



## Factors influencing students' choice of engineering major

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**FACTORS INFLUENCING STUDENTS' CHOICE  
OF ENGINEERING MAJOR, CASE STUDY  
AT THE UNIVERSITY OF NEW HAVEN**

**Abstract**

This research focuses upon evaluating decisions made by engineering students to choose or change their field of engineering study in order to determine influences and mechanisms that drive their choice of engineering major at the University of New Haven (UNH). Socializers (parents, peers, and faculty), self-identified competence, and media sources were studied for their level of influence and effect upon the selection of an engineering field. This research also investigates students' perceptions of different engineering majors at the University and their awareness and understanding of those majors. Understanding this type of decision and knowledge helps the University's engineering educators in emerging new undergraduate engineering majors or innovative interdisciplinary engineering programs attract and recruit students to these lesser known or understood majors. The long-term goal of this research is to develop a survey instrument that can be used at other universities in order to collect generalizeable information of the choice of engineering major. This paper presents select quantitative and qualitative results from this study. A survey was conducted of 97 voluntary participants from eight undergraduate programs within the College of Engineering. Some key findings indicate that gender and parental educational achievement levels affect choice of engineering major at UNH. In addition, only 66% of engineering students indicated that they had determined their specific major before visiting potential universities during their search. This should indicate to the University's engineering programs that there is significant opportunity to influence student decisions during the recruitment process or during their first and second years of study.

**Introduction**

This research focuses upon evaluating decisions made by engineering students to select or change their field of engineering study in order to determine influencers and mechanisms that drive their choice of engineering major at UNH. This type of study is more meaningful and necessary when conducted at a university that offers many different types of engineering degrees, and other liberal arts and professional degrees, since selecting and changing degrees within the university is possible and occurs with minimal cost.

UNH is a private university in Connecticut that has a total undergraduate population of 4,693 and an undergraduate engineering student population of 460. A survey was conducted of 97 voluntary participants from eight undergraduate programs within the College of Engineering. Participants included students studying chemical engineering, mechanical engineering, civil engineering, system engineering, computer engineering, electrical engineering, general engineering, and computer science. This study builds upon existing studies that focus upon why students choose a particular major within a broad area, such as business, science, or engineering.

Many social and cultural factors such as demographics, self-assessment and self-identified competence, stereotypes, and socialization (parents, peers and faculty) are underlying reasons for a student to choose a major. These may include personal beliefs, perceived barriers to success, personal interests in the field of study, and attainment values. Students are influenced by a multitude of external sources and environmental factors including socializers, general public media, and targeted media and information.

*Research Question 1: How important are specific socializers, interest, and external influencers when selecting or changing engineering majors for UNH engineering students?*

The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology<sup>1</sup> found that there are four important eras in girls' lives when they start losing *interest* in STEM disciplines: while entering middle school, during late high school, college and graduate school, and in their professional lives. This study focuses upon *one of the most important indicators of interest*, the choice of major decision.

*Research Question 2: Do important influencers on the choice of engineering major affect male and female UNH engineering students differently when selecting or changing majors?*

Education researchers cite parental education background and achievement levels as a factor influencing a child's education performance and career choice. Parental education attainment level is used, for example, by the National Assessment of Education Progress (NEAP) for longitudinal studies that report on education progress in reading and mathematics of 9, 13, and 17 year old students in U.S. schools.<sup>2</sup>

*Research Question 3: Do important influencers on the choice of engineering major affect UNH engineering students differently based upon their parents' educational background or achievement level?*

The UNH Tagliatela College of Engineering offers seven different types of engineering majors, computer science, and information technology as potential areas of study. This research seeks to determine why students choose one engineering field vs. another and what influencers affect that decision. This research also seeks to investigate why students chose to change majors into the field of engineering or why students switch from one engineering major to another.

*Research Question 4: How do important influencers on the choice of engineering major affect students' choice to select an engineering major or switch majors within the engineering field?*

Understanding results could lead to the development of K-12 programs that expose students to correct perceptions of the wide variety of engineering majors and careers, and allow students to build connections to the field of engineering. The results of this process could encourage more students from underrepresented groups to enter engineering fields. This paper presents select quantitative and qualitative results from this study.

## **Literature Review**

Career options are numerous, increasingly specialized, and every year thousands of students choose colleges and majors that can lead them into these careers. Studies as to how individuals make the decision of one major versus another span all disciplines. One area of Choice of Major research focuses upon understanding the influences impacting an individual's choice. Four factors were identified by Galotti and Kozberg<sup>3</sup> as influencing an individual's choice of major: "how much I care about the subject", "something I do well in", "something with good career opportunities," and "what I want to do with this major after college." Other research areas focus upon how the choice of major impacts student and career outcomes, like educational persistence or career success. For instance, Montmarquette, Cannings and Mahseredjian<sup>4</sup> theorized that undergraduates who failed to finish college may be due, in part, to an ill-advised choice of major concentration. Other research focuses upon studying barriers to underrepresented groups entrance into certain majors or why students may or may not choose specific majors or areas of study.

### Influences upon the Choice of Major Decision

Social cognitive career theory (SCCT) as proposed by Lent et al.<sup>5</sup> hypothesizes that behavior (choice of career) is a function of the dynamic interplay between beliefs and environmental conditions. General social cognitive theory suggests that self-efficacy beliefs determine whether an action will be pursued, how much effort will be given to that pursuit, the persistence in the face of obstacles and ultimately the performance level of the action.<sup>6</sup> In 1996, Lent, Brown and Hackett,<sup>7</sup> proposed a concentric model of environmental layers that surround the person and form the context for his or her career behavior. Furthermore, a person with interest in a particular career path is unlikely to pursue that path if the individual perceives barriers to entering or advancing in that career. Perceived barriers include internal factors (such as confidence in ability to manage the difficult situations that may arise) and external factors (such as ability to obtain student loans).

### Choice of Major in STEM Fields

A major focus area in engineering education research has been improving the levels of retention, persistence, and recruitment of engineering students. Reasons for students to enter engineering programs include the influence of family, high school teachers, and peers; previous success in math and science courses; and interests in the career track as stated by Seymour & Hewitt.<sup>8</sup> The large-scale study investigated relationships between choice of a science, math, or engineering major and the likelihood of degree completion in the chosen major. The authors identified that those who choose an engineering field based on personal interest were more likely to persist than those who choose the same major for reasons such as family influence and prior success in math and science courses. Recent work by Matusovich et al.<sup>9</sup> has demonstrated that a primary reason that students persist in engineering programs is because they identify engineering with their sense of self, an attainment value as described by Eccles expectancy-value theory.<sup>10</sup>

### Underrepresented Groups in STEM Majors and Fields

Efforts to remain competitive internationally in engineering and technology require that engineering departments train a diverse set of talented students. Chubin et al.<sup>11</sup> found that gender

and ethnic diversity are commonly identified as issues of concern within engineering. Representation of women and ethnic minorities has stagnated during the past decade. Females were awarded only 18.4% of bachelor's degrees in 2011 (20.9% in 2002), and Black or African American students were awarded 4.2% of bachelor's degrees in engineering (5.4% in 2002).<sup>12,13</sup> The urgency for investment in STEM education is underscored by recent trends in engineering enrollment. Over the last decade, Aud et al.<sup>14</sup> found that undergraduate degrees awarded in the fields of engineering have declined from 6.3 to 5.4 percent of the total degrees conferred in the United States.

Within the context of science, technical, engineering and math-related (STEM) educational domains, there is an underrepresentation of women and particular racial-ethnic groups.<sup>15</sup> The authors<sup>15</sup> studied "the cognitive person (self-efficacy, outcome expectations), contextual (social supports and barriers), and outcome (interest and choice goal) variables to engineering students at three universities (one predominantly White and two historically Black)." The purpose of that study was to assess the degree to which the data fit SCCT's interest and choice models across gender and university type (i.e., predominantly White and historically Black universities)." Findings of the study concluded "that students at both HBCUs [historically black colleges and universities] reported stronger self-efficacy, outcome expectations, technical interests, social support, and educational goals than did students at the predominantly White university. The groups did not, however, differ significantly in their experience with social barriers regarding pursuit of engineering majors. Meanwhile, women did not differ significantly from men across most of the social cognitive variables, echoing earlier findings that male and female engineering students tend to report similar levels of academic self-efficacy<sup>16,17</sup> as well as technical interests and outcome expectations."<sup>15</sup> However, these findings may be directly related to strong social support in HBCUs and the demographic of the study's population (undergraduate freshmen). In addition, the author's findings suggest that the predictive utility of the social cognitive variables is not moderated by student gender or by university type.<sup>15</sup>

Several studies have focused on the impact of race and/or gender on entering and persisting in engineering. There exists persistent under-representation of women in STEM fields. Despite women's increased enrollment at U.S. colleges and universities, undergraduate women still choose STEM majors and persist in STEM careers at significantly lower rates than undergraduate men.<sup>18</sup> Even as women and men enroll in institutions of higher education in increasing numbers overall,<sup>19</sup> the differences in their engineering enrollment numbers indicate gender equity issues in STEM disciplines. Smith<sup>20</sup> conducted interviews of currently enrolled female students and aimed at identifying the factors that lead female undergraduate students to pursue an academic major in engineering. The study identified three intrinsic factors that each of the participants possessed prior to entering engineering: personal motivation to succeed/achieve, math & science self-efficacy, and the will to survive. Takihira et al.<sup>21</sup> studied the extent of gender differences in the persistence and performance variables within institutions with varying degrees of acceptance selectivity and sought to shed light on the general characteristics of students and institutions that are associated with those two variables using 126 institutions. Findings of this study concluded that despite gender, students with better academic skills and mathematical reasoning were much more likely to persist than those who did not possess these skills. Maple and Stage<sup>22</sup> used a longitudinal model of seven exogenous constructs to explore the relationships among background characteristics of students, ability, high school experiences, and

choice of quantitative major. The results of this study identified the mother's education as a significant positive predictor of sophomore choice of quantitative major for black females.

Scott and Mallinckrod<sup>23</sup> supports Maple and Stage<sup>22</sup> findings of parental influence for major choice. They studied the underrepresentation of women in science and engineering careers by conducting a longitudinal study surveying women, when in high school, who expressed an interest in these careers. The identified parental bond Care (Mother Care and Father Care) positively correlated to science self-efficacy.

### The Choice of Specific Major within Broad Disciplines

In 2008, Walstrom et al.<sup>24</sup> published a study specifically aimed at understanding how business students selected their major and why they didn't necessarily choose an Information Systems major within the area of business. The study involved entry level college students and identified that the students who did not select Information Systems were just simply unaware of what the major entailed, what sort of job security it would provide upon graduation, and the level of pay associated with the major. Additionally, the study identified main sources of information used by the students in selecting their major.

## **Methods**

### Research Goals and Survey Instrument Development

An extensive literature review was conducted in order to create a good survey instrument, based upon previous survey development and findings, that would result in answering the posed research questions. The long-term goal of this research is to develop a survey instrument that can be used at several universities in order to collect generalizable information of the choice of engineering major.

A survey consisting of 24 questions was developed based primarily on the instrument deployed by Walstrom et al.<sup>24</sup> Questions pertaining to demographics, parents' education, and recollection of desire to study engineering were added to the instrument. A combination of multiple choice and open-ended questions were used. In addition, questions were customized to reflect the choices available at UNH. (Refer to Appendix A for complete survey tool questions; note that the questions in the appendix appear numbered to facilitate analysis – the actual tool did not have questions numbered.) The survey was approved by the University's Institutional Review Board. The on-line application Survey Monkey® was used to deploy and collect the data. Email invitations with unique links were sent out to 235 full-time engineering undergraduates; this excluded the first-year students and any student who at the time had not declared a major. Students who completed the survey were given the option to enter a raffle for a \$100 gift certificate. Students were also asked their willingness to participate in follow-up interviews for further development of the survey instrument and to better understand certain types of responses to questions.

