

Understanding the role of knowledge related to financial resources on decisions to attend graduate school

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Abstract— Although many factors exist as to why students choose not to pursue graduate study, one significant barrier is the lack of knowledge regarding financial resources available to pursue such study. To explore this, we developed and launched a pilot survey that probed student career plans, current and perceived financial resources, perceptions about the application process for graduate school and the role of finances in their decision to pursue an advanced degree. We also interviewed three undergraduate respondents to further elucidate their views of the utility of graduate degrees in their field and how they went about gathering knowledge about the financial support available for graduate studies. The findings confirmed that most undergraduate students begin to consider graduate school as juniors and seniors. While the participants most often selected financial factors as influencing their graduate school decisions, interviews showed that students amassed financial knowledge from their acquaintances within industry or from graduate students in other disciplines.

Keywords—*financial aid, graduate school, funding sources*

I. INTRODUCTION

Over the next decade, there will continue to be increasing demand for people with engineering undergraduate and graduate degrees in academic, government, and industry sectors [1]. For example, from 2012 to 2022, bioengineering related positions are expected to grow by 27%, civil engineering by 20%, computer engineering by 7% and environmental engineering by 15%. In addition to the net increase of positions, an 18% increase in the number of jobs requiring master's (M.S.) degrees from 2008 to 2018 is also projected [2]. These predictions correlate with the authors' observations of local hiring demands relative to their institution. During a recent career fair, 39% of the companies registered indicated a desire to employ master's level STEM graduates [3].

Given that only 25% of students with bachelor's (B.S.) degrees in engineering earn a M.S. degree within 10 years of completing their B.S. [2], students with a master's degree seeking their first position are more competitive. To meet this demand from industry, universities must first focus on

increasing the number of students entering graduate programs and then on supporting those students persistence to graduation.

This study centers on understanding possible barriers for undergraduates within science, technology, engineering or mathematics programs (STEM) to enter graduate school. Researchers have postulated that a combination of factors influence a students' decision to attend graduate school in general or in non-STEM disciplines including the status of the economy [4], their academic standing [5], a desire to develop more skills prior to entering the workforce, and many other motivations [6, 7]. Although these factors, among others, may still exist for the student, the lack of financial resources and support may becoming a more significant barrier [8, 9]. It has been suggested that STEM students accumulating loan debt as undergraduates were less likely to pursue advanced study immediately upon graduation, a difficulty that is particularly relevant for STEM students of color [7, 10]. When asked why they choose not to pursue graduate study and immediately enter into the workforce, participants cited fear of accumulating more debt as the primary hindrance [8].

Therefore, this pilot study seeks to determine (1) when and how undergraduate students gain knowledge about options to finance graduate school; (2) how engineering undergraduates view finances relative to other factors when choosing if/where to attend graduate school; (3) how undergraduates perceive that they will receive the same financial support sources for their graduate program as they did their B.S. program; and (4) the extent to which undergraduate understanding of graduate school financial aid opportunities affect their preference towards entering an M.S. or Ph.D. program.

II. METHOD AND PARTICIPANTS

A. Participants

Participants for this study included both undergraduate and graduate students enrolled in engineering, science and mathematics programs at a southeastern public doctoral

university (The Carnegie Classification of Institutions of Higher Education™ was ‘Doctoral Universities: Highest Research Activity’).

B. Survey and Follow Up Interviews

A 39-item electronic pilot survey, focusing on demographics, perception of financial resources, and future goals for undergraduate and graduate student participants, was administered at the beginning of the spring 2016 semester. Items were developed based on the authors’ experience and were reviewed by other group members prior to launch. Potential participants were sent an invitation to the electronic survey through email. Participants who completed the survey were asked to indicate if they were willing to participate in a semi-structured interviews. Three individuals were selected to participate and were reflective of the diversity of the participant pool (range of student loan totals) and were considering both industry and research positions upon graduation. The interview transcripts were used to inform survey findings.

