineers do, and how they get use to use the equipment all by entering the commands in computer programs. Beside of that industrial engineers thinks of how they can improve the process of making product fast and useable than it was.

Other students were more reflective in terms of what they gained from hearing the lecture on an engineering decision, and they way that it affirmed (or dissuaded in this case) an engineering educational pathway:

I learned that I for sure do not want to be an electrical engineer.

Following the two week presentations given by each department, feedback was given to the presenter(s) and the Program Coordinators so that the information could be used to improve their presentation in the future.

Students were also tracked after completion of the engineering orientation course. Figure 1 summarizes the findings in which 60% of students did not change their intended engineering discipline (from the one they indicated at the start of the semester) and continued taking the First-Year Engineering Course in the Spring semester, Engineering Computing, as planned (they didn't fail any prerequisites). But there were many students that did change their intended engineering discipline, 21%. There was an additional 11% of students that failed or stopped attending the other primary First-Year Engineering Course Engineering Concepts, so it is not clear as to their future plans (inside or outside of engineering). Those students were all sent exit surveys to gain feedback, but that is beyond the score of this study. The smallest proportions were 3% of students who failed math or chemistry (but plan to retake them and continue in engineering), 3% of student who changed their major to a different non-engineering STEM major, and 2% of students that changed to a major outside of the STEM College.

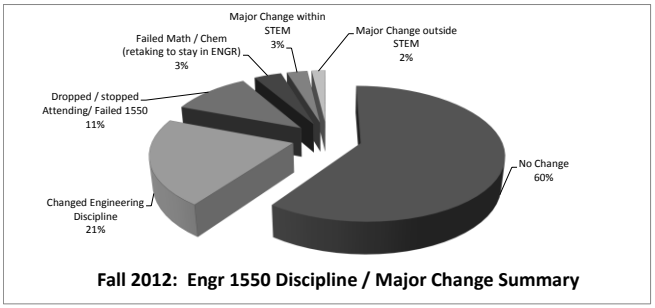

FIGURE 1
SUMMARY OF WHERE STUDENTS WENT AFTER THE COURSE

Figure 2 summarizes students' response to how the Engineering Orientation Course influenced them personally. This question was asked on the final survey for the semester and response choices were: (1) It affirmed my plans; (2) I changed from my original plans, or (3) Minimal influence. The vast majority of students said that it affirmed what they originally thought, 71%. While 20% indicated that they

changed from the engineering major they originally thought, and finally 9% said it did not influence them.

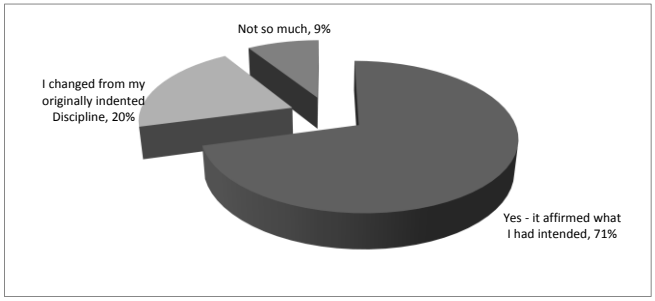

FIGURE 2
ENGINEERING ORIENTATION COURSE INFLUENCE

Every survey also had a final question that allowed students to write in any concerns they had that the First-Year Engineering Program should be aware of. This question was often skipped; however, many bigger issues were identified for students early on in the semester as a result. For example students might indicate they were having issues with a project group, so the instructor could intercede. Or if there were homework issues such as access to help from TA's, office hours, or how they were graded then feedback could be given directly to the individual with concerns. Finally, students that indicated they were struggling with a course such as Calculus or Chemistry we were able to refer them to the Center for Student Progress for tutoring help. With over 200 students in the class, it took ~1 hour per week to respond to student concerns raised from this survey question.