## Participants and Survey Execution

The survey was conducted using participants from eight undergraduate programs within the College of Engineering. 97 qualified participants representing students studying chemical engineering, mechanical engineering, civil engineering, system engineering, computer engineering, electrical engineering, general engineering, and computer science voluntarily responded to the survey which was conducted during the spring 2012 semester.

The College of Engineering at UNH has a total undergraduate engineering student population of 460. Women represent 50.4% of the total university undergraduate population, however, only represent 10% of the undergraduate engineering student population. Although the University is known for producing graduates with professional degrees in business, science, and engineering, undergraduate degrees in the arts and humanities may also be pursued. Students who leave engineering study have a wide variety of other options at the University.

The College of Engineering offers Bachelors of Science degrees in Civil, Mechanical, System, Electrical, Computer, General and Chemical Engineering. It also offers degrees in Information Technology and Computer Science. Demographic information for the fall 2012 engineering student population is shown in Figure 1. The average SAT score for the 129 fall 2012 enrolled students in the College of Engineering students was 1612.

COLLEGE/DEPT/MAJOR	Gender		FT/PT		Ethnicity								Dom/Int		
	F	M	FT	PT	Amer Indian/ Alaska Nat	Asian	Black Or African American	Hispanic	Nat Hawaiian Other Pacific Islander	Non- resident Alien	Two Or More Races	Unknown	White	Dom	Int
B.S. Chemical Engineering	10	45	49	6			8	1		27		7	12	28	27
B.S. Computer Engineering	1	33	30	4			2	1		5		13	13	29	5
B.S. Electrical Engineering	9	64	59	14		2	8	3		17	3	15	25	56	17
B.S. Civil Engineering	7	69	67	9		1	4	3		14		28	26	62	14
B.S. General Engineering	1	9	6	4			2	2				3	3	10	0
B.S. Mechanical Engineering	8	147	130	25			5	1		44	2	31	72	111	44
B.S. System Engineering	5	18	22	1		1		1		9		5	7	14	9
B.S. Undeclared Engineering	4	30	32	2			5			1	1	19	8	33	1
<b>COLLEGE OF ENGR Total</b>	<b>45</b>	<b>415</b>	<b>395</b>	<b>65</b>	<b>0</b>	<b>4</b>	<b>34</b>	<b>12</b>	<b>0</b>	<b>117</b>	<b>6</b>	<b>121</b>	<b>166</b>	<b>343</b>	<b>117</b>
<b>% Breakdown</b>	<b>10%</b>	<b>90%</b>	<b>86%</b>	<b>14%</b>	<b>0%</b>	<b>1%</b>	<b>7%</b>	<b>3%</b>	<b>0%</b>	<b>25%</b>	<b>1%</b>	<b>26%</b>	<b>36%</b>	<b>75%</b>	<b>25%</b>
COLLEGE/DEPT/MAJOR	Gender		FT/PT		Ethnicity								Dom/Int		

Figure 1. Demographic information for fall 2012 engineering student population

## Results and Analysis

### Descriptive Results

Of the 97 student respondents, 76 (78.4%) are male and 21 (21.6%) are female (Question 2), a higher female response rate than the engineering female student population of 10% in the College of Engineering. 83 of the respondents are reported being 18 through 24 years old and 14 students reported being age 25 or older (Question 3). No respondents reported being younger than 18. The question of age was asked because students who are older than 24 years old may have delayed pursuing an engineering career because they delayed pursuing a college degree generally, pursued another 4-year degree first and are now pursuing a second major, or pursued a non-degree career and are now returning to obtain a 4-year degree. All of these different circumstances may lead those aged 25 or older to have very different reasons for pursuing particular majors, or a more mature perspective on selecting and pursuing an engineering degree. Some of the students who are 25 or older may be taking longer than traditional students to complete their degree. Further work could study whether these students select majors differently. 22.7% of respondents reported being a sophomore, 27.8% reported junior status, and 49.5% reported senior status (Question 4). A separate study is planned for freshman to be executed during the fall 2013 semester. Students were asked about their parents' educational achievement level and results are shown in Figure 2 (Question 5).

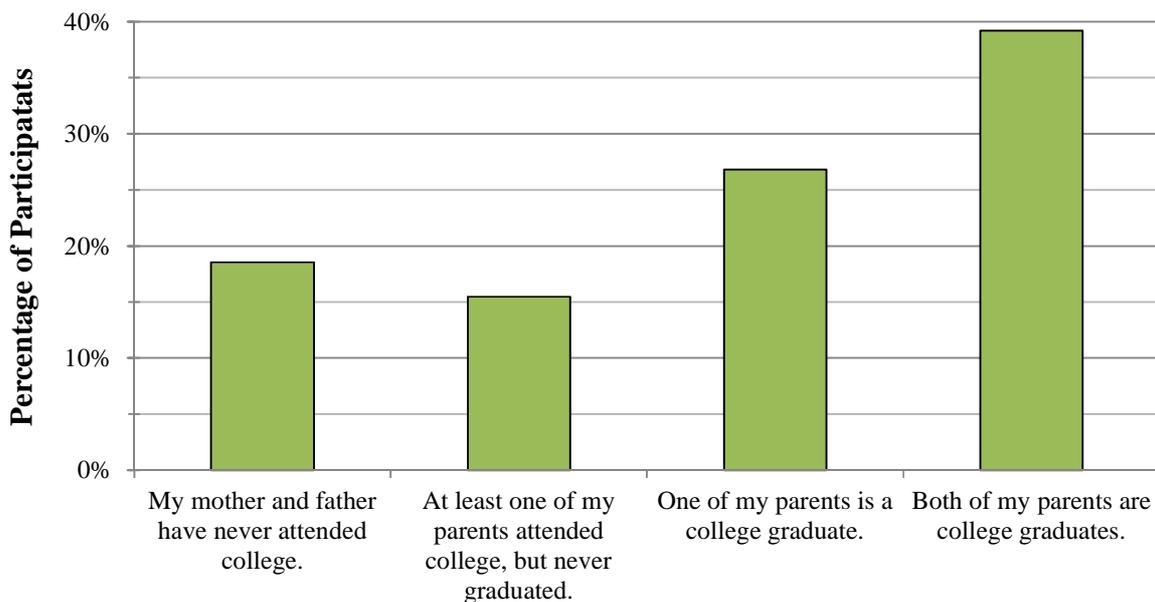


Figure 2. Parents' educational achievement level

Students were asked about when they started considering engineering as a major and asked about their current major (Question 6 and 7). These results are shown in Figure 3 and Figure 4. It is unclear through use of the survey instrument the confidence level or accuracy in student responses related to when students first remember wanting to be an engineer or their interest in particular aspects of engineering (Question 6). The question was asked to compare current student perceptions about early interest to current research. More information concerning

confidence and accuracy related to Question 6 could be gained during follow-up individual interviews.

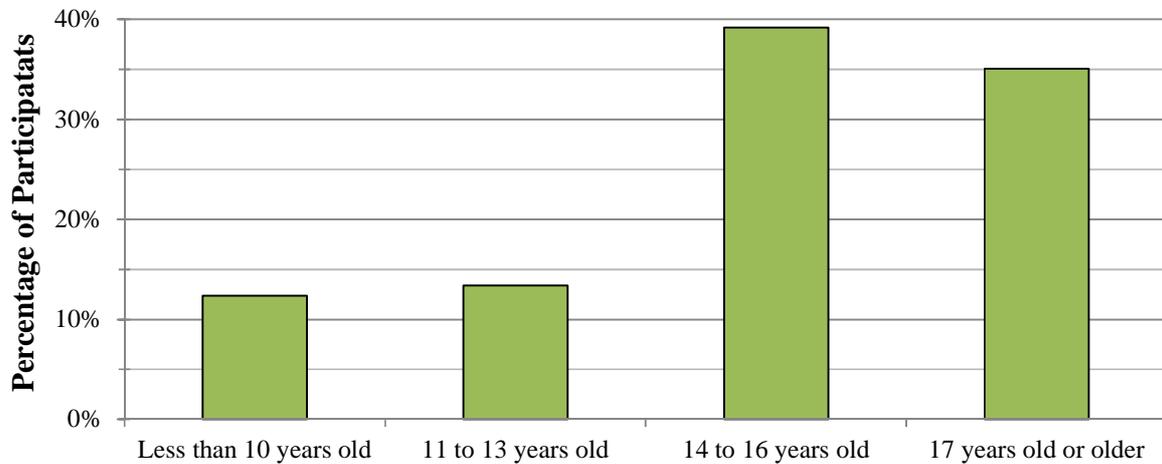


Figure 3. Timing of desire to study engineering

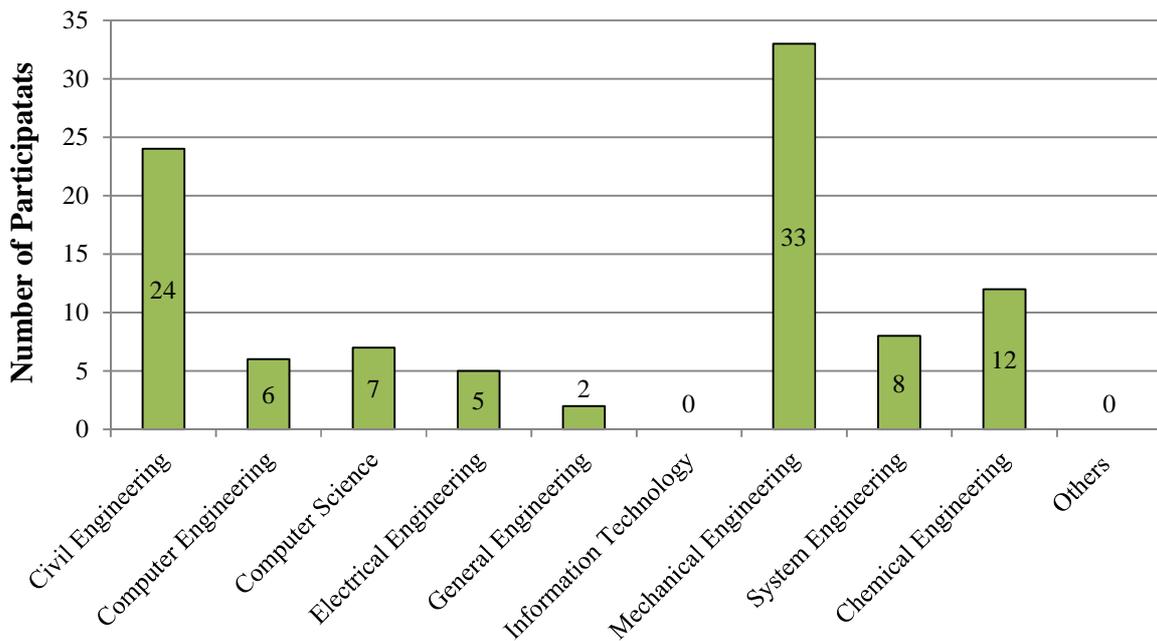


Figure 4. Indication of current major

Students were asked when they first made a decision about their major (Question 8). 82% reported that they chose their specific engineering major prior to their freshman year, however, only 66% of engineering majors were certain of their engineering discipline before they started applying and investigating engineering colleges. *This should indicate to UNH engineering programs that there is significant opportunity to influence student decisions during the recruitment process and during their first and second years of study at the university. This*

finding corroborates researchers who estimate 40% of entering freshmen are uncertain about their choice of major.<sup>25</sup>

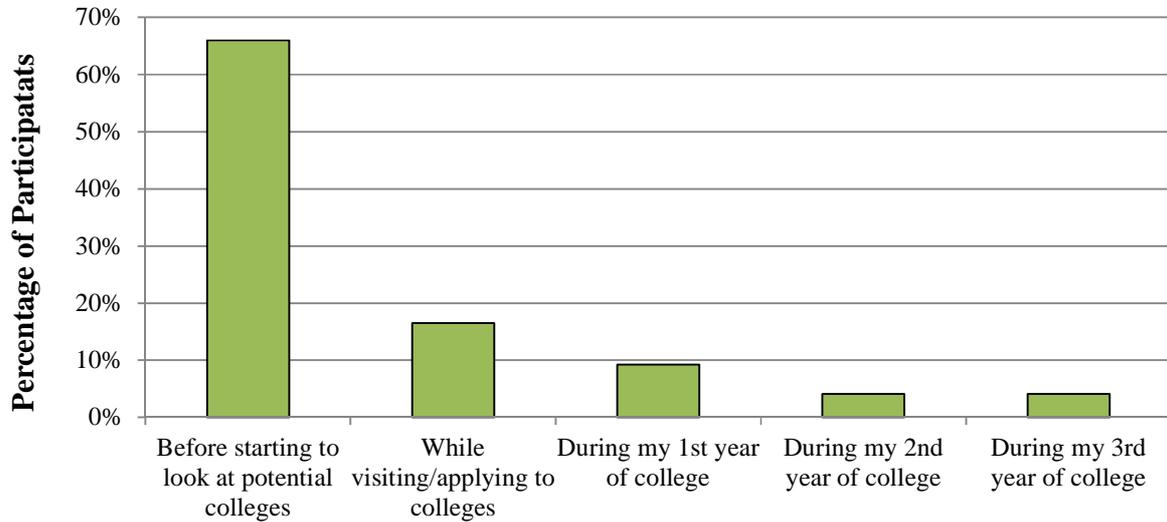


Figure 5. Timing of choosing an engineering major

Student respondents were asked if they are currently in their original chosen major or if they changed majors (Question 9). Responses are shown in Figure 6.

