Career Certainty: Differences Between Career Certain and Uncertain Engineering Students

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Abstract

To gain a deeper understanding of the career decisions of undergraduate engineering students, this research paper explores the differences between students who show a high degree of career certainty and those who are rather uncertain about what their professional future should look like. These analyses were based on a dataset from a nationwide survey of engineering undergraduates (n=5,819) from 27 institutions in the United States. The survey was designed with an interest in understanding engineering students' career pathways. For the purpose of this study, students were designated as either "career uncertain" or "career certain" according to their survey answers. Those two groups were then compared against a variety of background characteristics, past experiences and personality variables.

The results suggest that career uncertain and career certain students do not differ on background variables such as gender, age or family income. However, when it comes to students' past experiences, the percentage of students who had already gained internship experiences during their time in college was significantly higher among career certain students as compared to career uncertain students. As expected, seniors were more certain about their professional future than juniors. Similarly, a higher percentage of career certain students reported talking about their professional future with other students or faculty members more frequently. Furthermore, career certain students were significantly more likely to show a higher level of innovation self-efficacy and engineering task self-efficacy. In addition, career certain students were more likely to have career goals that involved innovation and they also considered several job characteristics as more important than did uncertain students. On average, career certain engineering students were also more certain about staying in engineering one, five and ten years *after* graduation.

Overall, the results of this research suggest that more hands-on experiences and fostering stronger beliefs in their engineering skills can contribute to undergraduates becoming more certain about their future professional careers.

1. Introduction and research questions

Career-related choices are considered to be among the most important decisions people make during their lifetime. This is because the decision to choose a particular career or career pathway has a major impact on individuals' economic and emotional well-being, lifestyles, and social standing (Gati & Tal, 2008; Gordon & Steele, 2015). Making a career decision, however, is a complex process in which individuals have to gauge many possible career alternatives by weighing the pros and cons. In addition, individuals have to identify their own preferences in order to find the most suitable or promising match. The complexity of this career decision-making process is especially true nowadays since the working environment of the 21st century is characterized by constant changes in a highly competitive job market. Furthermore, new economic trends frequently emerge, creating new career opportunities and

reshuffling the job market. As a consequence, choosing among career pathways can be seen as a very unstable and unpredictable process (Guichard & Dumora, 2008; Gati & Tal, 2008).

Many students face difficulties in their career decision-making process and therefore are uncertain regarding what kind of career they want to pursue. According to Slaney (1988) in his review of empirical studies about career indecision, some 20 to 30% of college students were found to be undecided about their future career. Research suggests that students who are unable to resolve their career indecision – an individual's inability to make a career decision (Gati, Krausz & Osipow, 1996) –may be "less committed to their career, experience less satisfaction, and generally fail to become active contributors to society despite their extensive accumulation of knowledge and education" (Daniels, Stewart, Stupnisky, Perry, & LoVerso, 2011, p. 410).

While some students have problems with choosing a career, there are other students who know exactly what they want to do immediately after graduation. To gain a deeper understanding of career decisions, the current study investigates the following research questions (RQs) based on survey data from undergraduate engineering students in the U.S.:

RQ 1: *How certain are undergraduate engineering students about their future career plans?*

RQ 2: *How do engineering students who are "career certain" differ from those who express some level of uncertainty when thinking about their professional futures?*

In this study, career certainty is defined as "the degree to which individuals feel confident, or decided, about their occupational plans" (Hartung, 1995, p. 1). Thereby, "career certain" students are those students with the highest degree of confidence, or decidedness about their occupational plans.

2. Theoretical Background

Existing literature describes the difference between career certain and uncertain students, considering various variables (Guay et al., 2003), including a student's background characteristics. The results suggest that there was no significant difference in the career certainty of males and females (e.g. Harren et al., 1978; Lunneborg, 1975; Daniels et al., 2011; Guay et al., 2003; Esters, 2007). The age of students was also the subject of research and led to conflicting results. Whereas Neice and Bradley (1979) found empirical evidence identifying age to be an "extremely important factor in career decidedness" (p. 275), other studies did not find any significant differences between younger and older students (e.g. Lunneborg, 1975, Daniels et al., 2011). Regarding the income or education of students' parents and their effect on career certainty, empirical studies did not find any significant results (Ashby, Wall & Osipow, 1966; Holland and Holland, 1977).

