Why Engineering?: Students' reasons for choosing an engineering major.

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Why Engineering? Students' Reasons for Choosing an Engineering Major

Introduction

Engineers are a necessary component of our workforce. Between 2003 and 2009, 41% of engineering students who began pursuing their bachelor's degree ultimately left the major (Chen & Soldner, 2013). Accordingly, retention in engineering programs continues to be a central focus for many researchers. One potential precursor to retention may be the reasons students have for initially choosing an engineering major. Therefore, further investigation into the reasons students choose engineering is an important area of study.

Students pursue different majors for an assortment of reasons. Many processes have been identified surrounding the decision-making process in selecting a college major (Beggs, Bantham & Taylor, 2008; Germeijs, Luyckx, Notelaers, Goossens, & Verschueren, 2012). Using qualitative and quantitative methods, Beggs et al. (2008) identified six factors that were reported as influences in major selection among participants: information search, match with interests, job characteristics, financial considerations, psycho/social benefits, and major attributes. High value was placed on matched interests, followed by course/major attributes, job characteristics, financial considerations, psycho/social benefits, and, finally, information search. In another study, first year college students were asked to share their criteria and alternatives they considered when selecting a major in an open-ended manner and then asked to rate their responses (Galotti, 1999). When asked to repeat the exercise a year later, only half of the original criteria reappeared, while comfort and confidence in the decision increased. Although there have been some qualitative studies on the topic of major selection, this remains a gap in the literature that career theories can be used to explain.

Career theories can provide insight into reasons for major selection among first-year college students. While some researchers focus on person-environment fit career theories (Porter & Umbach, 2006) in which the focus is on understanding how the environment suits or does not suit the individual's personality, others theories place emphasis on self-efficacy beliefs, personal goals, and outcome expectations (Lent et al., 2008; Miller et al, 2015). Because factors such as self-efficacy have emerged as critical constructs in prior research with engineering students, we selected Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994) to serve as the overarching framework for understanding students' reasons for selecting engineering as a major.

Social Cognitive Career Theory

The Social Cognitive Career Theory (SCCT; Lent et al., 1994) posits that individuals' interests, choices, achievement, and satisfaction interact with each other. Emphasis is placed on interest development, selection of career or academic major, performance, and persistence, as well as career and academic interest, choice, and performance were important to the development of the theory. Socio-cognitive mechanisms including self-efficacy, expected outcomes, goals, and contextual factors (including experiential and learning factors) are emphasized. This theory proposes a link between self-efficacy, outcome expectations, and interest. Aptitudes and values, often learned through modeling, play a role in outcome expectations. Given that students have outcome expectations, we propose that SCCT can be applied to major selection for engineering students.

SCCT can be linked to college major selection and performance, including engineering. Factors that affect adjustment in first-year engineering majors, as well as their self-efficacy beliefs and outcome expectations, regarding careers within the field have been examined (Miller et al., 2015). Major barriers include academic performance, time management, work/life balances, as well as completing other demands. Participants identified factors such as modeling, social support, and performance experience (success and failures) in affecting their confidence and ability to complete their degree. In regards to positive outcomes of earning an engineering degree, participants reported extrinsic work beliefs (49%) and intrinsic work conditions (38%). Participants also noted a desire to give back to the community and develop a social network. Researchers have used the SCCT across cultures and have demonstrated that the theory fits among selected cultures (Kim & Seo, 2014; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). In a study with South Korean engineering undergraduates, social-cognitive predictors aligned with the interests and goals among students, indicating cross-cultural applicability of the theory (Kim & Seo, 2014.) This fit was also found within multiple ethnic identities among biological science majors and engineering majors (Byers-Winston et al., 2010).

More specifically, the major tenets of SCCT include person variables and contextual factors. Person variables included in the theory are self-efficacy beliefs, personal goals, outcome expectations, and interest, while contextual factors include environmental supports and barriers. As one might expect, this creates a better depiction of the individual and the decision-making process that ultimately may affect major retention.