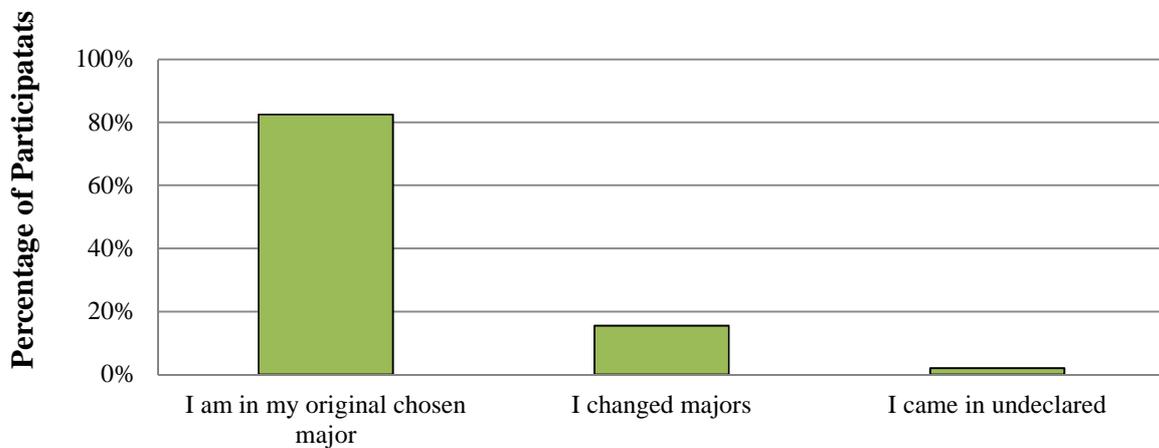


Figure 6. Selection of major while in college

Follow up questions were asked of the 14 students who indicated that they had changed their majors (Question 11). These results are summarized in Table 1 and Table 2. These changes were categorized according to Eccles' expectancy value theory,<sup>10</sup> which is used to describe how individuals value engagement in certain types of activities.

This approach has been found to be an effective approach to framing the selection and change of major decision since it is based upon motivation theory and may be a good method to understand

at deeper levels how and why students choose, change, or persist in their major and degree.<sup>9</sup> One of the principal authors generated the categories based on categories provided by Eccles' Expectancy Value Theory and its expected contributors. Then, the other author along with a faculty member and two graduate students not involved in the research project categorized each response independently. The results were compiled by one of the authors and any differing responses (fewer than 20%) were discussed until all were in agreement on the categorization.

The first four categories were created based upon Eccles' Expectancy Value Theory: Interest, Importance (Utility Value), Relative Cost and Attainment. Six of 15 of the respondents indicated interest in a particular engineering field as a principle reason for selecting their major. This was the category with the largest number of motivators. Student 1 stated interest in performing certain tasks (programming) that led to the decision. Student 5 also indicated interest in performing certain tasks, but in addition, interest in a particular work process and function (software development). Student 8 indicated broad interest in engineering and science as a motivator. Student 12 has a desire to work in the automotive or aviation industries, and felt mechanical engineering was the best way to enter those fields. Student 13 indicated that aligning the choice of field to a hobby was good idea and affected the decision. Student 14 indicated an interest in the curriculum as well as potential to be employed (Importance). Two others (Students 2 and 14) indicated that labor market demand and work potential drove their choice of major decision. There were surprisingly few indications for Importance in the students' choice of major descriptions. Student 7 indicated that relative cost drove the decision because the student could utilize previous credit towards an engineering degree.

Attainment value refers to the value obtained when engaging in an activity that affects sense of self or aids a person in achieving satisfaction with their self identity. Four students identified attainment values as a reason they chose their major. Student 9 stated,

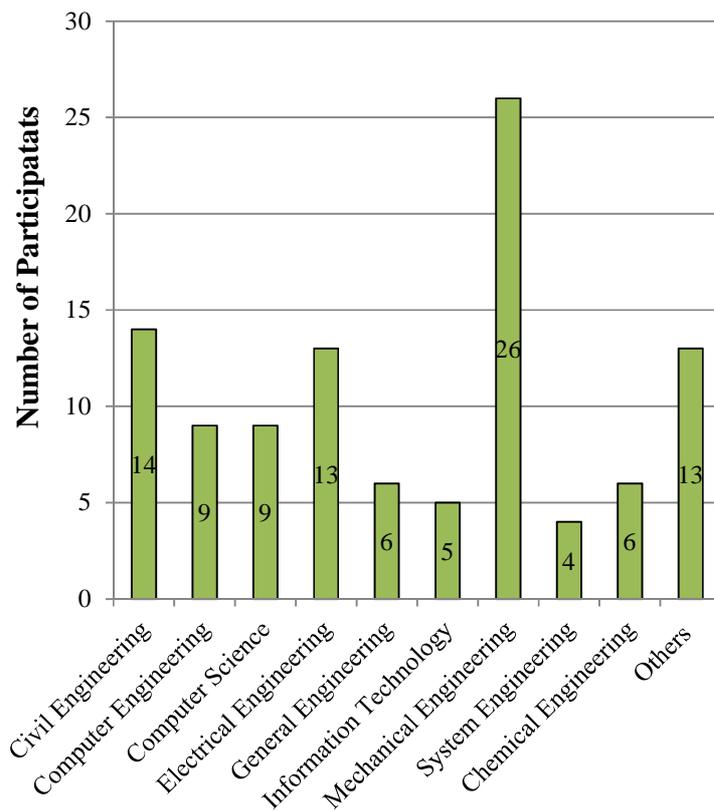
*"I felt like I was not a business type of person, and I couldn't do work in that field. I liked working with my hands and creating new things. Throughout my childhood, I would always build things and create stuff. So that's why I chose engineering."*

Two specific categories of competence were created to determine if students would indicate their ability to perform well in college affected their choice of major. No students indicated that their ability to perform well in classes or perform well in experiential education opportunities, like internships or undergraduate research affected their choice of major. Student 2 specifically indicated the role of a socializer in the decision (family members). No students talked about influences related to collective identity beliefs.





56% of the student participants responded that they considered other majors when selecting their major and university (Question 15). These 54 students (Open Responders) were asked what other engineering majors they considered when selecting their primary major (Question 16) and their responses are shown in Figure 7. All respondents were asked if they considered other majors other than engineering, and if so, which ones (Question 17). A summary of their open-ended responses are shown in Figure 8.



Others: Aerospace & Aeronautical Engineering (5), Software Engineering (2), Petroleum Engineering (1), Industrial Engineering (2), Naval Architectural Engineering(1), Fire Science Engineering(1), Architectural Engineering (1), MIS(1)

Figure 7. 54 Responders' Interest in Other Engineering Fields

Before enrolling at this university did you consider other non-engineering majors?	Interest Level
Chemistry	1
Pre-dental	1
Architecture	1
Art	1
Business	2
Mathematics	2
Accounting	2
Criminal Justice	1
Political Science	1
Forensic science	4
Law Enforcement	1
Culinary arts	1
English	1
Sound Recording	2
Music	2
Business Administration	1
Construction Management	1
Teaching	1
Broadcasting	1
Others	2

(25 Students, 4 multiple responses) 29

Figure 8. 25 Students' Open Responses to interest in other non-engineering major

Students were asked about the effect of socializers, competence attitudes, university knowledge and area of study knowledge levels upon their choice of major (Question 18). Results in percentage of respondents indicating importance level are shown in Appendix B. Factors such as Personal Interest in Subject Matter (59%), Probability of Working in Field After Graduation (56%), Long-Term Salary Prospects (51%), Job Security of Related Occupations (49%) and Occupational Growth Forecasts/Predictions (45%) were found to be rated "Very Important." High School Career Interest Assessments (59%), High School Guidance Counselor (56%), Friends (51%), High School Teachers (49%), and Flexibility of Work Schedule (45%) rated the

highest in the Not Important Category. Using the variance measure, there was very little agreement on importance levels in the following five influence categories: Opportunity to Participate in Student Organizations (0.12%), Flexibility of Work Schedule (0.18%), Probability of Graduating with Honors in Major (0.46%), Family Member(s) (0.52%), and High School Teacher(s) (0.55%).

**Analytical Results: Underrepresented Groups**

An analysis of variance (ANOVA) test was conducted to test where gender (Question 2) and parental education level (Question 5) resulted in a significantly different response to survey questions at the 0.05 significance level. Table 3 shows selected responses for Question 6 through Question 17.

Table 3. Gender and parental education level affect upon selected responses to Questions 6, 7, 8, 9, 15, and 17

p-values for factor significance upon response at the 0.05 significance level	Significance of Gender upon Response (Q2)	Significance of Parental Education Attainment upon Response (Q5)
Q6. How old were you when you first recall the desire to study engineering?	0.251	0.614
Q7. We know you are enrolled in the College of Engineering, please tell us what major you are currently pursuing.	0.193	0.997
Q8. Approximately when did you decide on [Q7] as your major?	0.407	0.978
<b>Q9. Did you start in the same major or did you change majors?</b>	<b>0.007*</b>	0.840
Q15. When first deciding on college, did you consider other engineering majors?	0.407	0.108
Q17. Before enrolling at UNH, did you consider other non-engineering majors?	0.148	0.337

Females at UNH responded significantly different to Question 9 ( $p = 0.007$ ), which indicates their differing level of commitment to their engineering major. Results to Question 9 are shown by gender in Figure 9. A follow-up multiple comparison test was run using a Tukey Test (pairwise comparison test) in order to indicate which levels were significantly different. Females at UNH were more likely than males to come into the College of Engineering as an Undeclared Engineering major than indicating an engineering major their first semester (level 1 vs. 3). Females at UNH were also more likely than males to change engineering majors than remain in their original major (level 1 vs. 2).

There is anecdotal belief at some universities that women may seek and find coping mechanisms, such as a change in engineering major, in order to remain in an engineering major or at their current institution. This questions was studied in a similar way at Georgia Tech. The researchers (1) analyzed major changes to see if there was a quantitative difference across gender

(2) determined if there was a quantitative difference and investigated if the patterns of changes were different and (3) interviewed students to find out their opinions of major changing.<sup>26</sup>

Females did not respond differently to Questions 6, 7, 8, 15 or 17 and parental education levels had no significant impact on any of the responses to the questions listed in Table 3.