Past research also focused on a student's personality and its effect on career certainty. A construct that occurs across various studies and was assumed to be related to career certainty is a student's self-efficacy. 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). Research showed that self-efficacy is inversely related to career *indecision*, i.e. the higher a student's self-efficacy the more certain he or she is about his or her professional future (Taylor & Betz, 1983; Feldman, 2003; Betz & Voyten, 1997).

Another important aspect of personality is students' interests. Studies about students' vocational interests and their relationship with career certainty have had mixed results. Ashby et al. (1966) found no differences between decided and undecided students with regard to their vocational interests. In contrast, Feldman (2003) notes that students with many vocational interests might experience greater career indecision because it is more difficult for them to decide on a single career option. A more recent study by Burns (2013) investigated students of different vocational interest types and concluded that interests can be strong predictors of career indecision or career certainty, respectively.

Additional studies analyzed variables relating to a student's past experiences and their effect on career certainty or indecision. These past experiences refer to either a student's experiences during school (high school, college) or to a student's hands-on experiences (e.g. internships). One variable in the context of school experiences is academic achievement operationalized in the form of students' grade point average (GPA). A study by Lunnebourg (1975) found that career decided students on average had a higher college and high school math GPA than undecided students. However, findings by Ashby et al. (1966) showed a difference in the high school GPAs between undecided and decided students but not in their college GPAs. A broad variety of other specific school tests and exams were compared among career certain and uncertain students which led to inconsistent findings (Ashby et al., 1966). Nevertheless, those studies suggest that academic achievement might somehow be related to career certainty. In the context of school experiences, a study by Daniels et al. (2011) came to the conclusion that the level of career indecision was not significantly different between students of different college years (first-year students compared to second-year or above).

Jordaan et al. (2009) conducted an empirical study exploring levels of career indecision in students with variable work experience. Their results show that students who had a full-time job (while in school) expressed a significantly lower level of career indecision than those who worked only part-time or not at all. There was, however, no difference between the two latter groups. These findings are in accordance with those of Neapolitan (1992), who also came to the conclusion that an internship significantly helped students gain more clarity about their career choice by "providing information on occupations, reducing indecisiveness and anxiety regarding choice, and increasing confidence in the ability to choose" (p. 222).

In conclusion, studies about career certainty and indecision do not provide a uniform picture. As the research findings demonstrate, the differences between career certain and uncertain college students are sometimes conflicting and confusing (cf. Kelly & Pulver, 2003; Gordon, 2015; Hirschi & Läge, 2007; Lunnebourg, 1975; Slanely, 1988). The two major reasons for this are described as follows.

Firstly, research studies about career certainty and indecision are hardly comparable because most of the studies in this field have used varying approaches to differentiate between career certain and uncertain students. The majority of studies used specific instruments (i.e. scales) to measure career indecision. For instance, one of the first instruments of its kind is the Career Decision Scale (CDS) developed by Osipow et al. (1976), which was used in several studies, including recent ones (e.g. Jordaan et al., 2009; Burns et al., 2013). But there are many other instruments which take a completely different approach (e.g. the Career Factors

Inventory of Chartrand & Robbins, 1997), or improve upon existing scales (e.g. the Decision-Making Difficulties Questionnaire of Osipow & Gati, 1998; Osipow, 1999).

Secondly, the studies about career certainty and indecision differ in the populations they are examining. For instance, Daniels et al. (2011) looked at physical education students, Neapolitan (1992) focused on students with a major in sociology, Jordaan et al. (2009) looked only at specific honors degrees and Neice and Bradley (1979) at psychology students. In contrast, Ashby et al. (1966) more comprehensively considered all freshmen students of every field (e.g. business, teaching, liberal arts, etc.) in their sample. Thus, one reason why some variables show significant effects in one study but not in another might simply be because those studies analyzed students from different fields who might have their own unique characteristics.

The literature review conducted for this research found no studies that had a focus on comparing career certain and uncertain *engineering* students. Therefore, this study aims to address questions and issues to inform current and future engineering education practice and research.

3. Methods

3.1 Design of the Survey Instrument and Dataset

The Engineering Majors Survey (EMS) was a critical component of a major longitudinal study of engineering students' interests and career goals surrounding innovation and entrepreneurship (I&E) sponsored by the NSF-funded National Center for Engineering Pathways to Innovation (Epicenter). In 2015, the EMS instrument was administered to over 30,000 engineering juniors across 27 schools in the United States. The survey instrument included 35 questions covering five main topics/sections: (1) Current Plan of Study, (2) School Experiences, (3) Beliefs, Expectations, and Interests, (4) Future Career Goals and (5) Background.