III. PRELIMINARY RESULTS AND DISCUSSION

A. Pilot Study

In this pilot study, 161 STEM students completed the survey, with respondents balanced between undergraduate students (51.6%) and graduate students (48.4%) respectively. Most were from engineering programs-undergraduate engineering majors (81.9%) and engineering graduate students (80.8%). This was admittedly a low response rate from the available cohort of approximately 5,500 undergraduate, 1000 masters and 850 doctoral level graduate students. Therefore, our inferences are limited to students from STEM programs that would complete an electronic survey focused on demographics, financial, and future goals for undergraduate and graduate student participants.

B. Undergraduate Student Participants

Undergraduate responses were mostly from in-state students (67.4%), who were primarily upperclassmen (54.2% seniors, 14.5% juniors, 19.3% sophomores, 7.2% freshmen). These participants self-identified as 3.6% Asian/Pacific Islander, 77.1% Caucasian, 6.0% African American, 3.6% Hispanic, 21.2% Middle Eastern and 4.8% selected ‘other’ while 3.6% did not disclose this information.

C. Graduate Student Participants

The study included doctoral students (Ph.D., 58.7%), those seeking a masters of science (M.S., 34.7%) and those within masters of engineering programs (M. Engr., 6.7%). The graduate participants were all from STEM programs-engineering (80.8%), mathematics (3.8%) and science

(15.4%). Unlike their undergraduate counterparts, most were from out of state (66.7%). Regarding demographics, most were Caucasian (59.2%) with the remaining respondents self-identifying as African American (4.0%), Asian/Pacific Islander (22.4%) Hispanic (7.9%), Middle Eastern (2.6%), and other (2.6%) and the remaining 1.3% did not disclose.

D. Determining When Students Began Considering Attending Graduate School

Current graduate students described when they began considering attending STEM graduate programs (Table 1). Most graduate students (53.8%) report that they began to consider graduate school during their junior and senior years of their undergraduate programs. A slightly higher number began considering pursuing a master’s level program after completing their undergraduate degrees (23.1%) than those considering a doctoral program (15.9%; Table 1). These percentages suggest that students are focused on completing their degrees early in their programs (freshman and sophomore) and only start to focus on career paths in later terms (juniors and seniors).

Table 1. Graduate survey participants were asked to identify when they began considering attending STEM graduate programs.

Degree Pursuing	M.S. (n = 26)	Ph.D. (n = 44)
In or Prior to High School	7.7%	6.8%
Undergraduate- Freshman or Sophomore Year	15.4%	11.4%
Undergraduate- Junior or Senior Year	53.8%	63.6%
After Completing Undergraduate Program	23.1%	15.9%
Don't Remember	0.0%	2.3%

E. Options After Undergraduate Degree Completion

Data suggests that some STEM undergraduates consider non-traditional careers after completing their undergraduate studies [11]. Specifically, Pantiz highlighted that engineers (a subset of STEM undergraduates) cross over into non-engineering jobs because the U.S. job market rewards their skills more highly in those disciplines rather than in the traditional engineering vocation [12]. To construct a survey item about career aspirations, we utilized the National Science Foundation (NSF) report *Restructuring Engineering Education* which highlighted the range of career aspirations considered by undergraduate STEM students. Table 2 shows that most undergraduates were interested in pursuing either a position within industry or a STEM graduate program.

F. Sources of Financial Support for Graduate School

To understand how students perceived their options for financial support, we asked our undergraduate respondents their views about the potential financial resources available for pursuing graduate study. We intentionally split undergraduates indicating interest in attending graduate school from those who did not (responses in Table 2). Both groups had a similar average GPA (Table 3).

Table 2. Undergraduate participants were asked to identify their interest in pursuing a range of career opportunities upon completing undergraduate study. The cohort was most interested in obtaining a job in industry or pursuing STEM graduate study. Students were also asked to identify if they had actively pursued the option by taking the necessary exams, researching positions, etc.

STEM Undergraduate Student Potential Futures (<i>n</i> = 83)	Reported Being Interested in Pursuing Option	Actively Pursued Option
Join industry in a science, technology, engineering or mathematics field	83.1%	77.1%
Attend graduate school in a science, technology, engineering or mathematics field	65.1%	54.2%
Obtain a Masters in Business Administration	12.0%	3.6%
Attend Medical Schooling (Dental, Medical, Pharmacy or Chiropractic)	10.8%	8.4%
Go into service work (Peace Corp, Teach for America, AmeriCorps)	8.4%	4.8%
Work within K-12 Education	3.6%	1.2%
Attend Law School	2.4%	0.0%

Table 3: The grade point averages of students intending to attend graduate school and not attend graduate school were not significantly different.