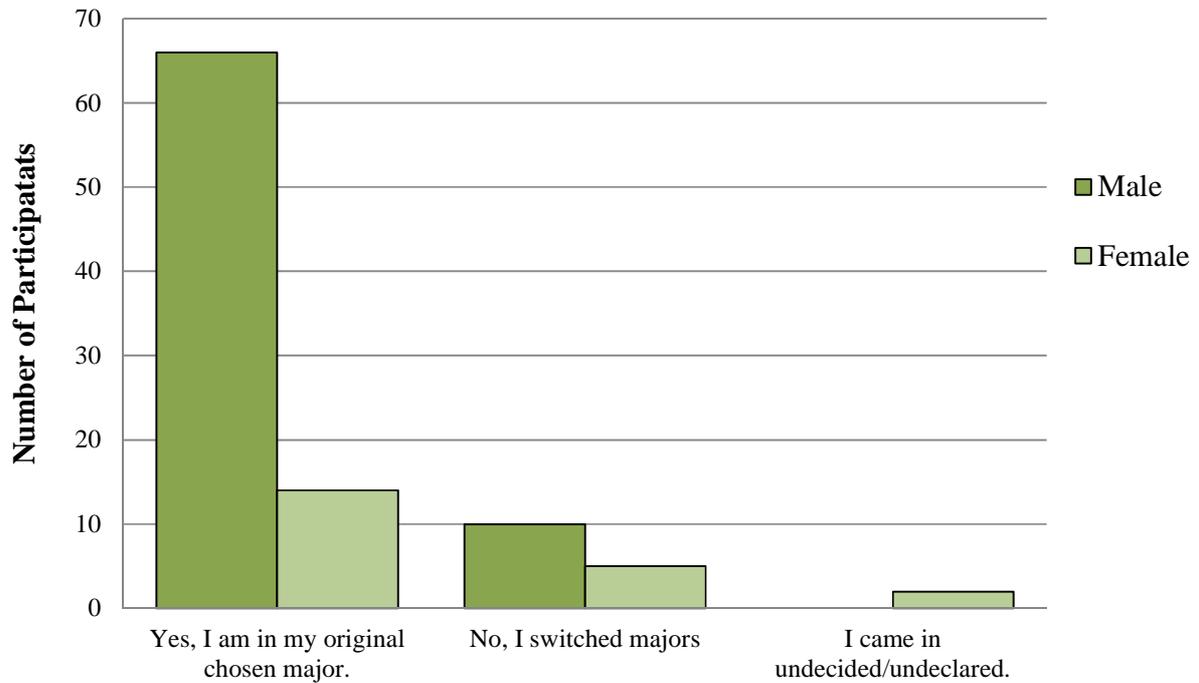


Figure 9. Level of commitment to individual engineering majors by gender

Table 4 shows responses to Question 18. This set of questions relates to influencers upon the choice of engineering major decision.

<b>p-values for factor significance upon response at the 0.05 significance level</b>		
Q18. For each of the following, please rate the importance of the item listed for why you selected [Q7] as your major. Use the scale provided, where 6 represents Very Important and 1 represents Not Important.	Significance of Gender upon Response (Q2)	Significance of Parental Education Attainment upon Response (Q5)
<i>18-1 Personal Interest in Subject Matter</i>	0.812	0.348
<i>18-2 Difficulty of Subject Matter</i>	0.804	0.466
<i>18-3 Ease of Subject Matter</i>	0.665	0.142
<i>18-4 Performance in High School Science Courses</i>	0.144	0.636
<i>18-5 Performance in High School Math Courses</i>	0.200	0.512
<i>18-6 Family Member(s)</i>	0.679	0.787
<i>18-7 Friend(s)</i>	0.873	0.084
<i>18-8 High School Guidance Counselor(s)</i>	0.578	0.393
<i>18-9 High School Teacher(s)</i>	0.456	0.367
<i>18-10 High School Career Interest Tests/Assessments</i>	0.407	0.510
<i>18-11 Reputation of the University</i>	0.783	0.641
<i>18-12 Reputation of Degree Program at University</i>	0.449	0.626
<i>18-13 Quality of Professor(s) at University</i>	0.832	0.421
<i>18-14 Opportunity to Participate in Student Organization (s)</i>	0.816	0.414
<i>18-15 Flexibility of Work Schedule</i>	0.563	0.477
<i>18-16 Job Security of related occupations</i>	0.718	0.883
<i>18-17 Long term Salary Prospects</i>	0.872	0.118
<b><i>18-18 Prestige/Image of Profession</i></b>	0.535	<b>0.017*</b>
<b><i>18-19 Starting Salary</i></b>	0.806	<b>0.008*</b>
<i>18-20 Probability of Working in Field After Graduation</i>	0.613	0.339
<i>18-21 Occupational Growth Forecasts/Predictions</i>	0.332	0.248
<b><i>18-22 Probability of Graduating with Honors in Major</i></b>	<b>0.027*</b>	<b>0.025*</b>

Table 4. Influencers upon the choice of engineering major decision by gender and parental education level. (Asterisks (\*)) denote significance at the 0.05 level

Females responded significantly different to Question 18-22, which asked how important the probability of graduating “with honors in their major” was upon their choice of their engineering major ( $p = 0.027$ ). Results to Question 18-22 are shown by gender in Figure 10. A follow-up multiple comparison test was run using a Tukey Test (pairwise comparison test) in order to indicate which levels were significantly different. Females responded significantly differently at levels 1 Not Important, level 3 Slightly Unimportant, and level 6 Very Important. Males at UNH tend to not consider whether they will graduate with honors when selecting their major, whereas it is more important to females.

An opportunity for follow-up interviews with students may indicate if students misconstrued this question to mean how important this is to them now to graduate with honors compared to how important it was in the selection of their major. Follow-up questions could also pursue why the graduating with honors status is a more important factor for males than for females.

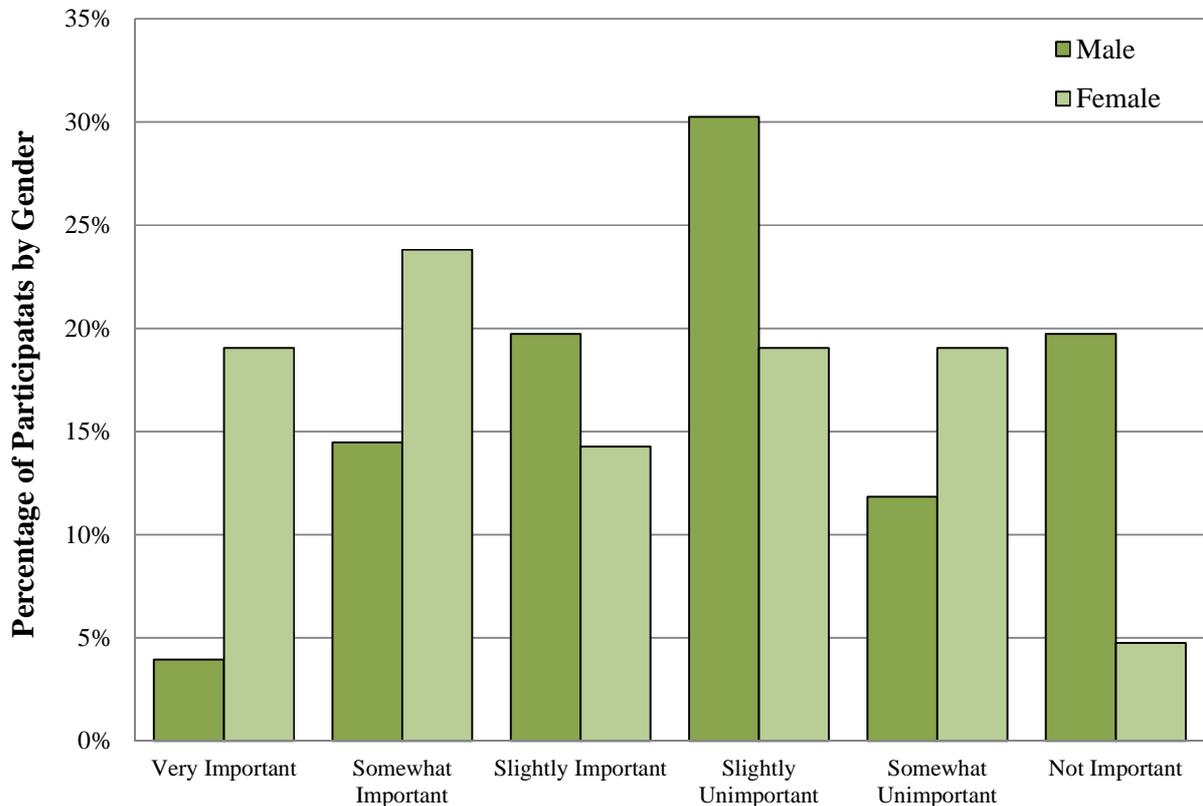


Figure 10. Q18-22: How females responded significantly differently than males to whether graduating with honors in their major had an effect upon their choice of engineering major

Students with differing parental education levels responded significantly different to Questions 18-18 ( $p = 0.017$ ), 18-19 ( $p = 0.008$ ), and 18-22 ( $p = 0.025$ ). Results to Question 18-18, 18-19, and 18-22 are shown by parental education level in Figure 11, Figure 12, and Figure 13. Follow-up multiple comparison tests were run using Tukey Tests (pairwise comparison tests) in order to indicate which levels were significantly different.

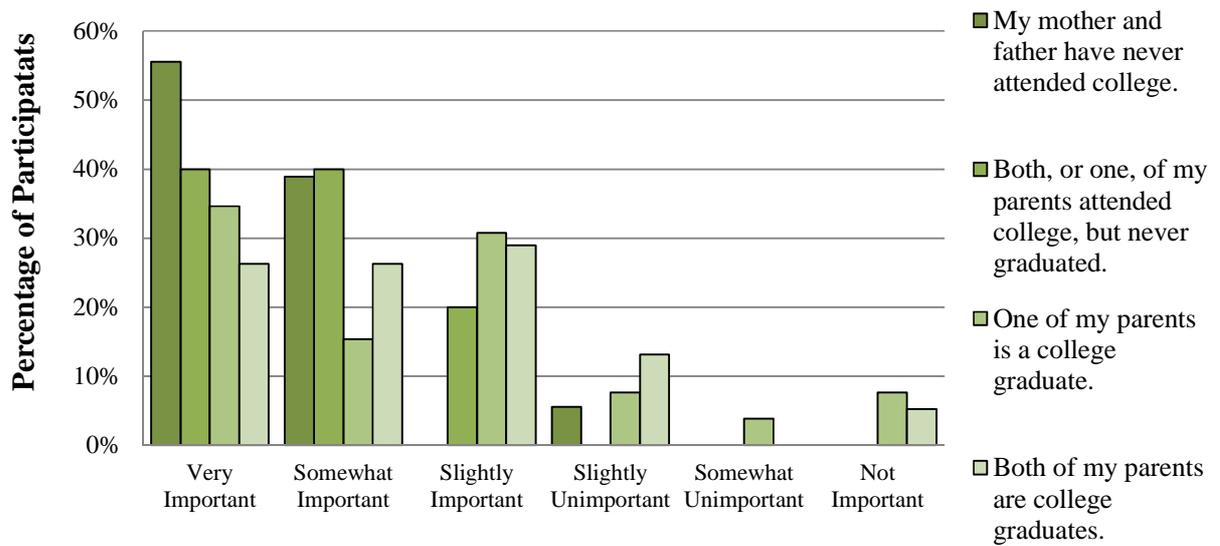


Figure 11. How prestige/image of profession affects the choice of engineering major by parental education level

For Question 18-18 shown in Figure 11, prestige/image of the chosen engineering profession was less important to students whose parents either both graduated from college or at least one graduated from college. It was significantly more important to students who had neither parent attend or graduate from college. For Question 18-19, starting salary was significantly more important to students where neither parent attended college compared to those who had parents that both graduated from college (level 1 vs. level 4). These results are shown in Figure 12.