Social Cognitive Career Theory (SCCT) (Lent, Brown, Hackett, 1994; Lent and Brown, 2006) served as the organizing theoretical framework for the design of the EMS. SCCT has been used to explore students' interest in pursuing an engineering major (e.g., Lent et al. 2005), engineering student retention (e.g., Atadero, Rambo-Hernandez, & Balgopal, 2015), engineering alumni's career choices (e.g., Brunhaver, 2015), and the retention of women engineers in the workforce (Fouad & Singh, 2011; Singh et al., 2013). In the EMS, SCCT was used to develop and explore the relationships between the measures of innovation attitudes, interests, and goals which in turn, has informed our current investigation of career certainty and indecision (Gilmartin et al. 2017).

The final EMS data set from the 2015 administration included 5,819 respondents. Table 1 provides an overview of the distribution of survey respondents with regard to students' current progress in studies, gender and age.

Table 1: Description of the Engineering Majors Survey Respondents

Variables	*N*	*Percent*
Current academic standing		
Juniors	2714	46.6
Seniors	2384	41.0
Fifth-year seniors	721	12.4
Gender		
Females	1732	29.8
Males	4087	70.2
Mean age in years	24.24	

3.2 The Main Object of Research: Postgraduate Career Options (Question Q20)

In the fourth section of the EMS on "Future Career Goals", respondents were asked "How likely is it that you will do each of the following in the first five years after you graduate?" (Question Q20). The respondent was asked to rate each of the eight career options described in Table 2 on a five-point Likert scale ("Definitely will not", "Probably will not", "Might or might not", "Probably will" and "Definitely will").

Table 2: The Eight EMS Career Options in Q20

(A) Work as an employee for a small business or start-up company	**(B)** Work as an employee for a medium- or large-size business	**(C)** Work as an employee for a non-profit organization	**(D)** Work as an employee for the government, military, or public agency (excluding a school or college/university)
(E) Work as a teacher or educational professional in a K-12 school	**(F)** Work as a faculty member or educational professional in a college or university	**(G)** Found or start your own for-profit organization	**(H)** Found or start your own non-profit organization

In the current study, Q20 was used assess a student's career certainty. The eight question options were designed to cover the following career characteristics: *size of the company*, *organizational orientation* (i.e. for-profit vs. non-profit), *type of the organization* (private vs. public vs. educational institution) and *employment status* (i.e. employee vs. founder/self-employed). Only 21 survey respondents marked "Definitely will not" on every one of the eight items, suggesting that 1) these students did not find their appropriate career plan represented in Q20, and 2) with only 21 respondents, Q20 on the whole represents the majority of possible career alternatives being considered by today's engineering graduates. That said, it is important to mention that career certainty in this study is limited to students' certainty about the career alternatives/ job characteristics that are mentioned within these eight options defined in Q20.

3.3 Methods of Analysis

To investigate **RQ1**, it is of interest how students answered each of the eight career alternatives in Q20. The proportion of "Definitely will" or "Might or might not" answers offer insights into which of these alternatives led students to be *certain* or rather *uncertain*.

Therefore, the frequency distributions of each of the career alternatives will be compared against each other. Likewise, the frequency distribution of responses to Q21 – a student's estimation of having a job that involves engineering – will also be analyzed.

In order to address the second research question **(RQ2)**, the EMS students were categorized into two groups according to their level of career certainty as indicated by Q20 and then compared with one another. One of these two groups included those students who expressed being *definitely certain* about what they wanted to do as a professional after graduation whereas the other group represented students who were *more uncertain* about their career decisions. This study uses the following approach to assign students to one of the two groups: Students who marked "Definitely will" on at least one of the eight career options were categorized as career *certain* students. The remaining students were categorized as *more uncertain* (hereinafter called *uncertain*), since they did not express even one option that they were certain of. The purpose of this approach was to generate two distinct groups of students. Although students also express some level of career certainty when answering a career option with "Probably will" (i.e., being quite certain) or "Definitely will not" (i.e. being certain not choose an option) it is another "step" to really commit to one of the options by marking "Definitely will". Students who marked more than one option with "Definitely will" were also considered to be *career certain* since Q20 asked for a time period of five years in which it is possible (or nowadays even common) to have several clear job targets in consideration (either consecutively or in parallel).