Person Variables

Person variable are those variables that differ between individuals. In the SCCT model, these variables include self-efficacy beliefs, outcome expectations, personal goals, and interest. Self-efficacy is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). These beliefs are integrated with contextual factors and behaviors related to job performance or, in this case, academic setting, which can be influenced by past experiences, as well as confidence. Individuals also have outcome expectations, or beliefs about what the outcome of an event will be, within multiple domains, including physical, social, and self-evaluative outcomes (Bandura, 1986). Personal goals are aspirations that individuals have in regards to their futures, while interest involves the desire to pursue a particular activity.

Self-Efficacy Beliefs

In accordance with the SCCT framework, the strongest predictor of entrance into the Science, Technology, Engineering, and Mathematics (STEM) field is strong confidence in mathematics, in combination with having parents who held occupations in the STEM fields (Moakler & Kim, 2014). Modeling, social support, and performance experience (successes and failures) that increase confidence have also been identified as an influence on self-efficacy (Miller et al., 2015). Concannon and Barrow (2012) examined engineering self-efficacy in both women and men across grade levels, finding no significant difference in general self-efficacy. Lent et al. (2008) investigated self-efficacy in relation to interests, major choice, and outcome expectations of first and second year engineering students, and found that self-efficacy accounted for changes among interests, major choice, and outcome expectations. Both value constructs (interest attainment and utility) and expectancy related constructs (self-efficacy and expectancy) acted as predictors, while expectancy-related constructs acted as a stronger predictor than values-related constructs (Jones, Paretti, Hein, & Knott, 2010).

Outcome Expectations

Outcome expectations have been identified as predictors in major choice and performance (Beggs et al., 2008; Miller et al., 2015; Honken & Ralston, 2013). Financial considerations, psycho/social benefits, and major attributes were identified as reasons for major selection, which are considered types of outcome expectations (Beggs et al., 2008). When asked to identify positive outcomes of earning an engineering degree, participants' responses included extrinsic work beliefs (49%) and intrinsic work conditions (38%), while expecting various positive outcomes, with the mode of social networks (53%). Researchers also found that many participants were happy to be able to give back to the community (Miller et al, 2015).

Personal Goals

Another aspect of the SCCT is personal goals, or an individual's determination to achieve a given outcome. Career goals among freshmen undergraduate students, including job-related, school related, value related, and unknown goals, in relation to retention, academic performance, self-esteems, self-efficacy, and school and career commitment were identified as career goals (Hull-Blanks et al., 2005). Commitment, persistence and self-efficacy were positively correlated with each other, as well as with GPA, corresponding with the SCCT. Brown, Lent, Telander, and Tramayne (2011) found that goal challenges were unrelated to performance after controlling for self-efficacy and ability, but rather a necessary path from ability to goal difficulty. Personal goals correlate with outcome expectations, which is expected to influence both performance and retention (Byars-Winston et al., 2010).

Interest

Interest is another component of the SCCT, and has been identified as a predictor of college major selection and noted to be a valued aspect of the decision to pursue engineering (Beggs et al., 2008). Interest is linked to academic satisfaction, with satisfaction mediating interest and intention to persist (Lent el al., 2013). This alignment with interest has been found across cultures including South Korea (Kim and Seo, 2014). Interest is also noted as important among ethnic minority groups and among the gender binary (Lent et al., 2013). Byars-Winston et al. (2010) found that outcome expectations were related to interest, with the SCCT model fitting their findings. The predictability of engineering interest and major choice goals within the SCCT framework has been examined and fit the model; however, there were gender differences, in which men reported more self-efficacy and interest for engineering than women (Inda, Rodríguez, & Peña, 2013).

Contextual Factors: Environmental Supports and Barriers

Contextual factors, or factors within the environment, often play a significant role in an individual's career choice and persistence. Honken and Ralston (2013) focused on retention from engineering students in 2010 from their first year to their second year, and found that 71% of students had thought about other possible majors and career paths. Many of the participants in their sample perceived themselves as having high abilities, specifically in math and science, which was frequently endorsed by these participants as the reason why they elected to pursue an engineering major. Men perceive family as a barrier in comparison with women, who perceive them as a support in addition to peers (Inda et al., 2013). Lent et al. (2003) tested two types of SCCT models on both personal and contextual variables among those who were pursuing an engineering major, and found contextual supports and barriers were linked to their actions and choice goals, although indirectly through self-efficacy.