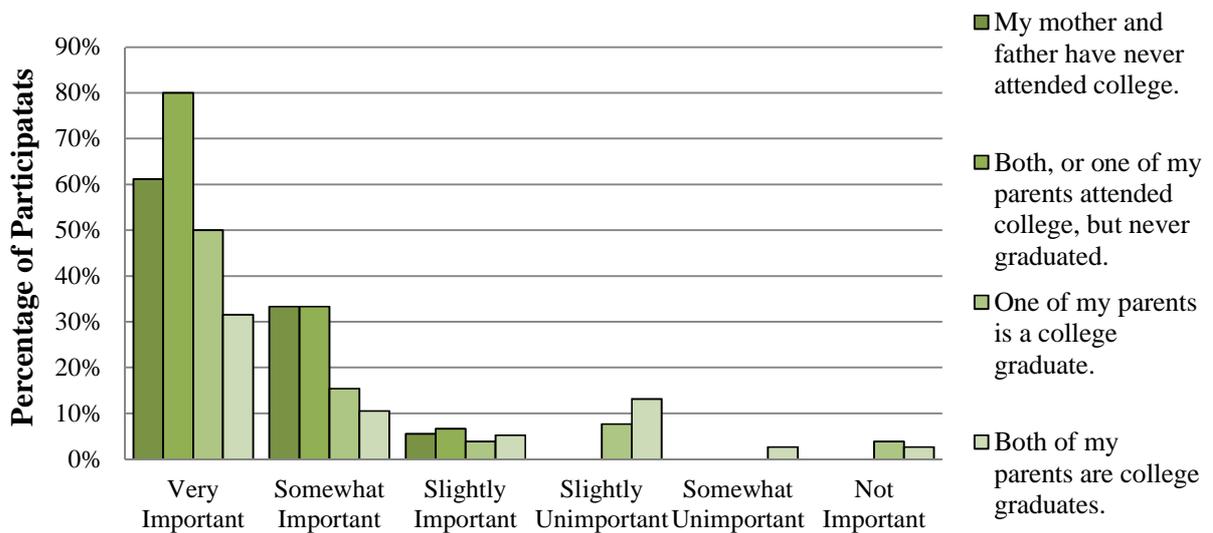


Figure 12. How starting salary affects the choice of engineering major by parental education level

For Question 18-22, students who had one parent graduate responded differently to “graduating with honors being somewhat important” when selecting their choice of engineering major. These results are shown in Figure 13.

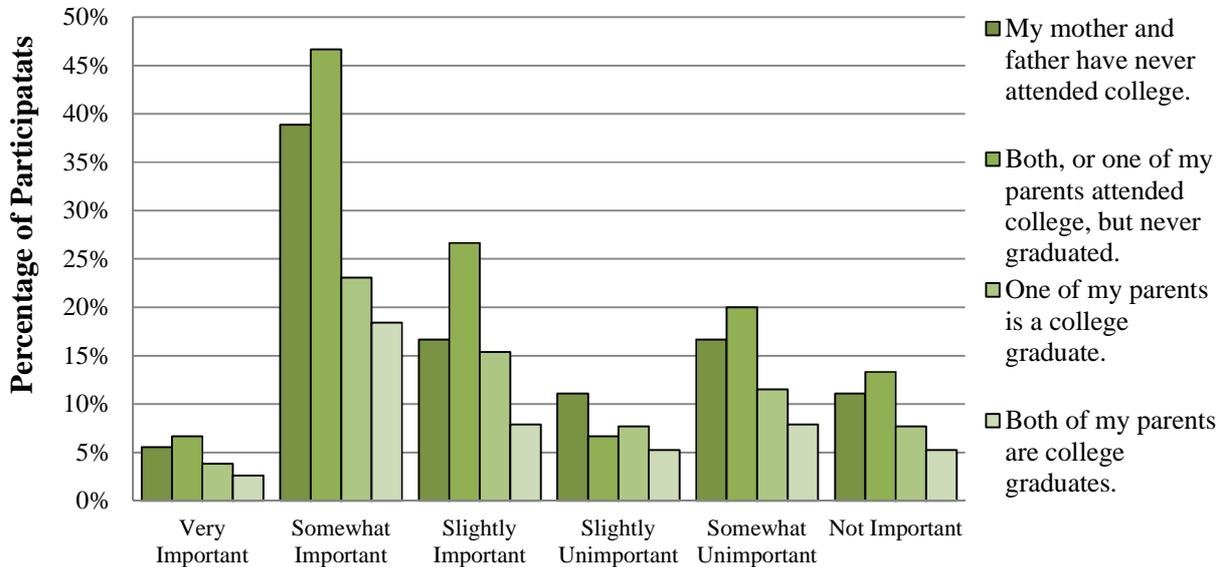
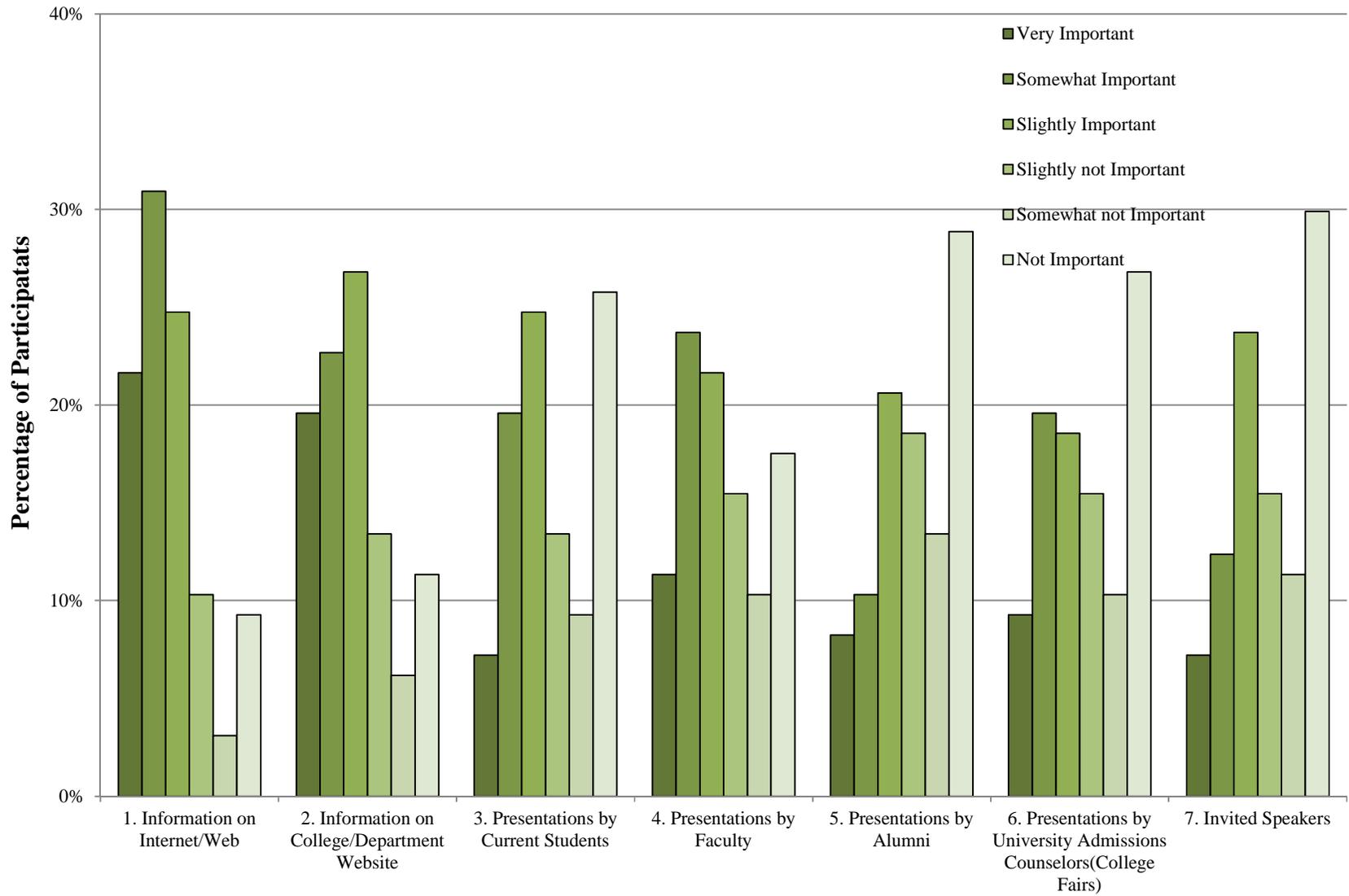


Figure 13. How graduating with honors in major affects the choice of engineering major by parental education level

An analysis of variance (ANOVA) test was conducted to test where gender (Question 2) and parental education level (Question 5) resulted in significantly different responses to Question Set 19 at the 0.05 significance level. Table 5 shows responses for Question 19 concerning media sources and socializer effects on the choice of engineering major. Figure 14 shows the entire results on media source influences on the choice of major.

p-values for factor significance upon response at the 0.05 significance level		
Q19. To what extent were the following information sources important in choosing your major? Use the scale provided, where 6 represents Very Important and 1 represents Not Important.	Significance of Gender (Q2) upon Response	Significance of Parental Education Level (Q5) upon Response
<i>19-1 Information on Internet/Web</i>	0.705	0.289
<b><i>19-2 Information on College/Department Website</i></b>	<b>0.047*</b>	0.305
<i>19-3 Presentations by Current Students</i>	0.680	0.373
<i>19-4 Presentations by Faculty</i>	0.896	0.282
<i>19-5 Presentations by Alumni</i>	0.645	0.069
<b><i>19-6 Presentations by University Admissions Counselors (College Fairs)</i></b>	0.836	<b>0.002*</b>
<i>19-7 Invited Speakers</i>	0.680	0.112
<i>19-8 Television or Movie portrayal of the occupation</i>	0.760	0.413
<i>19-9 Newspaper Articles</i>	0.572	0.190
<i>19-10 Brochures about the Major</i>	0.870	0.052
<i>19-11 Informational CDs or DVDs</i>	0.908	0.118
<b><i>19-12 Job listing in Classified Ads</i></b>	0.598	<b>0.008*</b>
<i>19-13 Online Job Listing(s)</i>	0.458	0.098

Table 5. Media source influencers according to Gender (Q2) and parental education level (Q5). Asterisks (\*) denote significance at the 0.05 level.