For an analysis of the differences between the two groups of students (certain vs. uncertain), independent t-tests and Chi-squared tests were used. The variables on which those differences were tested are described in the next section. It is important to note that due to the large sample size of 5,819 students, significance tests and their conclusions should be treated cautiously. Large sample sizes have more power to detect effects, however, this does not necessarily mean that these effects are important (Field, 2014). Therefore, the threshold for significance was set to 0.1% in this study. In addition to the p-values, the effect sizes – Cohen's d for the t-tests (Cohen, 1992) and Phi for the Chi-squared tests – were calculated and included in the interpretation of the results.

3.4 Description of the Variables Analyzed for RQ2

In the following, an overview of the variables in each EMS section that were drawn into the analyses of this study are presented. The variables were selected on the basis of the literature review conducted.

(1) Current plan of study

In the first section of the EMS survey "Current plan of study" the current academic standing of students was included in the analysis of career certainty. The EMS sample focused on junior and senior students which is why only those two groups exist in the data set. Juniors were coded with "0" and seniors (including fifth year seniors) with "1".

(2) School experiences (Table 3)

In the second section "School experiences" asked students several Yes-or-No questions about their time as an undergraduate. Particularly relevant to this study were the questions on

whether or not they attended a career-related event or meeting, founded their own organization or already gained hands-on experience in an engineering internship. Furthermore, students were asked how often they discussed their professional options with faculty members or other students.

Table 3: School Experiences Variable Descriptions

Variable	Scale
Attended a career related event or meeting	No (0), Yes (1)
Founded an own organization	No (0), Yes (1)
Internship experience	No (0), Yes (1)
Frequency of discussions about professional options with faculty members	Five-point Likert scale from "Never" (0) to "Very often" (4)
Frequency of discussions about professional options with other students	Five-point Likert scale from "Never" (0) to "Very often" (4)

(3) Beliefs, expectations and interests (Table 4)

In EMS section three on "Beliefs, expectations, and interests," students were asked how they think about themselves with regard to their interests and expectations of the future, as well as how they perceive their own abilities and skills. The EMS made use of the construct of self-efficacy as described earlier (see *Theoretical Background* section). In the development of the EMS, this construct was adapted to capture a student's confidence in his or her abilities in generating and gathering new ideas – labeled as *Innovation Self-Efficacy*. In a similar way, a student's confidence in his or her abilities to design and develop new technical prototypes, products or services was included and measured in a variable named *Engineering task self-efficacy*. For both types of self-efficacy, students were asked to rate their levels of confidence in several innovation- or engineering-related activities. All of those activities were measured on a five-point Likert scale from "Not confident" (0) to "Extremely confident" (4). For each type, the responses to each of these respective items were averaged in order to get a mean value for every student. The specific questions (items) which constitute both variables are shown in the appendix. The two variables and their underlying theoretical concepts are described in greater detail in the Engineering Majors Design Package (2015) and Gilmartin et al. (2017).

Another EMS variable captured a student's level of interest in the topics of innovation and entrepreneurship (I&E). In this variable, students were asked to state their levels of interest in seven innovation and entrepreneurship-related items, such as giving an elevator pitch, experimenting to find new ideas, or developing plans to implement new ideas (see appendix for all question items). Again, students could mark their level of interest in each of these items on a five-point Likert scale ranging from "Very low interest" (0) to "Very high interest" (4). A variable score was created by creating a mean value of each of the constituent items.

Table 4: Beliefs, Expectations, and Interests Variable Descriptions

Variable	Scale
Innovation Self-Efficacy (**ISE.6**; there are also studies about the EMS that used an innovation self-efficacy construct based on five items named ISE.5)	Average of six items each measured on five-point Likert scales from "Not confident" (0), to "Extremely confident" (4)
Engineering Task Self-Efficacy	Average of five items each measured on five-point Likert scales from "Not confident" (0), to "Extremely confident" (4)
Interest in Innovation & Entrepreneurship	Average of seven items each measured on five-point Likert scale from "Very low interest (0), to "Very high interest" (4)

(4) Future career goals (Table 5)

Aside from Q20 which probes interest in various career options and was used to categorize students into an *uncertain* and *certain* group, the fourth section of the EMS asked students about the perceived importance of several specific work activities in their future job. Those work activities had a focus on I&E, e.g. generating creative ideas, promoting those ideas to others or selling products and services on the marketplace (see appendix for all question items). These activities were combined into a single variable named *Career goals around innovative work*. Similar to the self-efficacy variables above, those career goals were measured on a five-point Likert scale ("Not important" to "Extremely important") and the item responses were summed up and divided by their total number to get a single mean score.

