

Challenges and Benefits of Applied Experience as an Engineering Returner in a Ph.D. Program

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I. Introduction

This research paper describes the experiences of returning students, defined as those PhD students with 5 or more years out of school between their undergraduate and doctoral degrees, who represent a largely overlooked pathway through advanced engineering education. Returners contribute to the diversity of perspectives and experiences necessary to address the complex global problems of our contemporary society. Given prior applied work experience in an engineering context, returners are likely to be aware of relevant engineering problems. Additionally, returners' combination of applied engineering work experience and advanced academic training may position them well to draw on both perspectives in developing innovative engineering solutions. Creative cognition theory suggests that innovation may thrive at intersections, including the combination of ideas from multiple contexts⁹. However, returners represent a relatively small proportion of engineering PhD students and the limited research about their experiences suggests they may face particular challenges in their doctoral studies compared to their direct-pathway peers (students who pursue a PhD shortly after their undergraduate education). In an effort to learn more about returners' perspectives, experiences, research, and approaches to engineering problem solving, our team designed and implemented what is, to our knowledge, the first large-scale mixed-methods study comparing returning and direct-pathway engineering PhD students. We draw on Eccles' expectancy-value theory (EVT), which describes achievement-related decision making as a function of an individual's expectancy of success at a given task and the values, including costs, they associate with that task. In this research paper, we focus specifically on how returners perceive the costs associated with their engineering work and how their experiences as returners and associated costs may shape their academic work and experiences.

II. Background

In engineering, the majority of students who pursue a PhD do so shortly after earning their undergraduate degree¹. The average age of students completing an engineering PhD is 30 which, estimating 5 years to complete a PhD, suggests many students begin their engineering doctoral study less than 5 years after their undergraduate study². While there may also be variations in time to degree across students, this graduation age data suggests returners with significant time between their degrees are in the minority within engineering programs. However, because returner status is not a commonly tracked demographic trait, little is known about variations in students' paths through doctoral programs.

Similarly, there is little research about the experiences of returning students at the doctoral level, particularly within engineering programs. However, research that exists on returning students at the undergraduate and graduate level across different academic fields suggests that returners may face distinct challenges. Common admissions requirements, such as the GRE, may be more likely to pose a challenge for returning students, as scores older than 5 years are typically not accepted and information on the exams that may be familiar to recent graduates may be less easily recalled by returners¹. Further, there is research that suggests the GRE disproportionately underestimates the chances of academic success for women over 24³. Returners may also face challenges once admitted, like a lack of recent experience with foundational mathematics or

having different work styles than their direct-pathway peers¹. It may also be more likely that returning students have additional family responsibilities related to childcare or care for aging parents that present an additional challenge to balancing academic and personal duties^{5,6}. In light of these differences, literature suggests returning students may feel out of place or unwelcomed in their graduate programs^{1,5}. An earlier qualitative study of engineering doctoral returners by two members of our team⁷ supports these findings and suggested returners face a number of costs, including those related to finances, balance of work and personal responsibilities, their level of academic preparedness, and adapting to the cultural environment of engineering PhD programs.

Despite these challenges, having extensive prior work experience before pursuing PhD work may prove to be valuable for returners' academic work. Returners have a wide range of past personal and professional experiences, which may include work in education, industry, government, or the military, that can inform their doctoral research⁸. Drawing on experiences and ideas from multiple contexts, which for returners may include their work context and doctoral program context, can be a source of innovation⁹. Further, returners bring an understanding of real-world engineering needs to their academic work, and their academic work may have more immediate applications within the engineering community⁷. Peters and Daly⁸ shared the example of one returning student who sought a PhD to address an issue that arose in her industry work experience with the plan to pursue work related to that issue upon completing her degree. One study on adult undergraduate returners suggests that, because of their past personal and work experiences, mature students were highly motivated and goal-directed¹⁰.

Returners also represent a new pathway through engineering education and add diversity of perspectives and experiences to graduate engineering programs. There are numerous, well-documented benefits of diverse teams, in terms of increased problem-solving capacity, broader perspectives, and more innovative solutions^{11, 12, 13, 14, 15}. Thus, returners' distinct experiences and perspectives may positively contribute to the research work of their teams and departments as well.