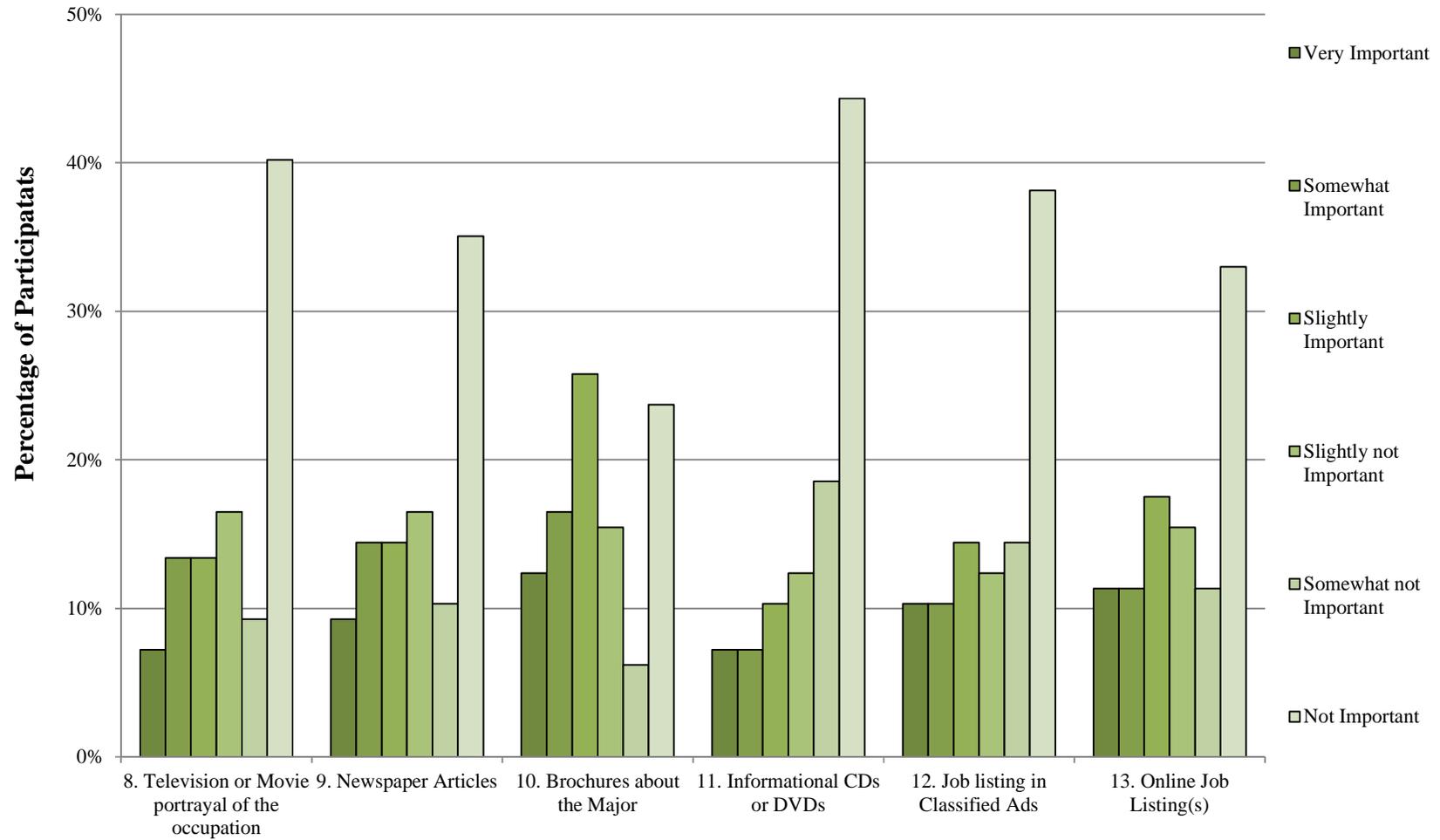


Figure 14. Media influencers on choice of engineering major decision

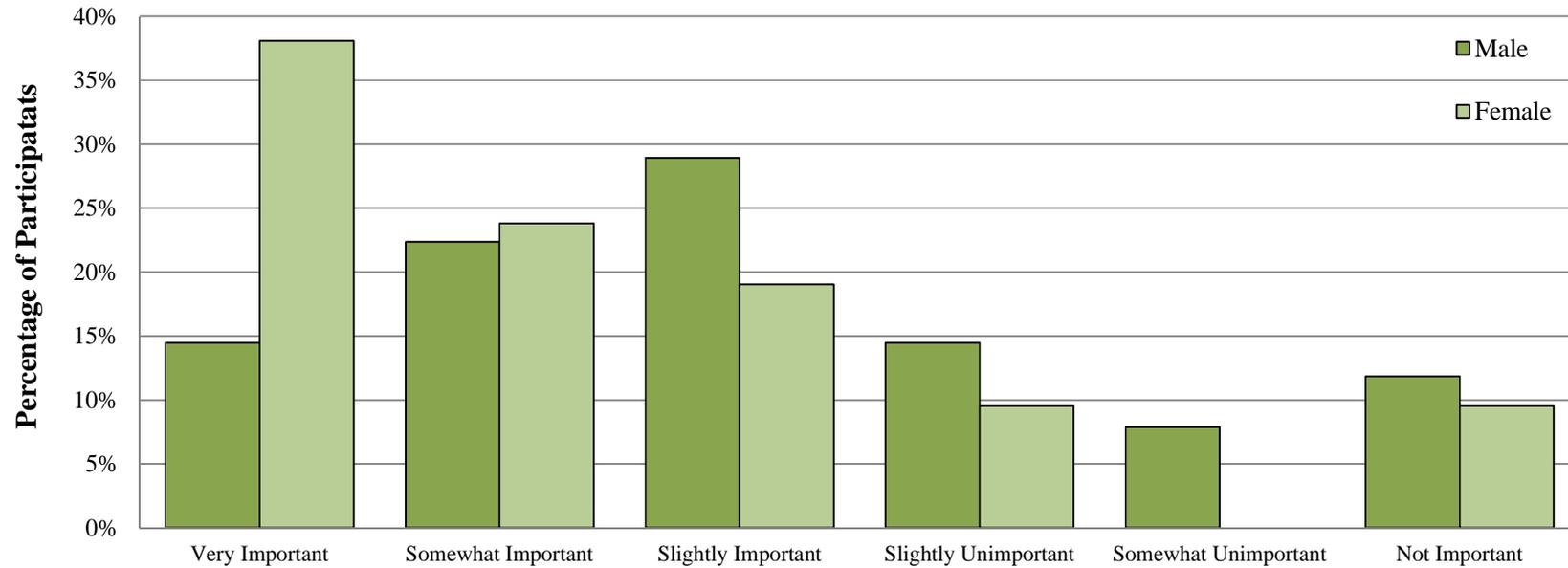


Figure 15. Q19-2: How females responded significantly differently than males to whether information found on college/department websites had an effect upon their choice of engineering major

Females responded significantly differently at level 4 Slightly Important, level 5 Somewhat Important and level 6 Very Important. Females found engineering college and department websites to be very important in determining their engineering field, much more so than males. Follow-up interview questions could determine whether females must rely on this type of source versus socializers due to the nature of their gender and traditional gender roles related to the engineering field.

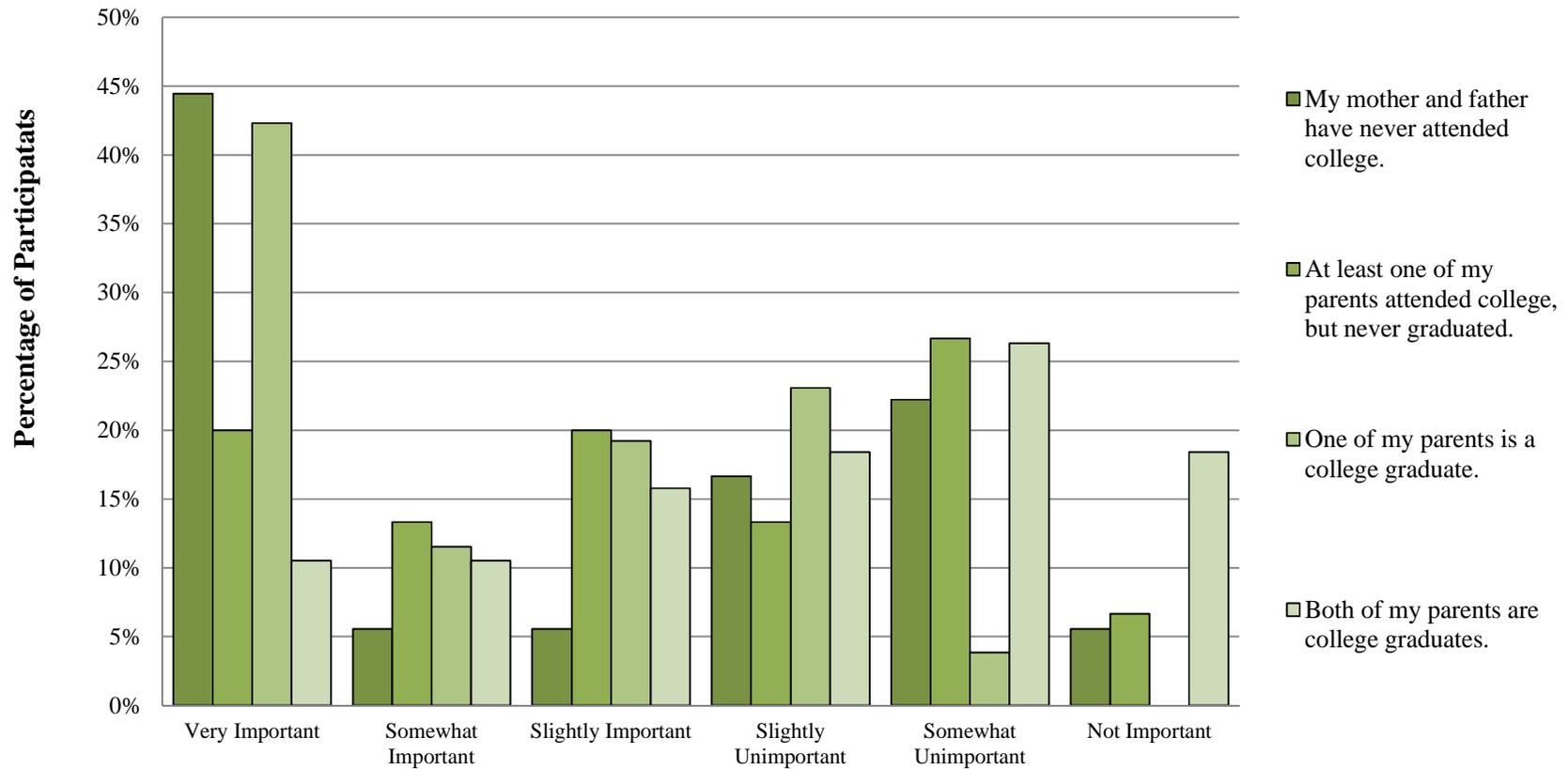


Figure 16. Q19-6: How students with parents with different education levels responded significantly differently questions concerning the effect Admissions Counselors/Job Fairs had upon their choice of engineering major

Students responded significantly different to level 1 (Not Important) according to their parental education levels. Students whose parents never attended college or never graduated thought that admissions counselors and career fairs did not affect their choice of major decision.

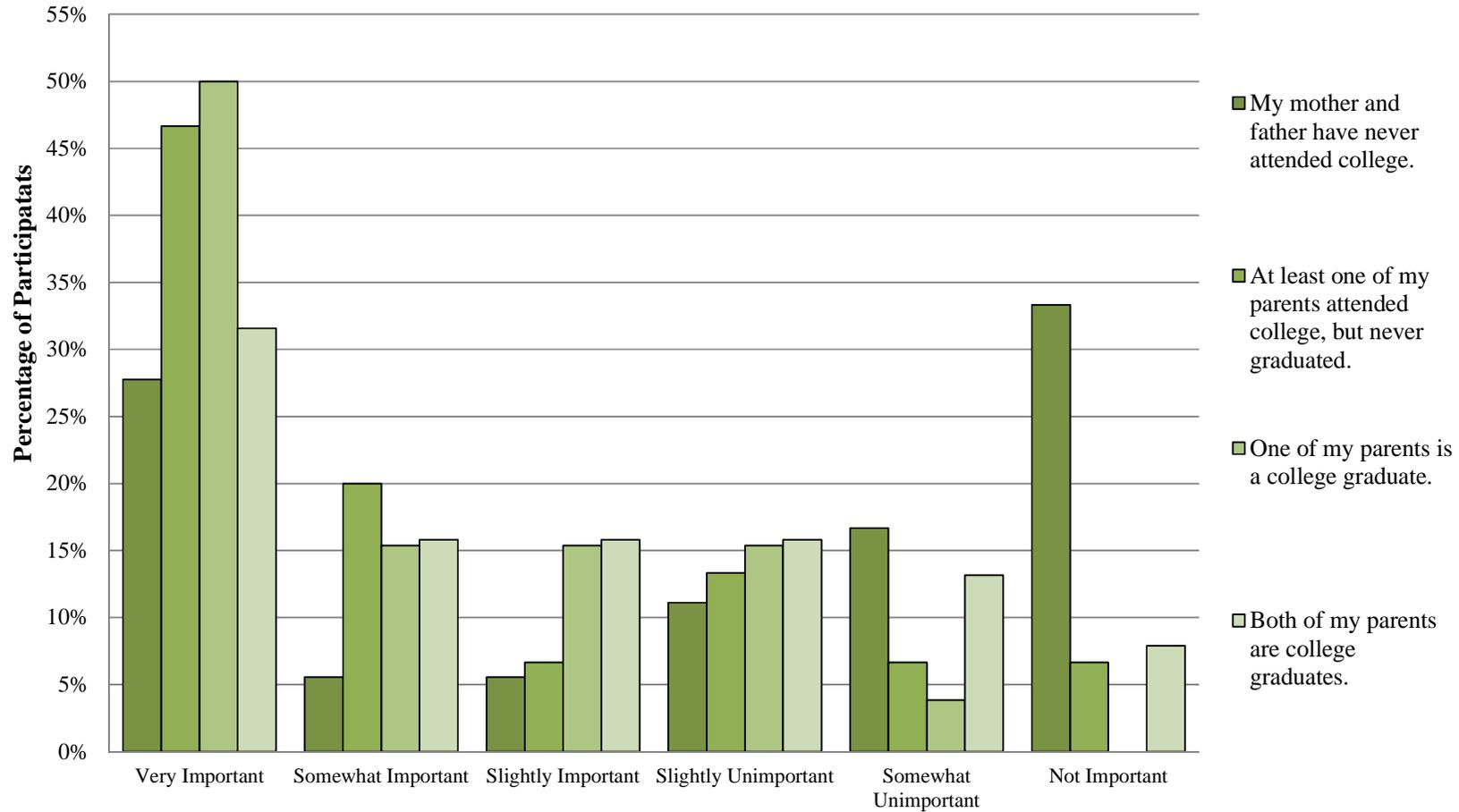


Figure 17. Q19-12 How students with parents with different education levels responded significantly differently questions concerning the effect Classified Job Ads had upon their choice of engineering major

Students responded significantly different to Level 1 (Not Important) according to their parental education levels. Students whose parents never attended college compared to ones that attended or graduated, thought that classified job ads did not affect their choice of major decision.

