AC 2011-408: UNDERGRADUATE ENGINEERING STUDENT PERCEPTIONS OF GRADUATE SCHOOL AND THE DECISION TO ENROLL

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Undergraduate Engineering Student Perceptions of Graduate School and the Decision to Enroll

Abstract

If the United States is to remain a globally recognized source of technological and scientific development, it must continue to recruit and retain domestic students into engineering master’s and doctoral programs. Although enrollment of domestic students in graduate science and engineering programs rose by 5.9% in 2007-2008, it is still approximately half of the growth of international student enrollment (11.0%). The focus of this study is to develop a more complete understanding of the factors that contribute to students’ decision processes with respect to pursuing a graduate degree in engineering. In this paper we present a brief overview of the instrument development along with the results from the survey, which examined how undergraduate engineering students viewed attending graduate school in engineering. Data were collected via an online survey instrument during the fall of 2010 at four universities across the United States, resulting in more than 1000 respondents. Results of the quantitative analysis indicate that the presence of role models and students’ perceptions of their chance of success and level of knowledge about several aspects of graduate school contribute to the decision to enroll. These results are discussed using a Social Cognitive Career Theory (SCCT) framework focusing on student self efficacy, and how they perceive graduate school’s alignment to their interests and future goals. The results of this study will help engineering faculty and administrators gain a better understanding of the issues surrounding the graduate school decision process, which will improve recruitment of potential graduate students and alleviate potential misconceptions regarding graduate engineering education.

I. Introduction

After two years of decline, first time graduate enrollment in science and engineering increased in 2006—by 16% for foreign students but only 1% for domestic students\(^1\). Although enrollment of domestic students in graduate science and engineering programs experienced larger growth in 2007-2008 (5.9%), it is still approximately half of the growth of international student enrollment, which increased by 11.0 percent during this time. Over the period of 1999 to 2009, 85% of doctorates earned by international students were in science and engineering, compared with only 61% for US students\(^2\). In 2009, temporary visa holders represented the majority of doctorate recipients in engineering, and over half of these doctorates were earned by students from China, India and South Korea\(^2\). The continued increase of international students studying in the United States has been punctuated by periods of both growth and decline for American students; however, U.S. students still represent the smaller fraction of students in many engineering disciplines. Though recent findings and predictions about the future of the American economy\(^3\) and the spread of globalization to every corner of the world\(^4\) have prompted some changes in undergraduate engineering education, why has this urgency not extended to growth of American students attending graduate school in engineering? And similarly, how does this gap in engineering graduate students translate to diminished U.S. competitiveness in 2040?
A decline in students attending graduate school in engineering translates into a loss of opportunity for personal growth, a loss of prospective workforce talent, and the potential loss of creativity in shaping future technological innovations. With globalization threatening to move jobs to other parts of the world, the U.S. must foster innovation and creativity in order to maintain global competitiveness. The knowledge density of modern economies has steadily increased, and the ability of the U.S. to adapt to changes in the development, production and commercialization of knowledge represents a major contribution to maintaining its technological edge. One way of generating new knowledge is through university research, and the training of graduate students. This element that will prove critical for expanding the knowledge base of the United States. On an individual level, a graduate degree in engineering offers students rewards as well, including a higher starting salary, the possibility to move into more senior positions, and personal growth and a sense of accomplishment from completing the degree. Despite the advantages of a graduate degree, and the aforementioned need for knowledge development, domestic engineering students still lag behind their international counterparts at U.S. universities. This paper takes a focused look at why this may be, using a social cognitive career theory lens on data collected from a survey of over 1000 undergraduate students, to examine what underlies the decision to attend graduate school, and guided by the following research questions:

1. What elements of social cognitive career theory are relevant for students considering graduate school in engineering, and how are these manifest in the decision process?
2. What do students feel are the factors in their decision to attend (or not attend) graduate school?

We begin with a discussion of the social cognitive career theory framework followed by an explanation of the study methodology. We then examine the results of the study in light of the research questions and discuss implications for universities and directions for future work.

II. Theoretical Framework

Social Cognitive Career Theory (SCCT), grounded in Bandura’s social cognitive theory, was developed as a means of explaining career choice and development through the use of socio-cognitive constructs. Social Cognitive Career Theory focuses on how career choices develop, how academic interests and decisions mature, and ultimately how these influence individual action. These developments are viewed in light of three primary areas: self efficacy, outcome expectations, and goals.