Another question in this section (Q21) asked students how likely it is that their future work will involve engineering one, five and ten years after graduation. This resulted in three variables (one for each period of time) which were also included in the analysis, and are discussed in relation to RQ1. Table 5 describes the two variables of the *Future Career Goals* section.

Table 5: Future Career Goals Variable Descriptions

Variable	Scale
Career Goals Around Innovative Work	Average of six items each measured on five-point Likert scale from "Not confident" (0), to "Extremely confident" (4)
Work Involving Engineering a) One year after graduation b) Five years after graduation c) Ten years after graduation	Five-point Likert scale from "Definitely will not" (0), to "Definitely will" (4)

(5) Background (Table 6)

From the last section, background variables *Gender*, *Age* and *Perceived family income* were included. The latter variable represents a student's subjective perception of his or her family's incoming while growing up. Table 6 describes the background variables and how they were coded.

Table 6: Background Variable Descriptions

Variable	Scale
Gender	Female (0), Male (1)
Age	Continuous variable
Perceived family income	Five-point Likert scale from "Low income" (0) to "High Income" (4)
College GPA	Ordinal variable with 8 nuances: "C- or lower" (0), "C" (1), "C+" (2), "B-" (3), "B" (4), "B+" (5), "A-" (6), "A or A" (7)

4. Results

4.1 RQ 1: *How certain are undergraduate engineering students about their future career plans?*

The frequency distribution of Q20 responses in Table 7 reveals that students were most *uncertain* (relative to the other 8 options) about working as an employee for a small company or startup (item A); some 46.8% marked "might or might not" in terms of this option. Only 5.6% expressed *certainty* (marking "Definitely will").

Next on the "*uncertainty"* list was being an "Employee for the government, military or public agency" (item D), with 38.1% marking "might or might not." In this case, only 5.2% of the students expressed certainty about this option (marking "Definitely will").

Interestingly, when skewness measures were compared for items A and D, there was a nearly normal distribution of "certainty-uncertainty" responses for working for a small company or start-up (skewness of 0.074), as compared to responses related to working for the government, military or public agency, where there was a bias towards the "Definitely will not" or "Probably will not" response (skewness of 0.202).

The largest proportion of students were *certain* about wanting a career as an employee for a medium or large company (item B), with 14.5% expressing "Definitely will". Another 28.6% are *uncertain* about this option (marking "might or might not."). We note that the size of the *certain* group for working for a medium or large company is nearly three times larger than for items A (small company or start-up) and D (government, military or public agency), and the uncertain group is significantly smaller (28.6% vs. 46.8% and 38.1%). Furthermore another 51% of the students expressed that they "probably will" work for a medium or large company; this led to a strong negative skewness (-0.628) of item B and to the only negative skewness of all items in Q20.

Three other items have a large positive skewness, indicating that proportionally more students are leaning away from these options. These are working for a non-profit (item C, 2% certain, skewness of 0.526), forming a for-profit organization (item G, 3% certain, skewness of 0.536) and forming a non-profit organization (item H, 1.2% certain, skewness of 0.855).

The two education options had the largest proportion of students expressing that they definitely would not pursue them. As related to being a faculty member or educational professional in a college or university (item D), 40.9% said "Definitely not," and as related to being teacher or educational professional in a K-12 school (item E), 56.9% said "Definitely not." The respective skewnesses are 0.923 and 1.491.

Table 7: Frequency Distribution Q20 Career Options

Q20 Career Options	Definitely will not (0)		Probably will not (1)		Might or might not (2)		Probably will (3)		Definitely will (4)		Skewness
	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	
A. Employee for a small company or startup	263	4.5	1302	22.4	**2724**	**46.8**	1206	20.7	324	5.6	0.074
B. Employee for a medium/ large company	95	1.6	247	4.2	1665	28.6	**2968**	**51.0**	844	14.5	-0.628
C. Employee for a non-profit organization	882	15.2	**2631**	**45.2**	1693	29.1	495	8.5	118	2.0	0.526
D. Employee for the government, military, or public agency	645	11.1	1738	29.9	**2217**	**38.1**	915	15.7	304	5.2	0.202
E. Teacher or educational professional in a K-12 school	**3310**	**56.9**	1785	30.7	529	9.1	148	2.5	47	0.8	1.491
F. Faculty member or educational professional in a college or university	**2378**	**40.9**	2076	35.7	996	17.1	296	5.1	73	1.3	0.923
G. Found own for-profit organization	1578	27.1	**2001**	**34.4**	1513	26.0	550	9.5	177	3.0	0.556
H. Found own non-profit organization	2155	37.0	**2278**	**39.1**	1067	18.3	248	4.3	71	1.2	0.855

Note: The highest value in each row/ career option is in bold.