Undergraduate Participants	Average	STDEV
Interested in Grad School (<i>n</i> = 54)	3.40	0.46
Not Interested in Grad School (<i>n</i> = 29)	3.30	0.56

Table 4: Undergraduate participants were asked to identify the types of financial support they had received as undergraduates. Those anticipated attending graduate school were then asked to identify the types of support they anticipated to be available for graduate school.

	Undergraduate Students Interested in Pursuing STEM Graduate School		Undergraduate Students Not Interested in Pursuing Graduate School	
	<i>n</i> = 54		<i>n</i> = 29	
	Current Undergraduate Source	Anticipated Source for Graduate School	Current Undergraduate Source	Anticipated Source for Graduate School
Merit based scholarships	87.0%	72.2%	82.8%	10.3%
Need based grants	24.1%	27.8%	31.0%	6.9%
Student loans	55.6%	59.3%	51.7%	6.9%
Parent/family loans	24.1%	9.3%	24.1%	0.0%
Federal work-study program	3.7%	14.8%	10.3%	6.9%
Hourly position within the university during the academic year	37.0%	51.9%	34.5%	10.3%
Hourly position within the area during the academic year	18.5%	35.2%	24.1%	6.9%
Financial support from immediate family members	48.1%	20.4%	58.6%	6.9%

Participants indicated that they believed that the financial resources available during their undergraduate careers would not be the same as those used for their graduate programs (Table 4). The data reflects that students perceive a substantive decrease in support from immediate family (i.e. parent/family loans) and merit-based scholarships. Interestingly, but perhaps not surprisingly, those expressing no interest in pursuing graduate study indicated fewer potential sources of financial support. Clearly, the lack of student belief in financial support services for graduate study could be a primary barrier into graduate school.

G. Approaches for Applying and Accepting Graduate Programs

Undergraduates applying to graduate programs must select the number of programs to which they will apply. Graduates in our study applying to graduate programs (*n* = 78) typically applied to multiple graduate programs: single program (34.6%), two programs (11.5%), three programs (11.5%), four programs (11.5%), five programs (9.0%) and six or more programs (17.9%). When we consider only those undergraduate participants wishing to pursue an M.S. degree, 42.3% of applied to a single program.

H. Range of Acceptances and Financial Offers Experienced by Applicants

The students participating in this study were all accepted to graduate school and therefore, we cannot comment on the experience of all applicants not accepted into graduate programs. The graduate students reported that when accepted into graduate programs, 26.6% received no offers with financial support. This impacted a higher number of M.S. applicants than Ph.D. applicants. Half of the M.S. applicants received no support with offers while only 6.8% of Ph.D. students confirmed that they were accepted without any support from any institution. The role of finances plays a substantial factor for students accepting offers. When considering offers, the participants responded that the largest factors were the personal fit within the institution (70.7%), financial incentives (66.7%), advice from an advisor (52.0%) and the date the offer was received (25.3%). It should be noted that respondents could select all responses and this is not a ranked list.

I. Understanding Financial Need of Graduate Students

Understanding the financial barriers of graduate students cannot be obtained through traditional data sources. Unlike undergraduate students, many graduate students do not complete a 'Free Application for Student Federal Aid' (FAFSA) application. We determined that while 86.7% of the undergraduate study participants completed a FAFSA, only 24.0% of the graduate study participants reported that a FAFSA was submitted. Programs that are required to award assistance based on financial need, calculated by subtracting the estimated family contribution from the cost of attendance, are limited in doing so.

J. Insight from Undergraduate Interviews

The follow-up semi-structured interviews provided additional insight into the perceptions STEM undergraduates have about graduate school. Three of the participants (Ava, Dexter and Jordan) were all engineering majors in either their junior or senior year of college. Two students (Ava and Dexter) were interested in pursuing a Ph.D., and the other (Jordan) was interested in pursuing an M.S. (Table 5).