Self efficacy refers to a student’s belief about his or her personal abilities, which may include perceived ability to achieve academic milestones or overcome performance hurdles. Individuals develop their sense of self-efficacy from personal performance, learning by example, social interactions, and how they feel in a situation, and these beliefs are constantly changing based on interactions with others or changes in the environment. Examples of self efficacy in graduate school may be the ability to conduct independent research, write a paper, or present work to others. Undergraduate students may develop self efficacy for graduate school by increasing their understanding of what is involved in a graduate degree and what it is like to be a graduate student.
A student’s level of self efficacy is a result of his or her beliefs about abilities to perform a task. On the other hand, outcome expectations focus on the consequences he or she believes will occur as a result of performing the task or behavior. In many cases, outcome expectations are formed through past learning experiences, either direct or vicarious, and the perceived results of these experiences. Outcome expectations for prospective graduate students may be future employment opportunities, such as the type of job or nature of work, or a raise in starting salary. Other evidence of outcome expectations may be the selection of the advisor or research project. Outcome expectations are often influenced by self-efficacy, especially when the outcomes are judged based on the quality of a person’s performance of a task or behavior\textsuperscript{9, 10}. 

The final major tenet of SCCT concerns student goals. A goal is defined as a decision that an individual has made regarding future objectives or plans. Student goals may be the type of graduate degree they are interested in (MS or PhD), the type of job they want after graduation (industry or faculty), or the focus of their research topic. Behavior is organized and sustained based on these previously set goals.

In addition to self efficacy, outcome expectations and goals, we also consider factors that may be viewed as barriers or supports for students considering graduate school. These barriers or supports may be real or perceived, in that they could be actually experienced by students or expected to experience as a result of decision alternatives. Barriers to attending graduate school may be the cost of tuition, the time it takes to complete a degree, or not knowing how to get information for an application. Perceived barriers play a mitigating role in SCCT, where they can shape each experience and directly influence interests and choices. There are also supporting influences in graduate school as well; faculty advisors can offer guidance on the application process, make suggestions to undergraduate students about attending, and help guide research progression. Additional support may come in the form of interactions with current graduate students, especially if they are seen as positive.

The decision to attend graduate school, like the career decision process, emphasizes the connection between interests, goals, and actions along with the successes and failures that create self-efficacy and outcome expectations. Engineering students graduating from engineering programs have a relatively well laid out career path. At the graduate level however, this career path becomes less well formed, as students have more options made available to them. Using SCCT as a theoretical guide highlights the variables that may influence these decisions, in spite of or in conjunction with interests. Students may prematurely eliminate graduate school as an option because of low self-efficacy or misunderstood expectations. In addition, students may hold an inaccurate picture of what it means to be a graduate student, the perceived barriers to attendance, and how this experience relates to their goals. In the remainder of this paper, we consider how student self efficacy, expectations, and goals influence their decision to attend graduate school in engineering. In addition, we explore several misconceptions about graduate school that form perceived barriers to attending graduate school.

III. Methods

A. Setting and Sample
The setting for this study was four universities across the United States, each chosen to represent a variety of student demographics. The universities chosen are shown in Table 1. The first institution, EPUB, is a large public university on the east coast, while MPUB is a large public university in the Midwest. The third institution, SPUB, is a small public university on the east coast and WPRI is a large private university on the west coast. All four institutions have large engineering populations. For each institution we have shown the estimated total engineering student population using university supplied class sizes. We have also included the number of students who responded to the instrument, and computed the overall response rate.