Table 8 shows the frequency distribution of Q21, the question in which students were asked to estimate the likelihood that their work will involve engineering in the time periods of one, five and ten years after graduation.

Table 8: Frequency Distribution of Engineering Involvement over Time (Q21)

Time period	Definitely will not (0)		Probably will not (1)		Might or might not (2)		Probably will (3)		Definitely will (4)		Skew-ness
	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	
One year	81	1.4	161	2.8	642	11.0	1828	31.4	3107	**53.4**	-1.420
Five years	48	0.8	116	2.0	591	10.2	2143	36.8	2921	**50.2**	-1.293
Ten years	76	1.3	245	4.2	1157	19.9	1854	31.9	2487	**42.7**	-0.873

Notes: The highest value in each row is highlighted in bold.

The frequency distribution reveals that each of the three time periods has a strong negative skewness, caused by the large proportion of students who marked "Definitely will" or "Probably will" in each time period. However, this skewness decreases in magnitude as the periods of time increase, i.e. the proportion of students shifts slightly from the right side towards the center of the Likert scale ("Might or might not"). For the one and five-year periods, slightly more than half of the students stated that they are definitely *certain* that their future professional work will involve engineering. For the ten-year period this value decreased but still amounts to almost 43% of the sample. Overall, the percentages of students who expressed a high level of *certainty* ("Definitely/Probably will") in their intention to choose and stay in a job that involves engineering amounts to 84.8%, 77% and 74.6% for each of the three time periods respectively. In contrast, only a small percentage (1.4%, 0.8% and 1.3%, respectively) of students stated that their future job will definitely not involve engineering.

4.2. RQ 2: *How do engineering students who are "career certain" differ from those who express some level of uncertainty when thinking about their professional futures?*

For an analysis of the second research question the data set was split into two groups: *certain* and more *uncertain* students. As a reminder, in this study students who marked any of the eight career options of Q20 with "Definitely will" were declared as *certain*. The remaining students were declared as career *uncertain*. The resulting two groups were then compared on the abovementioned variables of the five EMS sections. Table 9 shows the results of the continuous variables that were analyzed using independent t-tests and Table 10 illustrates the results of the Chi-Squared tests which were used to investigate the categorical variables.

Table 9: T-Test Results Comparing Uncertain and Certain Students

	"Uncertain" students (n=4377)		"Certain" students (n=1442)					Effect size
Variable	M	SD	M	SD	df	t	p	**Cohen's d**
School experiences								
Discussed professional options with faculty members	1.54	1.12	1.77	1.25	5817	-6.50	.000	**.20***
Discussed professional options with other students	2.76	1.08	3.09	1.01	5817	-10.11	.000	**.31***
Beliefs, expectations, interests								
Innovation Self-Efficacy	2.53	.72	2.83	.74	5817	-13.53	.000	**.41***
Engineering Task Self-Efficacy	2.35	.83	2.66	.85	5817	-12.48	.000	**.37***
Interests in I&E	2.47	.65	2.69	.75	2204.86	-10.02	.000	**.33***
Future career goals								
Career goals around innovative work	2.45	.76	2.75	.82	2303.83	-11.99	.000	**.39***
Work will involve engineering (one year after graduation)	3.27	.86	3.49	.923	5817	-8.37	.000	**.25***
Work will involve engineering (five years after graduation)	3.30	.793	3.44	.825	5817	-5.95	.000	**.18**
Work will involve engineering (ten years after graduation)	3.08	.935	3.17	.989	5817	-2.86	.005	**.01**
Background								
Age	24.09	3.53	24.70	4.03	5817	-5.51	.000	**.17**
GPA	5.14	1.31	5.15	1.29	5817	-.36	.72	**.01**
Perceived family income	2.05	.933	2.03	1.00	2324.17	.693	.489	**.02**

Cohen's d significance levels: * > .20 (weak effect), ** > .50 (medium effect), *** > .80 (strong effect).