## **Conclusions and Future Work**

This research demonstrates the development and application of a new survey instrument to understand the choice of engineering major decision at the University of New Haven. Next steps in the research plan include conducting follow-up interviews with survey participants and further development of the survey instrument for the purposes of creating a reliable, accurate tool that can be used to assess the choice of engineering major decision at the University. In the future, the survey instrument could be adopted for use by other engineering schools in order to collect generalizable data for the choice of engineering major decision.

This study has some limitations. Because female respondents are such a small population, it may be necessary to collect data over several incoming classes to see if patterns occur or support conclusions related to this small population size. Also, some majors have low enrollments or acquire small numbers of students who transfer into those programs. Again, it may be necessary to collect data over several incoming classes to support findings in this study in a more conclusive way.

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## Appendix A: Survey

NOTE: Questions here are numbered to facilitate analysis and discussion; in the tool used, the questions were not numbered and except for Q1 responses to all other questions were optional.

- Q1. I voluntarily agree to participate in this study. (1) Yes or (2) No.
- Q2. Gender? (1) Male or (2) Female.
- Q3. Your current age is? (1) 17 or under, (2) 18-24, (3) 25 or older
- Q4. What is your level of progress towards your degree? (1) Sophomore (2) Junior (3) Senior
- Q5. Many students enrolled in a degree program are the first member of their families to pursue a college degree. (1) My mother and father have never attended college. (2) Both of my parents attended college, but never graduated. (3) One of my parents is a college graduate. (4) Both of my parents are college graduates.
- Q6. How old were you when you first recall the desire to study engineering? (1) Less than 10 years old, (2) 11 to 13 years old, (3) 14 to 16 years old, (4) 17 years old or older.
- Q7. We know you are enrolled in the College of Engineering, please tell us what major you are currently pursuing.
- Q8. Approximately when did you decide on [Q7] as your major?
- Q9. Did you start in the same major or did you change majors?
- Q10. What was your originally chosen major?
- Q11. Please tell us why did you change majors from your original choice?
- Q12. Even though you did not change your major, did you consider changing it? Yes or No.
- Q13. Why did you opt not to change majors after considering it?
- Q14. What sources of information did you use to make that decision?
- Q15. When first deciding on college, did you consider other engineering majors?
- Q16. Which other Engineering Majors did you consider before enrolling at XXX? (select all that apply; do not select [Q7])
- Q17. Before enrolling at XXX, did you consider other non-engineering majors?
- Q18. For each of the following, please rate the importance of the item listed for why you selected [Q7] as your major. Use the scale provided, where 6 represents Very Important and 1 represents Not Important.
- 18-1 Personal Interest in Subject Matter
  - 18-2 Difficulty of Subject Matter
  - 18-3 Ease of Subject Matter
  - 18-4 Performance in High School Science Courses
  - 18-5 Performance in High School Math Courses
  - 18-6 Family Member(s)
  - 18-7 Friend(s)
  - 18-8 High School Guidance Counselor(s)
  - 18-9 High School Teacher(s)
  - 18-10 High School Career Interest Tests/Assessments
  - 18-11 Reputation of the University
  - 18-12 Reputation of Degree Program at University
  - 18-13 Quality of Professor(s) at University
  - 18-14 Opportunity to Participate in Student Organization (s)
  - 18-15 Flexibility of Work Schedule
  - 18-16 Job Security of related occupations

- 18-17 Long term Salary Prospects
- 18-18 Prestige/Image of Profession
- 18-19 Starting Salary
- 18-20 Probability of Working in Field After Graduation
- 18-21 Occupational Growth Forecasts/Predictions
- 18-22 Probability of Graduating with Honors in Major
- 18-23 Opportunities of Ongoing Professional Development

Q19. To what extent were the following information sources important in choosing your major?

Use the scale provided, where 6 represents Very Important and 1 represents Not Important.

- 19-1 Information on Internet/Web
- 19-2 Information on College/Department Website
- 19-3 Presentations by Current Students
- 19-4 Presentations by Faculty
- 19-5 Presentations by Alumni
- 19-6 Presentations by University Admissions Counselors (College Fairs)
- 19-7 Invited Speakers
- 19-8 Television or Movie portrayal of the occupation
- 19-9 Newspaper Articles
- 19-10 Brochures about the Major
- 19-11 Informational CDs or DVDs
- 19-12 Job listing in Classified Ads
- 19-13 Online Job Listing(s)

Q20. Thinking back to High School, how knowledgeable and informed (aware) were you about possible careers in each of the following areas when you completed high school?

- 20-1 Chemical Engineering
- 20-2 Civil Engineering
- 20-3 Computer Engineering
- 20-4 Computer Science
- 20-5 Electrical Engineering
- 20-6 General Engineering
- 20-7 Information Technology
- 20-8 Mechanical Engineering
- 20-9 System Engineering
- 20-10 Math & Science
- 20-11 Business
- 20-12 Arts & Humanities
- 20-13 Social Science

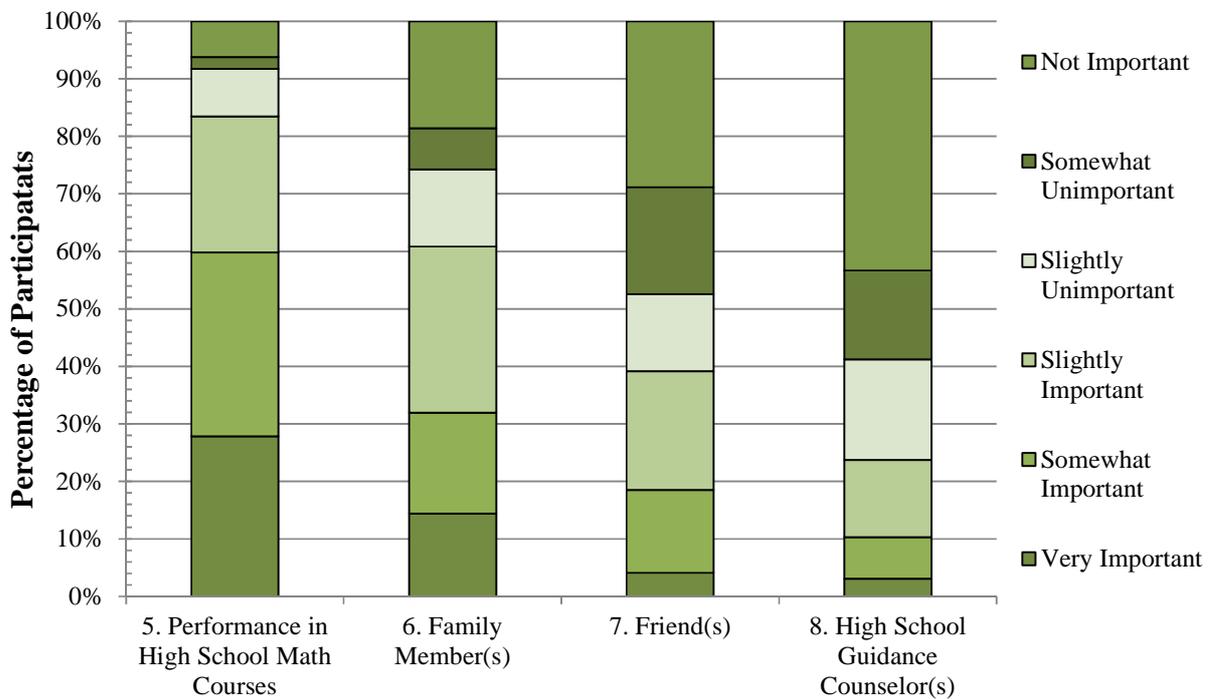
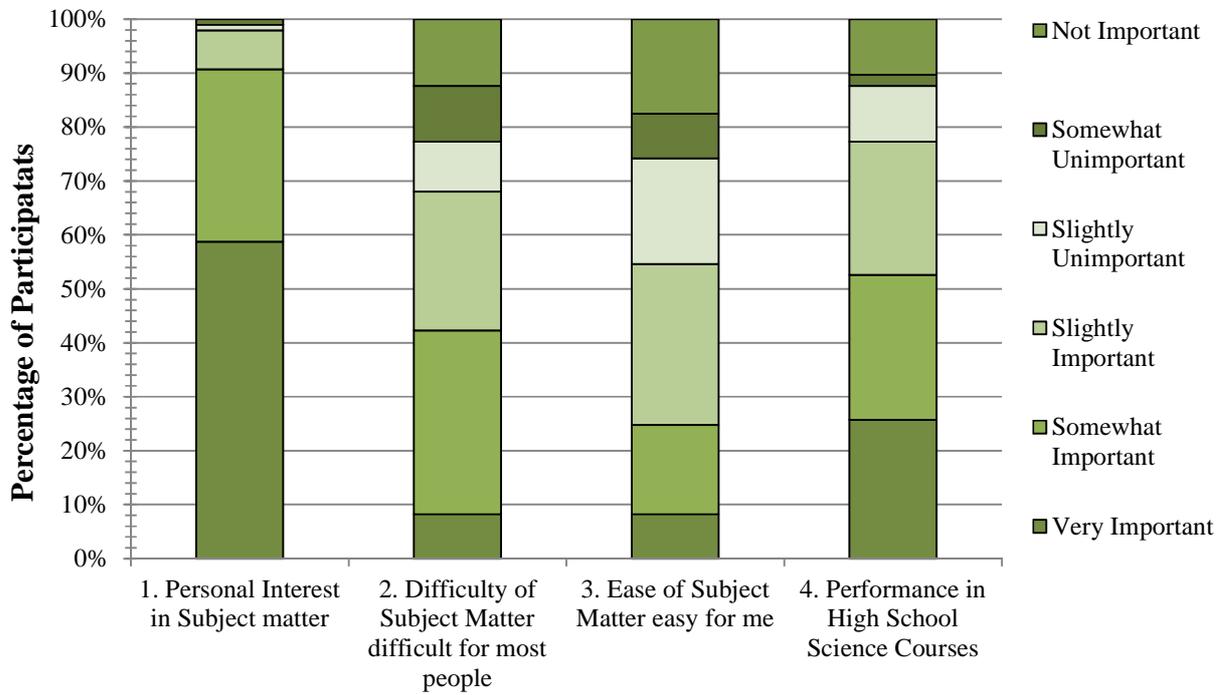
Q21. For each of the following you did not select as your engineering major, please tell us why not. [For each row, select all that apply, leave your chosen major [Q8] blank]