Table 1. Participating Universities with Corresponding Completed Surveys and Response Rates

<table>
<thead>
<tr>
<th>University</th>
<th>Upper-class Engineering Population</th>
<th>Completed Surveys</th>
<th>Attempted Surveys</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPUB</td>
<td>2933</td>
<td>463</td>
<td>621</td>
<td>21.17%</td>
</tr>
<tr>
<td>MPUB</td>
<td>2673</td>
<td>289</td>
<td>391</td>
<td>14.63%</td>
</tr>
<tr>
<td>SPUB</td>
<td>748</td>
<td>113</td>
<td>151</td>
<td>20.19%</td>
</tr>
<tr>
<td>WPRI</td>
<td>982</td>
<td>152</td>
<td>198</td>
<td>20.16%</td>
</tr>
<tr>
<td>Total</td>
<td>7336</td>
<td>1017</td>
<td>1361</td>
<td>18.55%</td>
</tr>
</tbody>
</table>

Upper-class students, those in their third year or beyond, were chosen for the sample because students in their first and second years would not have had much exposure to information about graduate school. Table 2 contains summary demographic information for the students from each of the four institutions in the sample.

Table 2. Summary Demographic Information for Participating Institutions

<table>
<thead>
<tr>
<th>University</th>
<th>Sex</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPUB</td>
<td>28% Female (130) 72% Male (333)</td>
<td>78% Caucasian (361) 3.0% Hispanic (14) 4.1% International (19) 8.4% Asian/Pacific Islander (39) 2.4% African American (11) 4.1% Prefer Not to answer (19)</td>
</tr>
<tr>
<td>MPUB</td>
<td>37% Female (107) 63% Male (182)</td>
<td>63% Caucasian (182) 2.1% Hispanic (6) 12.4% International (36) 16% Asian/Pacific Islander (46) 2.8% African American (8) 3.8% Prefer Not to answer (11)</td>
</tr>
<tr>
<td>SPUB</td>
<td>30% Female (34) 70% Male (79)</td>
<td>50% Caucasian (56) 3.5% Hispanic (4) 5.3% International (6) 21% Asian/Pacific Islander (24) 15% African American (17) 5.3% Prefer Not to answer (6)</td>
</tr>
<tr>
<td>WPRI</td>
<td>43.3% Female (66) 57% Male (86)</td>
<td>51% Caucasian (77) 9.2% Hispanic (14) 6.6% International (10) 26% Asian/Pacific Islander (40) 2.6% African American (4) 4.6% Prefer Not to answer (7)</td>
</tr>
<tr>
<td>Total Sample</td>
<td>33% Female (337) 67% Male (680)</td>
<td>66% Caucasian (676) 3.7% Hispanic (38) 7% International (71) 15% Asian/Pacific Islander (149) 3.9% African American (40) 4.2% Prefer Not to answer (43)</td>
</tr>
</tbody>
</table>
In addition, information about the students’ major, year in program, graduate degree(s) being considered, and participation in undergraduate research was also collected. These will be outlined and discussed further as part of the study results.

B. Data Collection

Data were collected via an online survey administered through a commercial web interface. Faculty or administrators from each of the participating institutions sent survey invitations through undergraduate student listservs with a link to the survey. This link directed participants to another website with the questionnaire. To ensure student responses remained protected, survey information could only be viewed by the research team. As an incentive, students who completed the instrument were able to enter a drawing for a gift card. Following the recommendations of Laguilles et al, incentives were used in an attempt to increase the overall response rate for each institution\textsuperscript{11}. Traditional online surveys have a volunteer response rate of approximately 10 percent\textsuperscript{12}, and through the use of incentives we were able to raise our overall response rate to 18.5 percent.

Each institution received a customized version of the same survey instrument; only the demographic items were modified for institution-specific degrees or programs. Each survey remained active at the participating institution for a period of three weeks, with two reminder emails sent during that timeframe. Once the surveys had closed for each university, the data were downloaded, compiled for individual institutions and then integrated into a single data set for analysis.