Current Study

Although many researchers have examined the reasons why first-year college students select their majors (Beggs et al., 2008; Galotti, 1999; Germeijs et al., 2012; Matusovich, Streveler, & Miller, 2010), there is still a need for a qualitative approach to understanding reasons for selecting an engineering major. Beggs et al. (2008) completed a qualitative investigation about decision-making, but it was not specific to engineering. Open-ended questions allow students to contemplate why they selected engineering, without the exposure to preexisting ideas about researcher expectations. We expected some reasons to correspond with tenets of SCCT (e.g., self-efficacy and outcome expectations, contextual factors); however, we also allowed for the possibility of novel reasons. Therefore, no specific *a priori* hypotheses were formulated as to the reasons that students would report when asked to explain why they chose engineering as a major.

Method

Participants

The study sample consisted of 390 first-year engineering students from a large university in the Midwest. Of these, 85.6% of participants self-identified as White (n = 334), 4.6% were Black (n = 18), 3.8% identified as multi-racial (n = 15), 3.3% were Asian (n = 13), 2.6% were Latino/a (n = 10). Based on institutional research data, 78.7% of the participants were male (n = 307), and 21.3% (n = 83) were female.

Procedures

During the first week of the fall semester of 2013, students taking a required introduction to engineering course were asked to complete a survey. The majority of the students in this course consisted of first-year students, who were the focus of the larger study.

Measures

For our current study, we used data from one open-ended question within the larger survey that asked, “What influenced your decision to study engineering?” There were 14 participants (3.6%), who did not answer this question and were therefore omitted from the analysis.

Results

Coding Qualitative Data

Before coding began, the two researchers involved in the data analysis recorded their biases regarding reasons for the selection of an engineering major and retention. This bias recording is recommended for qualitative research to ensure trustworthiness (Creswell, 2013). One researcher (doctoral student in a counseling-related field) expected to see responses such as prestige, family’s goals, and family’s careers, and extrinsic motivation factors. The other researcher (assistant professor in educational psychology with a research specialization in achievement motivation) reported a bias toward expecting factors related to competence-related beliefs, value-related beliefs, and extrinsic motivators (e.g., income, perceptions of belonging to a prestigious career path, etc.).

After the biases were recorded, the two researchers independently coded an initial set of 75 responses that were randomly selected from the full dataset. Using these 75 responses, we created an initial coding guide. The final coding guide can be found in Appendix A. After discussion, the rest of responses were double-coded and placed into categories based on the original 75 responses that were coded. This method is known as the constant comparative method (Creswell, 2013). If we noted that a category consistently appeared in the data, we would add a new category to the coding guide. Agreement rate was checked throughout this process and remained high (averaging 97%). Discrepancy rates were calculated at regular intervals to establish concordance in the coding process. The final categories are presented in Table 1. Representative sample responses are included for each code. Importantly, each student response was coded for the presence and absence of each code; therefore, codes are not mutually exclusive.

Table 1

Final Categories and Sample Student Responses

Categories	N	% of Sample
Interest in a Subject Matter: Student is interested in a subject "My interest in math."	104	26.7
Family Influences: Family is an engineer or encouraged them "My father is an engineer."	77	19.7
Prior Experience: A prior experience influenced them "Vex Robotics."	68	17.4
Nature of the field: Student perceives the field's opportunities positive "My desire to work with computers and math."	66	16.9
Career/Job Outlook: Student's perceived future career paths in field. "Job Opportunities."	56	14.4
Ability Level: Student's perceived ability level in subject "I have always excelled in math, science, and technology."	48	12.3
Social Influences: Being influenced by people outside of family "Family friend."	48	12.3
Love and Passion: Student loves or has passion for a subject "Love for calculus."	36	9.2
Financial Outlook: Student believes the financial outlook is good "Money."	22	5.6
Helping Society: Student believes choice will help society "I want to help people out."	13	3.3
Engineering as Means to an End: Program used as stepping stone "I want to attend medical school."	12	3.1
Desire for a Challenge: Student's desire of a challenge "Challenging Curriculum."	8	2.1

Note: Percentages do not sum to 100% because codes were not mutually exclusive; therefore, a given response could receive multiple codes.