Table 10: Chi-Squared Results Comparing Uncertain and Certain Students

Variable		Uncertain (proportion in %)	Certain (proportion in %)	Pearson Chi-Squared significance	Effect size Phi
Current plan of study					
Current academic standing	Junior	81.6	18.4	.000	**.14***
	Senior	69.7	30.3		
School experiences					
Attended a career related event	No	75.1	24.9	.936	**.001**
	Yes	75.2	24.8		
Founded own organization	No	75.8	24.2	.000	**.095**
	Yes	69.0	31.0		
Internship experience	No	82.0	18.0	.000	**.14***
	Yes	69.8	30.2		
Background					
Gender	Female	75.2	24.8	.958	**.001**
	Male	75.2	24.8		

Phi significance levels: * > .10 (weak effect), ** > .30 (medium effect), *** > .50 (strong effect)

In the following section, the results of the analyses of the variables from each of the five EMS sections are summarized.

(1) Current plan of study

The results of the Pearson Chi-Squared test in Table 10 showed that juniors and seniors differ significantly ($p < .000$) in their proportions of career *certain* and *uncertain* students. Whereas only 18.4% of the junior students were definitely *certain* about their future career this proportion amounts to 30.3% within the senior students. The value of Phi is 0.138 in this association which represents a small effect.

(2) School experiences

Students who attended a career-related event during their undergraduate years were not significantly different from those students who did not ($p = .936$) in terms of their career certainty. The proportions of *uncertain* and *certain* students in those two groups ("Attended: No" and "Attended: Yes") were almost identical.

This situation is different when one considers whether a student had already founded his or her own organization. Of those students who were founders, 31% belonged to the *certain* group. Within the non-founders, only 24.2% were *certain*. This difference is highly significant ($p < .001$). However, considering the effect size (0.095) this difference is below the threshold of 0.1 (small effect).

Within those students who engaged in internship experiences as students, 30.2% were certain about their professional future. In contrast, for the students who did not have any internship experience, this proportion decreased to 18%. This difference is highly statistically significant ($p < .001$). A Phi value of .14 indicates that this difference is small.

Two more variables from the "School experiences" section were included in the analyses, namely the frequency of how often students discussed their professional options with an engineering degree with either faculty members or their fellow students (Table 9). Both variables showed highly significant results ($p < .001$) such that *uncertain* students had lower scores than *certain* students, i.e. *uncertain* students had fewer discussions about job opportunities with faculty members and other students than *certain* students. The values of Cohen's d further reveal that this effect was larger when students reported talking more frequently to other students as compared to faculty members (.31 as compared to .20).

(3) Beliefs, expectations, and interests

The three variables from the third section of the EMS were measured on a continuous scale and thus, included in the t-test analyses in Table 9. On the measures of *Innovation Self-Efficacy*, *Engineering Task Self-Efficacy* and *Interest in I&E* all showed the same picture where career *uncertain* students had lower values on each variable as compared to the *certain* students. These differences between the groups were all highly significant ($p < .000$). The values for Cohen's d lie in the range of a small to medium effect (.414, .371 and .325, respectively).

(4) Future career goals

Similar to the self-efficacy and interest measures results, the career goals of students were significantly different between the *uncertain* and *certain* group. On average, career *certain*

students considered several characteristics of their future job as more important than did *uncertain* students. *Certain* students were also more likely to have career goals that involved innovation, and were more *certain* about staying in engineering one, five and ten years after graduation (though the strength of the differences was reduced the further into their post-graduate careers).

(5) Background

The fifth and last section of the EMS captured a student's background. Beginning with gender, the analyses showed no difference in the proportions of *uncertain* and *certain* students between males and females. The proportions were exactly the same, resulting in an insignificant p-value of .958 and an effect size of almost zero (Phi: 0.001).

The same held true for *GPA* and *perceived family income* (Table 9). The t-tests were insignificant (.72 and .489, respectively) with Cohen's d values close to zero, indicating that no difference between *uncertain* and *certain* students regarding grades and perceived family wealth.

There was a highly significant ($p < .001$) difference between *uncertain* and *certain* students with respect to their age. However, a Cohen's d value of .17 (< .2) suggests that this difference is very small.

5. Discussion

The results of this study revealed some expected findings but also some that were more surprising and even counter to past research.

First, this study suggested that seniors are more *certain* than juniors which is contradictory to the findings of Daniels et al. (2011) who concluded that there was no difference between students of different college years. However, it is important to note that Daniels et al. (2011) compared first year students to all other students (two or more years) combined. This might have obscured the effect of class year that might only be salient in the final years, as students get closer to graduation. Senior status could be taken as a proxy for more "life experience" which ideally give individuals more world and self-knowledge with which to navigate their career.

