Major Choice in First-Year Engineering Program

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***Abstract* — This paper is a work in progress analysis of major choices by first-year engineering students in the General Engineering (GE) program at Virginia Tech. A series of surveys are administered to GE students at three times over the course of their first year: in August at the beginning of the fall semester; in December at the end of the fall semester; and in April at the end of the spring semester. The surveys collect data about which majors GE students are interested in pursuing at the three points of administration.**

Social Cognitive Career Theory (SCCT) can be used to make inferences about how students declare their majors and why students decide to switch within or out of engineering. Using SCCT as the theoretical underpinning for this paper, we seek to gain better understanding of the relationships between the confidence of first year engineering students and their major choices, specifically as it pertains leaving the College of Engineering.

Keywords—first year engineering; first year programs; SCCT; major choice

I. Introduction

This paper is a work in progress analysis of major choices by first-year engineering students at Virginia Tech. Students are admitted to the College of Engineering as General Engineering (GE) majors and are enrolled in Foundations of Engineering I and II (fall and spring respectively). Foundations of Engineering I is a a Virginia Tech First Year Experience course designed to equip students with problem solving skills, inquiry skills, and integration of learning skills necessary for navigating college level curricula [1].

A series of surveys are administered to GE students at three times over the course of their first year: in August at the beginning of the fall semester; in December at the end of the fall semester; and in April at the end of the spring semester. All three surveys collect data about which majors GE students are interested in pursuing at the time of administration. Survey responses used in this study are from students who admitted as GE students for the 2015-16 academic year, completed all three surveys and consented to participate in the study. This represents a 67% total response rate amongst the 1743 2015-16 first-year GE students. Students are required to take these surveys and submit their confirmation of survey completion as a homework assignment in the first-year courses; however, their participation in research is voluntary. The goal of this study is to answer the following research question:

What is the difference in confidence in being an engineering student for students who are undecided about which engineering major to pursue over the course of the first-year engineering courses?

Thus our hypothesis for this research question is as follows:

H_1: There is a difference in confidence in being an engineering student for student who are undecided about which engineering major to pursue over the course of the first year.

II. Theory

Social Cognitive Career Theory (SCCT) can be used to make inferences about how students declare their majors and why students decide to switch within or out of engineering. Developed in 1994 by Lent, Brown, & Hackett as a derivation of Bandura's social cognitive framework, SCCT aims at understanding educational and occupational interest development, choice-making, performance and persistence, and satisfaction/well-being [2].

Social Cognitive Career Theory (SCCT) states that people form sustaining interest in an activity when they believe in their competency and anticipate positive valued outcomes [2]. SCCT explains that a person's inputs (gender, race, physical abilities, etc.) and background creates learning experiences that influences self-efficacy and outcome expectations. The level of self-efficacy and outcome expectations influences a person's goals, actions, and outcomes.

III. Confidence in Major Choice

The first year surveys, though not designed using SCCT directly, include relevant constructs using validated measures [3]. Survey items linked to SCCT include: 6 items related to interest; 10 items related to competence; and 12 items related to utility which may infer a student's outcome values such as final grade in a course, the decision to major in engineering, earning an engineering degree, etc. On each survey, students were asked the following questions relating to confidence in their major choice rated on a 6-point Likert scale:

1. I am confident in my choice of a specific major. (only asked of students who did not choose Undecided as their major choice)
2. I have sufficient information to make an informed choice about a specific engineering major.
3. I am confident that I want to study engineering.
4. My eventual career will directly relate to engineering.

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5. In the future, I will have a career that requires me to have engineering skills.
6. I plan to continue on in an engineering major.
7. I don't intend to change my major from engineering to a non-engineering major.

Over the course of the academic year, the number of students who are undecided about their major declines. However, due to the fact that our survey currently does not have an "other/non-engineering" major choice option, we have not explicitly captured students who decide to leave engineering at the end of the first year. However, by looking at the responses of students who choose Undecided as their major, we may be able to understand the role confidence plays in major choice.

IV. Preliminary Analysis and Results

To understand any possible connections between being undecided about engineering major and confidence to pursue engineering, we did a preliminary analysis of students who are Undecided and their responses to questions 3, 4, 6, and 7. Each question had the following answer choices: (1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Somewhat Agree, (5) Agree, and (6) Strongly Agree. For the purpose of this analysis, we focused more on students who had a level of disagreement to each of the questions (i.e., responded with 1, 2, or 3).