Based on frequencies, the top three reasons the participants identified for selecting a major in engineering were interest, family influence, and prior experience with something related to engineering. The least frequent responses included helping society, engineering as a means to an end, and a desire for a challenge. These categories were not mutually exclusive, and often included multiple response. Further analysis with these data will more closely examine patterns of codes.

Discussion

Results indicated that the top three reasons why individuals selected an engineering major included expressing an interest in the subject matter, being influenced by family, and prior experience with engineering-related activities. These motivators offer suggestions for recruitment purposes. For example, engineering faculty can focus on students who have interest in subjects that are related to engineering, and provide information regarding the major and field. Because prior experience played a large role in the sample, it could be beneficial to work with local schools and Project Lead the Way programs to expose more students to engineering. These are just a few ideas that could be implemented in recruitment.

There were some limitations in our study, one of which is that this study only occurs at one university. This is an external validity threat, as this pertains to the generalizability of our study. The demographics from our study are quite consistent with the 2013 national averages found by the National Science Foundation, indicating that generalizability is possible. As this research is currently in-progress, we have plans to investigate the relationship between reasons for selecting a major and retention. This analysis will provide further implications for engineering faculty to better understand the reasons that are associated with persistence in the major.

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Appendix A

Code Book

- Ability Level
  - Ability Level in Math
    - I am good at math.
  - Ability Level in Science
    - I am good in science.
  - Ability in Creating/Building things
    - I am good at building things
- Career/Job Outlook
  - Job Opportunity
    - There are great job opportunities.
  - Job Outlook
    - The job outlook looks good.
  - Job Security
    - Engineering will provide me job security.
- Desire of a Challenge
  - I want a challenge.
- Engineering as a Means to an End
  - Future Medical Field
    - Being in engineering will help me get into the medical field
- Desire to Fix things
  - I want to fix things.
- Desire to help others
  - I want to help others.
- Desire to innovate
  - I want to innovate/create new things.
- Desire to plan/design
  - I want to be able to plan and design things.
- Desire to work with renewable energy
  - I want to work with renewable energy.
- Desire to work/design with machines
  - I want to work with and design machines.
- Love and Passion
  - Enjoyment of math
    - I love math.
  - Enjoyment in making/building things
    - I love building things.
  - Enjoyment of science
    - I love science.
  - Love of the industry
    - I love the industry.
  - Passion for Engineering
    - I have a passion for engineering.
- Family

    - Family Influences
        - My family wants me to be an engineer.
    - Family members are engineers
        - My uncle is an engineer.
    - Parents
        - My parents want me to be an engineer.
    - Parent is an engineer
        - My dad is an engineer.
- Financial Outlook
    - Money
        - It pays well.
- Interest
    - Interest in Biology
        - I am interested in biology.
    - Interest in Bioengineering
        - I am interested in bioengineering.
    - Interest in vehicles
        - I am interested in cars.
    - Interest in Chemistry
        - I am interested in chemistry.
    - Interest in Computers
        - I am interested in computers.
    - Interest in Design
        - I am interested in designing things.
    - Interest in Engineering
        - I am interested in engineering.
    - Interest in engines
        - I am interested in engines and how they work.
    - Interest in math
        - I am interested in math.
- Lack of Interest in other fields
    - I am not interested in other fields outside of engineering.
- N/A
- Nature of the field
    - Nature of the Field
        - I love the nature of the field.
    - Practicality
        - It is a very practical career.
    - Subject Integration
        - I like and want to continue integrating math and chemistry.
- Prior Experience
    - Field Trip
        - I visited the bioengineering plant, and decided that I wanted to become an engineer.
    - Government Programs
        - The STEM initiative inspired me to major in engineering.

    - Prior Classes in High School
        - I took an engineering class in high school and I loved it.
    - Prior discussion with professionals
        - I talked to medical professionals and they recommended going in to engineering.
    - Prior discussion with engineering students
        - I talked to Speed School students, and this influenced me to pursue the engineering field.
    - Experience with Computers
        - I have a lot of experience with computers.
- Social Influences
    - Successful people that they know
        - I have talked to successful people who said that I should go into engineering.
    - Teachers
        - My high school teacher said I should be an engineer.
- Other