Table 5: Summary of undergraduate interview participant's college level, major, and graduate degree of interest.

	Ava	Dexter	Jordan
College Level	Junior	Junior	Senior
Major	Chemical Engineering	Bioengineering	Environmental Engineering
Graduate Degree of Interest	Ph. D.	Ph. D.	M. S.

During all three interviews, each participant articulated that they could either attend a STEM graduate program or go into an industrial position. The importance of attending graduate school to achieve their professional goals was less clear. From observation of STEM graduate students, Ava noted that:

"... she does a lot of research that contributes to academia but not (...) practicality ... there's no promise that it will actually (...) be put out into a plant ..."

However, Ava also commented that graduate school would give her the technical knowledge and options. When Ava was asked if she had looked into applying for graduate school, she placed emphasis on the fact that she was *"Just trying to get through undergrad."* From talking with other students, she has the impression that students pick research areas based on research experiences provided within a senior level course. Dexter conveyed in great detail the procedure for applying to graduate school (studying the respective research emphases at different institutions, touring campuses, completing the GRE).

K. Clarity of Graduate School Costs

Most strikingly, neither Ava, nor Dexter nor Jordan discussed the common financial resources used by graduate students. While Dexter was unsure how to support his graduate work, he was sure that it was possible. Ava, however, said that the lack of knowledge of financial options was deterring her from applying to graduate school.

"I would assume everything's just like even worse than undergrad financially.... I don't really know how the finances would go and I think that's one of the reasons why I'm just on the border line."

The transparency of graduate school costs was not the same as undergraduate costs to Ava. She identified that there was no tiered tuition cost structure for her undergraduate programs and she was confused by the tiers of graduate school tuition. To gain information about graduate school costs, Ava spoke with non-STEM graduate students and graduates who went directly to industry.

"... they always tell us how much people make like starting out, they never tell us how much like it costs to go to do something else. So, you never can make that comparison."

She had not spoken about financial costs with people who went to graduate school. Instead, she talked about costs with

people she knew who transitioned directly into industry. Not all undergraduates undertake research on the range of available graduate programs. Jordan described working for a research advisor during her undergraduate program. After her mentor moved to a different university, her mentor encouraged her to attend graduate school and promised to provide both a stipend and tuition assistance.

"If we're being really honest, I'm going there because I have this opportunity. I don't think I would have actively sought out going somewhere else just because I'm not sure. My GPA isn't the highest."

The interviews also indicated that students have a perception that M.S. funding is more difficult to obtain than Ph.D. funding. Jordan articulated,

"I met with the department chair there and she said that if I wanted to continue to get a Ph.D., they would find a way to do that. So I think it might be more readily available if you are interested, at least from my little group of friends. If you're interested in your Ph.D., that's – you might find funding more that way than just a master's degree."

IV. CONCLUSIONS AND FUTURE WORK

This work highlighted that many students do not perceive that the same number of financial resources will be available for graduate school as has been available during their undergraduate programs. These students are less likely to pursue graduate school. This work points to the role of financial social capital, networks of relationships who provide financial knowledge, in increasing the number of students pursuing STEM graduate programs.

V. IMPLICATIONS

The results from this pilot work show that STEM undergraduate students considering graduate school are not fully aware of the financial resources available to them. Therefore, the implication for those colleges and universities wanting to increase the number and perhaps diversity of students applying to graduate school is that they must identify mechanisms for informing these students. One possible mechanism to improve financial social capital is to form a *Community of Practice* as proposed by Wenger and colleagues [13-15]. While placing the students in a community of practice can allow for "legitimate peripheral participation" in their field, they can be used to improve social capital of participants.

In the future, the authors will focus on how financial social capital affects persistence through B.S./M.S. degrees. Many graduate programs in the U.S. allow students to accelerate their master's level studies by permitting students to apply a limited number of graduate level courses taken during the undergraduate timeframe to both the student's undergraduate and graduate degree requirements. Often, these programs require the student to have a high GPA, limit the number of credits applied between programs, require a form application that is reviewed by faculty and/or administrators for approval. Analysis of data from the author's institution show that only 64% of students accepted into this program enrolled as graduate students in the program.

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