A. Descriptive Statistics

At the beginning of the fall semester 180 student responded that they were Undecided about which engineering major they wanted to pursue. At the end of fall semester there were 95 Undecided students. At the end of the spring semester there were 30 Undecided students. No attempt was made to determine how many of these Undecided students were Undecided on all three surveys.

1) Q3. I am confident that I want to study engineering

At the beginning of the fall semester, 10.6% of Undecided students had some level of disagreement with this question. At the end of the fall semester 15.8% of the Undecided students had a level of disagreement. At the end of the spring semester 60% of the Undecided students had a level of disagreement with Q3

2) Q4. My eventual career will directly relate to engineering

At the beginning of the fall semester, of the Undecided students, 5% had a level of disagreement with this question. At the end of the fall semester 9.5% of Undecided students had a level of disagreement. At the end of the spring semester 50% of Undecided students had a level of disagreement.

3) Q6. I plan to continue on in an engineering major

At the beginning of the fall semester 1.7% of Undecided students had a level of disagreement with Q6. At the end of the fall semester 7.4% of Undecided students had a level of disagreement. At the end of the spring semester 56.7% of Undecided students had a level of disagreement.

4) Q7. I don't intend to change my major from engineering to a non-engineering major.

At the beginning of the fall semester 3.9% of the Undecided students had a level of disagreement with Q7. At the end of the fall semester 10.5% of students who were Undecided had a level of disagreement. At the end of the spring semester 60% of Undecided students had a level of disagreement.

The averages of the responses for Undecided students who had a level of disagreement with each of Q3, Q4, Q6 and Q7, on each survey, are listed below in Fig 1.

TABLE I.

	Beginning of Fall	**End of Fall**	**End of Spring**
Q3	2.00	2.13	1.72
Q4	2.89	2.78	2.00
Q6	3.00	2.43	1.63
Q7	2.86	2.50	1.61

Fig. 1. Mean response for survey items at three administration points

B. Statistical Test

An independent sample t-test was conducted to compare 1) responses at the beginning of the fall semester and the end of the fall semester, and 2) responses at the end of the fall semester and the end of the spring semester, to see if there was a statistically significant difference in the responses. We found that there was no statistically significant difference between the responses of undecided students when looking at the beginning of the fall semester versus the end of fall, and the end of the fall semester versus the end of spring. Therefore, the results of this preliminary analysis may indicate this to be typical behavior for our sample population [4]. The statistical significance (p-value) for the disagreeing survey results are displayed in Fig. 2 and Fig. 3.

TABLE II.

	Q3	**Q4**	**Q6**	**Q7**
p-value	0.96	0.97	0.85	0.90

Fig. 2. Beginning of Fall Semester versus End of Fall Semester

TABLE III.

	Q3	Q4	Q6	Q7
p-value	0.89	0.79	0.84	0.81

Fig. 3. End of Fall Semester versus End of Spring Semester

Discussion

In Social Cognitive Career Ttheory, input factors relating to a person's experience or background can infuence one's self-efficacy and subsequently their goals and the actions they take to achieve them. Given the results of the preliminary analysis, we must accept the null hypothesis that students who are undecided over the course of the first year are not necessarily lacking confidence nor experiencing low self-efficacy in engineering [5].

Although the results proved to be insignificant, there is a larger pool of data underexplored from the students who completed all three surveys in 2015-16. While this preliminary analysis focused on only undecided students, there are 14 engineering majors at Virginia Tech that students may choose from. Students who are interested in these majors may have also disagreed with these survey questions which may provide more insight on whether there is a difference between students' responses on selected survey items and their confidence in engineering. We also looked at students who were undecided at any given point of the semester as opposed to those who may have been consistently undecided over the course of the first year. This could also be a factor to look at more closely as we progress with this research. Lastly, we inferred that students who disagreed with these questions were more likely to have lower confidence in pursuing engineering; while having low confidence is a factor in one's choice to leave engineering [6], there may be outlying cases that we are not capturing due to the population we selected.

V. Conclusion and Future Work

As we work towards understanding how to best retain students, it is important that we understand as much as possible about the many factors that can influence a student's choice of major. At Virginia Tech not only do we collect data while students are in enginering but we also ask students who leave the college of engineering to complete an optional exit survey. With more strategic data collection of exit survey information, coupled with the addition of an "other/non-engineering" major choice option to the first year survey, we can really understand the role confidence plays in student major choice.

Future plans for this work more data collection including more extensive items related to confidence as well as exploring programmatic influences on student's confidence in choosing an engineering major.

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