1. Survey Instrument

This study represents section of a larger research agenda on recruiting and retaining graduate students in science and engineering. As part of this work we conducted a year of ethnographic observations and interviews with graduate research groups and undergraduate students. These interviews and observations were analyzed\textsuperscript{13, 14}, separately and used to develop a pair of instruments for graduate and undergraduate students respectively. Additionally, these qualitative data provided several working hypotheses that form the basis for this study. Detailed information about the survey development can be found in [citations blinded for review]. The undergraduate survey contains five sections. The first section gives a short overview of the purpose of the instrument and asks obtains participants consent. In addition to demographic information, the core of the survey contains a variety of five-point Likert items, multiple choice, check all that apply, and yes or no questions about graduate school. The Likert statements deal with topics such as self efficacy, student expectations, potential misconceptions, goals, barriers and support as they relate to research, graduate school, and career goals. These items were developed as a result of the ethnographic observations and interviews. Other questions examine how participants have interacted with other graduate students, what they view as the reasons to attend (or not attend) graduate school, when and where they might attend and what type of graduate degree they consider pursuing. The final section asks a single open ended question that probes any other thoughts, opinions, or information students have about their decision making process.
Four versions of the same survey were developed with appropriate differences in wording. To ensure content validity, the instrument was reviewed by student participants in the ethnographic observations, and then reviewed by several members of the project advisory board from the participating institutions. These reviews helped ensure the wording was accurate and the questions could be easily understood by a broad population. Finally a pilot test was conducted with approximately 50 participants from the host institution. This was accomplished to validate the instrument, ensuring the constructs developed during the ethnography and guided by the literature were measuring what we intended. Results of the pilot test indicated adequate internal consistency\textsuperscript{15}, and a few more modifications were made to the final instrument to account for any additional comments from the pilot. The final surveys were administered in the fall of 2010 at the four participating institutions.

C. Data Analysis

All Likert items contained a scale from 1-5, so descriptive statistics were computed, including the mean, standard deviation and variance for each item in the instrument. Due to the length of the instrument, these items are not reported individually in this paper; however detailed information is available by request from the first author. Demographics from the sample were summarized along with summary statistics for the non-Likert items. Several questions asked the participants to “check all that apply” from a list of available choices, and the percentages were computed for each of these items. Likert items belonging to one of the four SCCT themes were then organized together, and a Pearson correlation analysis\textsuperscript{16} was used to highlight significant contributing items as well as examine relationship between items.

IV. Results and Discussion

During instrument development, sections of questions were developed using data gathered from the ethnographic observations and interviews in combination with SCCT themes. These questions, combined with those from the literature, form the basis of the following sections of analysis: student self efficacy, outcome expectations, goals, and barriers and support. In another section of the survey (separate from the Likert items), we asked students to indicate the various reasons to attend or not to attend graduate school by selecting applicable items from a list. A discussion of these results will follow at the conclusion of this section.

A. Student Self Efficacy Regarding Graduate School

Several items were developed to measure student self efficacy as it relates to attending graduate school in engineering. Intent to attend graduate school was the dependent variable of interest, which was measured using the following Likert statement: “I am planning on attending graduate school in engineering.” Each of the self efficacy related statements is listed in Table 3 along with their corresponding mean for the entire sample. In addition, we have shown the Pearson Correlation Coefficient relating each self efficacy question to the student’s intent to pursue a graduate degree.
Table 3. Elements of Student Self Efficacy toward Graduate Education (1 being strongly disagree to 5 being strongly agree)

<table>
<thead>
<tr>
<th>Self Efficacy Term</th>
<th>Sample Mean</th>
<th>Correlation with Intent to Attend Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I decided to go to graduate school I would be successful</td>
<td>4.02</td>
<td>0.34</td>
</tr>
<tr>
<td>I can see myself as a graduate engineering student</td>
<td>3.76</td>
<td>0.78</td>
</tr>
<tr>
<td>I am comfortable teaching myself how to do things</td>
<td>3.75</td>
<td>0.2</td>
</tr>
<tr>
<td>I would be good at research</td>
<td>3.53</td>
<td>0.27</td>
</tr>
<tr>
<td>I’m worried that if I apply to graduate school I won’t get accepted</td>
<td>3.24</td>
<td>0.009</td>
</tr>
<tr>
<td>I understand what would be expected of me in graduate school</td>
<td>3.08</td>
<td>0.2</td>
</tr>
<tr>
<td>If I attended graduate school I would really be on my own</td>
<td>3.00</td>
<td>0.009</td>
</tr>
<tr>
<td>I understand what’s involved in applying to graduate school</td>
<td>2.79</td>
<td>0.2</td>
</tr>
<tr>
<td>Graduate school is something that other people do, not me</td>
<td>2.12</td>
<td>-0.48</td>
</tr>
</tbody>
</table>

These results indicate that students largely disagree with the statement that graduate school is for other people, meaning that they consider graduate school as something they could do if they wanted. This statement was negatively correlated with their intent to pursue a graduate degree (r = -0.48), confirming our assumption that students who disagreed with this statement are more likely to attend graduate school. On the positive side however, results indicate a strong correlation with being able to see themselves as a graduate student and their intent to attend (r = 0.78). Students showed high levels of perceived self efficacy both in their ability to teach themselves new things and in their ability to be successful in graduate school. Finally the prospect of being on their own or not getting accepted to graduate school does not appear to contribute at all to a student’s decision to attend. Both these items have extremely low correlations at 0.009.