We also see that more career *certain* students are more sure about staying in engineering one to ten years post-graduation (though the difference in commitment to engineering between *certain* and *uncertain* students becomes less pronounced the longer the projection time from graduation). In addition, their stronger expressed desire to stay in engineering is consistent with their greater engineering task self-efficacy, an observation which supports the SCCT model. According to SCCT, self-efficacy and future career goals both greatly influence an individual's career choice which might explain why career *certain* students have higher values on both variables.

The career *certain* students also have stronger innovation career goals, which is consistent with their stronger expression of innovation interest and their higher innovation self-efficacy. A higher value on the career goals variable might indicate a higher level of student engagement in thinking about their career and what they want to achieve in it. Those students

might have already sought out information about specific industries or job positions in which those career goals could be realized, and thus are more career *certain*.

Our analyses do not support exploration of causal statements such as, "What might contribute to greater career certainty?" However, we can identify a number of "practices" that are more commonly found among career *certain* students than career *uncertain* students. For example, career *certain* students are more likely to have had an internship. This finding is in line with former studies (e.g. Neapolitan, 1992). Furthermore, career *certain* students are more likely to have talked with faculty and peers about career options. Practices that do not differentiate between career *certai*n and career *uncertain* students are founding an organization or attending career-related events. Men and women are equally likely to be found in career *certain* and *uncertain* groups, and GPA, age and socioeconomic status do not seem to differentiate between career *certain* and *uncertain* students.

In conclusion, the career *uncertain* students are significantly different than their career *certain* counterparts with regard to some of their background characteristics, personality, future career goals, as well as school and work experiences.

6. Implications and Limitations

There are a number of implications that our study suggests to support students to become *certain* (or at least more certain) about their professional future. First, students should be encouraged to take advantage of internship opportunities where possible. In addition, engineering departments should consider how advising systems can foster faculty-student conversations about possible career options for graduates with an engineering degree. This should not only be left to campus career centers and academic advisors. Moreover, opportunities for students to learn from one another and exchange experiences should also be encouraged. Finally, educational practices should be used that help students build their engineering and innovation self-efficacies (e.g. project based learning) which can greatly influence students' career choices according to SCCT.

However, these conclusions and implications should be treated cautiously due to this study's limitations. First, due to the cross-sectional and not longitudinal nature of the EMS, causal interpretations are not readily possible. A regression analysis with its corresponding model could give further insights into which of these variables lead students to be career *certain*. Second, the EMS instruments and scales were not designed to differentiate between career *certain* and career *uncertain* students. The methods for defining and describing these characteristics still need to be validated and tested in further research.

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Appendix

Innovation Self-Efficacy and Engineering Task Self-Efficacy Items

How confident are you in your ability to do each of the following at this time?

Innovation Self-Efficacy Items

1. Ask a lot of questions
2. Generate new ideas by observing the world
3. Experiment as a way to understand how things work
4. Actively search for new ideas
5. Build a large network of contacts with whom you can interact to get ideas for new products or services
6. Connect concepts and ideas that appear, at first glance, to be unconnected

Engineering Task Self-Efficacy Items

1. Design a new product or project to meet specified requirements
2. Conduct experiments, build prototypes, or construct mathematical models to develop or evaluate a design
3. Develop and integrate component sub-systems to build a complete system or product
4. Analyze the operation or functional performance of a complete system
5. Troubleshoot a failure of a technical component or system

Level of Interest in Innovation and Entrepreneurship Items

How much interest do you have in:

1. Experimenting in order to find new ideas
2. Giving an "elevator pitch" or presentation to a panel of judges about a new product or business idea
3. Finding resources to bring new ideas to life
4. Developing plans and schedules to implement new ideas
5. Conducting basic research on phenomena in order to create new knowledge
6. Working on products, projects, or services that address societal challenges
7. Working on products, projects, or services that have significant financial potential

Career Goals Importance of Job/Work Activities Items

How important is it to you to be involved in the following job or work activities in the first five years after you graduate?

1. Searching out new technologies, processes, techniques, and/or product ideas
2. Generating creative ideas
3. Promoting and championing ideas to others
4. Investigating and securing resources needed to implement new ideas
5. Developing adequate plans and schedules for the implementation of new ideas
6. Selling a product or service in the marketplace