CONCLUSIONS

So much focus in engineering education has been on active learning strategies and offering students project based learning experiences, but there seems to still be a need (or an opportunity) for more traditional approaches involving lectures. We believe that both may be appropriate depending on the course, content, objectives, and number of students. Quite frankly, large lecture courses are less more economical from the standpoint of requiring many fewer faculty to execute and if students still meet the learning objectives then a case can be made for maintaining passivity in certain educational contexts.

From our limited study, we would affirm that students did find value in the Engineering Orientation Course, ENGR 1500 to learn about the different engineering disciplines available to them at Youngstown State University. One in five students actually switched which engineering discipline they planned to pursue in the future, and three out of four students said it helped affirm their engineering educational plans going forward. For every presentation, students indicated they learned something from it and it increased their disciplinary knowledge (even if it was not the discipline they planned to pursue in the future). It also increased students excitement for an engineering discipline – even if just temporarily. This was evidenced by the higher rating of interest in an engineering discipline during the weeks they were presented (as compared to the overall average for that discipline).

This study does have limitations; it is based on self-reported data from students at a single institution. The next step is to expand the study to other similar and dissimilar engineering programs around the country. Additionally, focus group interviews would strengthen the results reported in this study trough triangulation of qualitative and quantitative methods. This will be pursued in a future, expanded study.

ACKNOWLEDGMENT

I would like to thank all the students enrolled in ENGR 1500 during the fall of 2012 at Youngstown State University for giving such candid feedback. I would also like to acknowledge the advising staff, in particular Debbie Kucharski, for her help in tracking students' performance in classes beyond the First-Year Engineering Courses.

REFERENCES

[1] National Academy of Engineering (NAE). Educating the Engineer of 2020: Adapting Engineering Education to the New Century. (2005). Nataional Academy Press.

[2] Bonwell, C., and Eison, J. Active Learning: Creating Excitement in the Classroom. ASHEERIC Higher Education Report No.1, George Washington University, Washington, DC , 1991.

[3] Felder, R. and Brent, R. Active Learning: An Introduction. ASQ Higher Education Brief, 2(4), 2009.

[4] Goodman, I., Cunningham, C., Lachapelle, C., Thompson, M., Bittinger, K., Brennan, R., and Delci, M. Final Report of the Women's Experiences in College (WECE) Project. April 2002. http://www.grginc.com/WECE_FINAL_REPORT.pdf

[5] Prince, M. Does Active Learning Work? A Review of the Research. Journal of Engineering Education, vol. 93(3), 2004.

[6] Kvam, P. The Effects of Active Learning Methods on Student Retention in Engineering Statistics. The American Statistician, Vol. 54, No. 2. (May, 2000), pp. 136-140.

[7] Burke, R. and Mattis, M. Women and Minorities in Science, Technology, Engineering, and Mathematics: Upping the Numbers. Edward Elgar Publishing, 2007.

[8] Farrell, E. Engineering a Warmer Welcome for Female Students: The Discipline Tries to Stress its Social Relevance, an Important Factor for Many Women. C*hronicle Higher Education.* 2002, *February 22*.

[9] Widnall, S. Digits of Pi: Barriers and Enablers for Women in Engineering. Presented at the SE Regional NAE Meeting, Georgia Institute of Technology, April 26, 2000.

AUTHOR INFORMATION

Dr. Meyers background is in Engineering Education with experience in assessment, specifically of programs that might influence an incoming student's experience, affect retention rates and the factors that determine the overall long term success of students entering an engineering program. She is the Director of the STEM College's First-Year Engineering Program, the entry point for all beginning engineering students designed to provide a smooth transition from high school to University. Having been involved with the program at the University of Notre Dame for the past 7 years and now at YSU has made her deeply familiar with the requirements for a thorough undergraduate curriculum that successfully transfers an in-depth understanding of the core principles of math, science and engineering to the incoming students through innovative coursework, mentoring and team work, and the value of hands-on teaching and one to one interaction of faculty and students.

Kerry L. Meyers, kmeyers@ysu.edu, 330-941-3028, 2420 Moser Hall, Youngstown State University, Youngstown, Ohio, 44555.