These results indicate that students’ ability to envision themselves as graduate students is the largest self efficacy contributor to their intent to pursue graduate education. This is also visible in their strong disagreement with the statement that graduate school is for other people, not them. Although the level of correlation is not as strong, students agree that they would be successful as graduate engineering students (mean = 4.02) and feel that they would be good at research (mean = 3.53). In addition to self efficacy, SCCT indicates that students’ outcome expectations about possible career choices will affect their decision. In the next section, we consider several expectations about graduate school that may influence a student’s decision to attend.

B. Students’ Outcome Expectations of Graduate School in Engineering

Outcome expectations focus on the consequences someone believes will occur as a result of performing the task or behavior. Participants are in agreement that attending graduate school will create more opportunities (mean = 4.12), and this is correlated relatively well with their intent to pursue an advanced degree (r = 0.43). Students agree that completing a PhD would take
too much time (mean = 3.65); however, this does not correlate with their decision to pursue a graduate degree. Interestingly, students do not feel that having a PhD would make them overqualified to work in industry, nor do they agree that only people who teach should get a PhD. In fact, other than the creation of more opportunities, none of the other suspected outcome expectations correlate with the decision to attend graduate school.

Table 4. Student Outcome Expectations Regarding Graduate Education (1 being strongly disagree to 5 being strongly agree)

<table>
<thead>
<tr>
<th>Outcome Expectations</th>
<th>Sample Mean</th>
<th>Correlation with Intent to Attend Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attending graduate school would create more</td>
<td>4.16</td>
<td>0.43</td>
</tr>
<tr>
<td>opportunities for me</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completing a PhD would take too much time</td>
<td>3.65</td>
<td>-0.16</td>
</tr>
<tr>
<td>Graduate school will be similar to my undergraduate program except with harder classes</td>
<td>3.00</td>
<td>-0.06</td>
</tr>
<tr>
<td>Having a PhD would make me overqualified to work in industry</td>
<td>2.82</td>
<td>-0.03</td>
</tr>
<tr>
<td>Only people who want to teach get a PhD</td>
<td>2.53</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

These results indicate that students have a fairly clear understanding about some of the “myths” of graduate school; i.e. only people who want to teach get PhD ‘s and that a doctorate makes you overqualified for work in industry. However it is a bit concerning that students do not disagree that graduate school would be similar to undergrad except with harder classes. This may be an indication that there are still some misconceptions present about what it is like to be a graduate student, beyond the potential future career outcomes.

C. Impact of Student Career Goals

The final major component of SCCT concerns student goals. A goal is defined as a decision that an individual has made regarding his or her future objectives or plans. Behavior is organized and sustained based on these previously set goals. Generally, students agree that their undergraduate education has prepared them to make a decision about attending graduate school (mean = 3.39). The preparation to make an informed decision is slightly correlated with the decision to enroll at \( r = 0.165 \), indicating that there is a lesser connection than some of the more prominent items.

Table 5. Impact of Student Career Goals on Graduate School Attendance (1 being strongly disagree to 5 being strongly agree)

<table>
<thead>
<tr>
<th>Goals</th>
<th>Sample Mean</th>
<th>Correlation with Intent to Attend Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>My undergraduate education has prepared me to make a decision about attending graduate school</td>
<td>3.39</td>
<td>0.165</td>
</tr>
<tr>
<td>A graduate degree is required for the job that I want</td>
<td>2.95</td>
<td>0.39</td>
</tr>
</tbody>
</table>

What is more striking however is that students do not agree that a graduate degree is required for the job they want (mean = 2.95) and this correlates well with their decision to enroll in a graduate program (\( r = 0.39 \)). This presents an interesting scenario in which there is a disconnect
between what the future U.S. economy needs for innovation, and what graduating engineers want
in prospective employment. This is an area where additional research would be useful to explore
whether industry leaders are encouraging their potential employees to have advanced degrees or
whether students really feel that they are not required. In addition to the three main tenets of
SCCT, we have also asked students specific questions about potential barriers to attending
graduate school as well as what support programs or people are in place to guide them in their
decision.