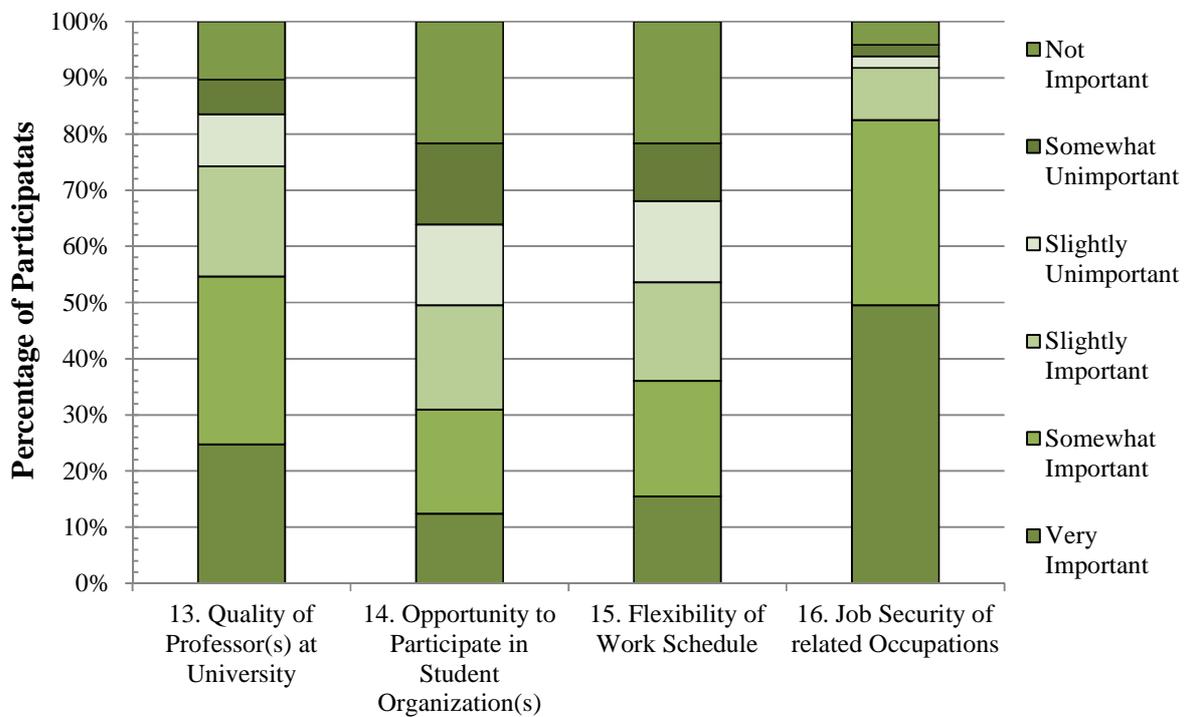
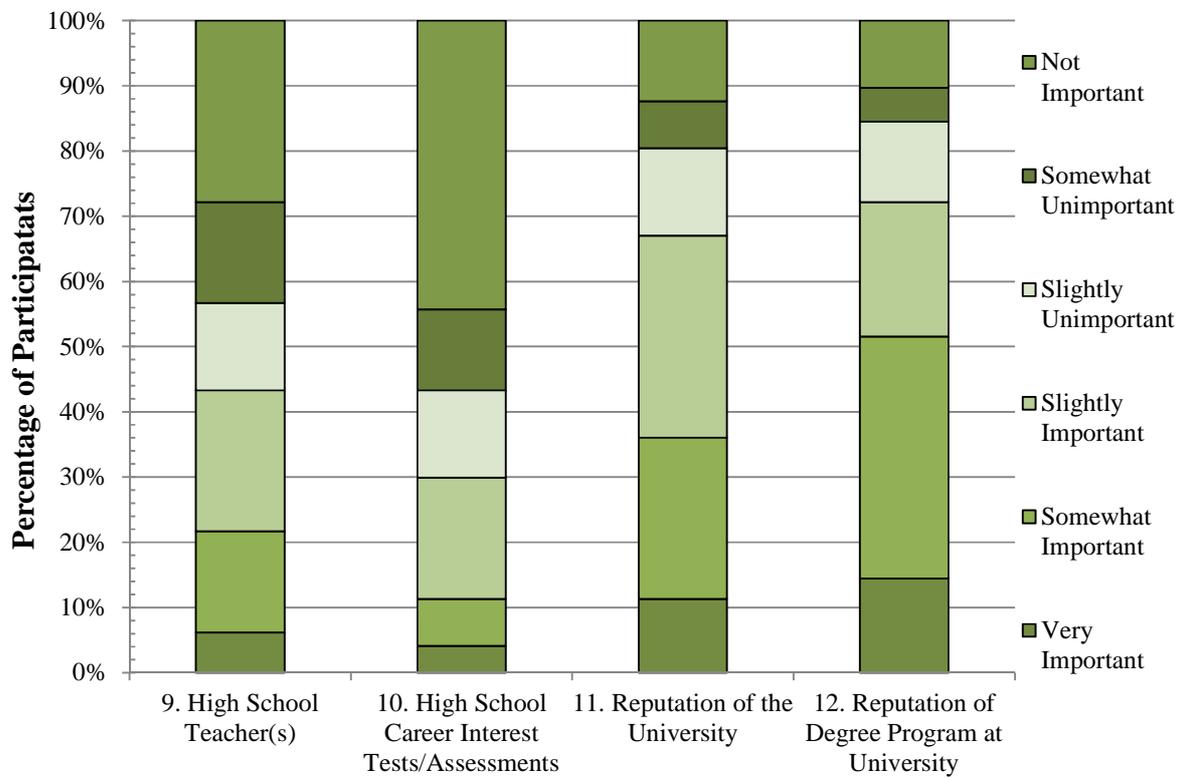
Q22. If you chose "Other Reason(s) not listed" as the response to any of the majors in the above question, please explain; else, write Not Applicable or N/A.

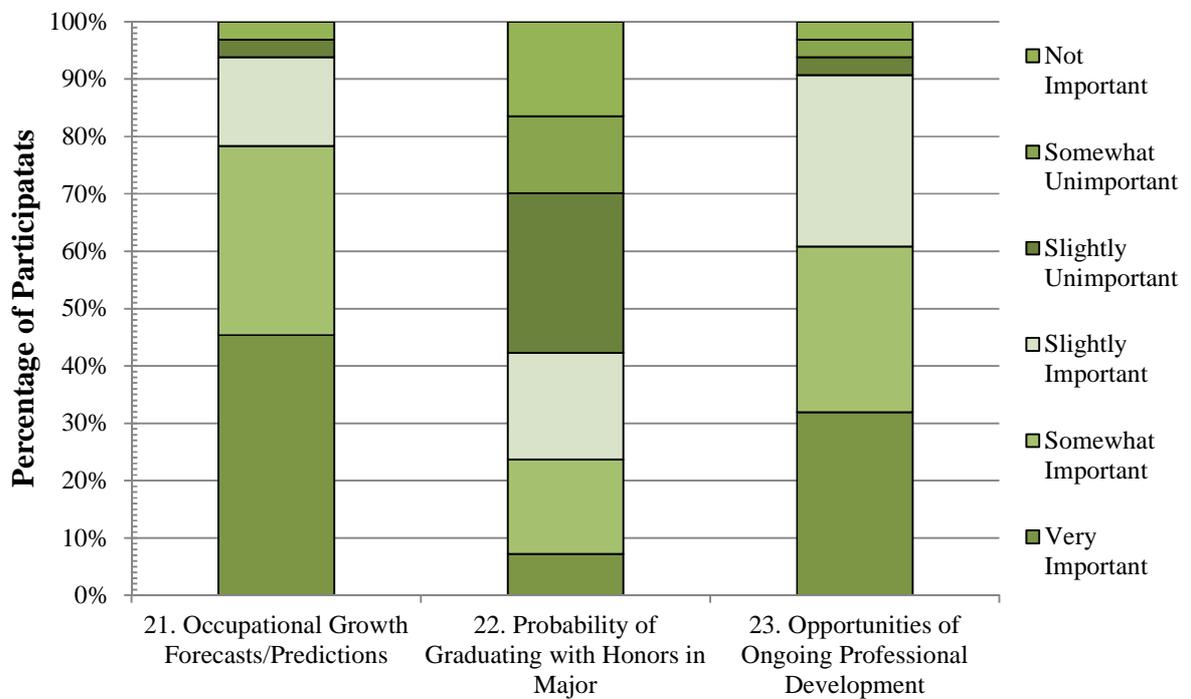
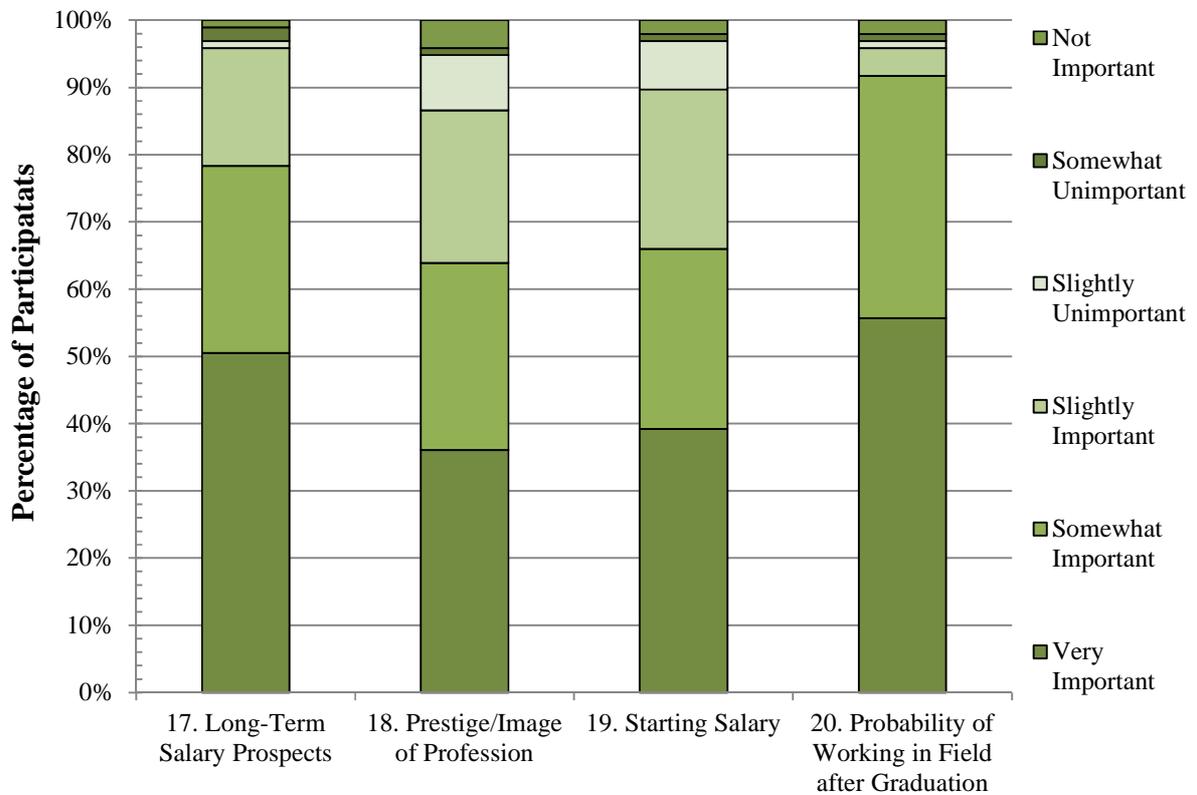
Q23. In your own words, please tell us (in a bit more detail) why you did not select some of the other majors listed.

Q24. Would you be willing to participate in a focus group and/or a structured interview where we may ask follow-up questions in an effort to understand better the factors influencing your choice of major?

## Appendix B: Influencers on Choice of Major







**Appendix C: Media Influencers on Choice of Major**