D. Evidence of Barriers and Support to Attending Graduate School

Table 6 presents several items that were identified during the ethnographic observations and
interviews that may be perceived as barriers to attending graduate school; the financial burden
and having questions they could not get answered. Overall, students agreed that graduate school
would be difficult for them to afford (mean = 3.1) and not surprisingly this was negatively
correlated with their decision to enroll in a graduate programs. When asked if they were aware
that financial support was available in the form of a stipend, student agreement ranged from 47%
to 63% among the four universities surveyed. This indicates that while many students may not
be able to afford graduate school in engineering, they are not aware of all of the financial support
that may be available. Finally students disagreed that there were questions that they could not get
answered, however this was not correlated with the decision to enroll in graduate school.

In addition to the barriers to attending graduate school we also explored the types of support that
undergraduate students had within the university setting. We limited our focus to sources of
support within the university and academic setting, specifically related to graduate education,
and therefore did not include many other possible sources of support such as family, friends,
religious affiliation, other clubs etc.

Table 6. Perceived Barriers and Sources of Support for the Graduate School Decision (1 being
strongly disagree to 5 being strongly agree)

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Sample Mean</th>
<th>Correlation with Intent to Attend Graduate School</th>
</tr>
</thead>
<tbody>
<tr>
<td>I cannot afford graduate school</td>
<td>3.1</td>
<td>-0.18</td>
</tr>
<tr>
<td>I don't know who to ask the questions I have about</td>
<td>2.8</td>
<td>0.02</td>
</tr>
<tr>
<td>attending graduate school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My interactions with graduate students have been</td>
<td>3.85</td>
<td>0.157</td>
</tr>
<tr>
<td>positive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have discussed graduate school with current</td>
<td>3.29</td>
<td>0.24</td>
</tr>
<tr>
<td>graduate students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One or more of my professors have told me I should go</td>
<td>3.16</td>
<td>0.263</td>
</tr>
<tr>
<td>to graduate school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have discussed graduate school with engineering</td>
<td>2.68</td>
<td>0.353</td>
</tr>
<tr>
<td>professors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We expected to find that students who had positive interactions with potential role models within
the graduate school community would be more likely to enroll in a graduate program than would
students without these interactions. Students agreed relatively strongly that their interactions
with other graduate students have been positive (mean = 3.85), and this correlated slightly with a decision to enroll. While fewer students have discussed graduate school with current graduate students (mean = 3.29), this more strongly correlates with the decision to enroll in a graduate program. We also asked students about their interactions with faculty members in their engineering departments. Unlike their interactions with graduate students, overall participants had not discussed graduate school with engineering professors (mean = 2.68) and this correlated well with their decision to enroll (or not enroll). However we also asked students if one or more of their professors had suggested they go to graduate school. These results indicated student agreement (mean = 3.16) and a correlation of 0.263. At this time it is unclear as to why there is a difference in these two items, and future work will qualitatively explore the nature of undergraduate student interactions with engineering faculty and graduate students.

These sources of support and perceived barriers provide information about where students may have experiences or interactions that directly influence their outcome expectations or self efficacy about graduate school. The four themes, when taken together, help form a more complete picture about the decision making process of undergraduate students considering graduate school in engineering. Next we take a look at participant reports for the reasons to attend graduate school, or not to attend graduate school, and compare these to the previous results.

E. Student Thoughts on Reasons to Attend or Not Attend Graduate School

In addition to the individual Likert items, we also asked students what their primary reasons were for attending or not attending graduate school in engineering. Figure 1 shows the combined students responses from the four institutions.

![Figure 1. Participant Reasons for Attending Graduate School](image-url)
The top two reasons, to learn more (22%), and to have an advanced degree (22%), are followed closely by the desire to earn more money at 20%. The next closest reason is to learn how to do research at 11% followed by a requirement for a specific career (10%). Other reasons students indicated were as a fallback for not getting a job (9%), and to switch to another area of study (5%). These results were not unexpected, and confirm some of the earlier items about career goals and outcome expectations from the Likert questions. We were interested in what students thought were the reasons not to attend graduate school, shown in Figure 2.

The number one reason that students feel they should not attend graduate school is the fact that they cannot afford the tuition (18%). However, this stands in contrast to the report that nearly 50% of participants knew there was tuition support available. This indicates that students may not fully understand how the graduate support systems work, or the other financial opportunities available to them. Following close behind financial concerns was the fact that students just wanted a break from school (15%) and the thought that a graduate school would take too much time (15%). Other notable concerns were that their grades weren’t good enough (12%) and they need to start earning money to pay off student loans (11%).

Figure 2. Participant Reasons for NOT Attending Graduate School
Needing a break from school aside, many of these concerns could be addressed through a department workshop or small seminar to educate students on things such as the application process, financial possibilities in graduate school, and how this may ultimately lead to the activities they previously mentioned reasons they were considering graduate school. While eight percent of students felt that graduate school was not required for the career they would want, they may not have a good understanding of all of the possible careers available should they pursue an advanced degree. In addition, with more and more students completing bachelor’s degrees, a graduate degree may help to single students out for better jobs, or make them more competitive for the jobs they want upon graduation.

VI. Conclusions and Future Work

In this paper we presented the results of a survey which used SCCT to examine key factors that contributed to a student’s decision to enroll in graduate school. This instrument was administered at four institutions across the United States during the fall of 2010 and resulted in over 1000 responses. Results of the quantitative analysis indicate that the presence of role models and students’ perceptions of their chance of success and level of knowledge about several aspects of graduate school contribute to the decision to enroll. Using SCCT as a theoretical framework, we examined four constructs: self efficacy, outcome expectations, goals, and barriers and support. Specifically, a student’s ability to see themselves as a graduate student directly influences their self efficacy and directly contributes to their decision to attend graduate school. Students also agreed that they felt they would be successful if they attended graduate school in engineering.

In general, these data indicate that students do not have low self efficacy about their chance of success in graduate school. Regarding students outcome expectations, they strongly agree that attending graduate school in engineering would create more opportunities for them, but they also feel it would take too much time. The length of the program lessened the likelihood they would enroll despite the potential increase in salary and job opportunities upon completion. Interestingly, students goals do not appear to point towards graduate school; students do not agree that a graduate degree is required for the job they want. Considering the increased opportunities, the mismatch in goals may be interpreted as a lack of understanding about the types of job opportunities available with something like a master’s degree. This poses a new research area exploring the link between industry employers and graduate degrees. With so many companies sending their employees back to graduate school, many students may not be aware that they really need a graduate degree for the jobs they are applying for.

The final construct we explored with these data was potential barriers and support for attending graduate school. Overall, students feel that the financial burden is the biggest barrier to attending graduate school, even though over half reported knowing that many graduate students received financial support for tuition and other expenses. This contradiction indicates that students may not fully understand the types of financial support available, and what they really entail. This is something that universities can handle directly, by holding seminars for undergraduate students that may be considering graduate school, and explaining things like the admissions process, research and teaching stipends, and how graduate school is different from undergraduate programs. These would also provide prospective student’s access to current
graduate students and faculty, items that were shown to be strong supporting factors for the
decision to attend.

If students feel they would be successful in engineering, and that it would create more
opportunities for them, there must be reasons other than financial that are keeping them from
attending. As noted previously, 22% of the students surveyed indicated that the biggest reason to
go to graduate school was “to learn more”, however they are still enrolling at considerably lower
rates than their peers from other countries. These results indicate that information from
universities and industry employers to students is lost in translation; students do not appear to be
making the connection. Industry employers and Universities need to find new and better ways to
get the information about graduate school to their students, so that students are making a decision
to attend graduate school based on solid (and correct) information.

These results highlight one of the ways to examine the student decision making process for
graduate school in engineering. Future work will involve examining whether there are
differences present in the data based on demographic variables including gender, ethnicity,
academic department and university. In addition we plan to conduct an exploratory factor
analysis of the Likert statements to determine if other items contribute to the current SCCT
model.

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