III. Theoretical Framework

Eccles'¹⁶ expectancy-value model informed our survey development and analyses of returners and direct-pathway students' experiences and perspectives that potentially shape their decisions to enroll and persist in their engineering doctoral programs. Expectancy-value theory (EVT) suggests that achievement-related decisions reflect individuals' expectations of success or competence beliefs related to a particular task, and the subjective task value they associate with a given option^{17, 18, 19}. These beliefs and values are shaped by individuals' personal identities, past experiences, the social context in which they are embedded, and their interactions with a given set of cultural norms^{18, 19}. Eccles and colleagues identify four types of subjective task value:

- Interest-enjoyment value: the extent to which an individual anticipates enjoying an activity. This type of value is likely to be integrated into an individual's self-concept.
- Attainment-achievement value: how a choice aligns with an individual's personal needs, values, and identity. This includes an individual's perception of the extent to which a choice reflects their personality, goals, and ideal images of self.
- Utility Value: how a choice is perceived as advancing a more externally held, practical goal, such as financial reward.

- Relative cost: the anticipated sacrifices associated with a given choice. These may include the effort or time required, or the psychological toll of engaging in a particular activity.

Though cost was originally conceptualized by Eccles and colleagues^{17, 18, 19} as one component of subjective task value, there are increasing calls for considering cost in greater detail as a separate component of an expectancy-value, or expectancy-value-cost, model^{20, 21, 22}. Flake et al.²¹ advocated for examining cost as a separate factor, distinct from value, as they argued students cite experienced or anticipated costs as separate from their perceptions of values and that these costs are directly linked to educational outcomes. There have been several efforts to characterize different types of costs that may differently affect students' achievement-based decision making and other outcomes. The difficulty of a given task has long been recognized as part of the cost associated with a task^{23, 24}. More recent studies^{25, 26}, explored the loss of valued alternatives as another potential element of cost. Battle and Wigfield²⁷ attempted to develop a multidimensional scale measuring the costs associated with women's pursuit of graduate study. They intended for their scale to capture the effort required and the loss of valued alternatives as a result of choosing to pursue graduate study, as well as the psychological cost of failure and feelings of ambivalence about the worth of a graduate degree given possible consequences. However, only 9 of their original 24 items loaded on a single factor, with other items discarded due to cross loadings. Building on Battle and Wigfield's²⁷ work, Perez, Cromley, & Kaplan²⁸ developed and tested a three dimensional cost scale that captured the cost of effort, opportunity cost (or loss of valued alternatives), and psychological costs associated with majoring in a science field. They found all three cost subscales were significantly and negatively related with students' intentions to persist in science, with the effort subscale having the strongest negative relationship with persistence. Informed by Perez et al.'s evidence of potential multidimensionality of the cost construct, Flake et al.²¹ developed a new cost scale intended for broader use in an academic context. Similar to the scale developed by Perez and colleagues, Flake et al.'s scale included task effort, loss of valued alternatives cost, and emotional cost. Flake et al. also suggested a new dimension, the cost of outside efforts, related to other demands on an individuals' time and energy that may increase the cost associated with a particular task. Their preliminary analyses suggested that all four dimensions of cost were negatively associated with students' expectancy of success, value, and a number of student outcomes including academic performance, long-term interest in a domain, and overall motivation.

In parallel to many of the recent efforts exploring cost in greater depth, our team has been studying the particular costs returners associate with pursuing a PhD (as well as their values and expectancy of success). Our teams' earlier qualitative study⁷ also suggested several distinct types of costs returners associated with pursuing an engineering doctorate, including financial burden, balance between academic and other responsibilities, intellectual challenges, and adapting to a different culture and work environment. Grounded in these qualitative findings, in a subsequent study²⁹ we developed and tested a scale intended to measure the costs returners and direct-pathway students associate with earning an engineering PhD. Consistent with findings from our team's earlier qualitative study and recent literature on the multidimensionality of cost as a separate construct within the expectancy-value model, our analyses suggested our cost scale was

comprised of three distinct latent cost types: balance, financial, and academic cost. Balance cost reflects the level of challenge that students face managing both their academic and personal responsibilities (such as family, household, or community duties) and feelings of regret or stress resulting from having to make difficult decisions about how they allocate their time. Financial cost refers to students' perceived challenges related to both expenses associated with doctoral study and opportunity costs related to devoting time to their degree instead of potentially more lucrative employment. Academic cost reflects students' challenges related to both the cultural and academic demands associated with pursuing a doctoral degree, and does not exclusively reflect their sense of self-efficacy in engineering.

IV. Methods

Limited empirical literature suggests returning students may face distinct challenges related to their decisions to pursue engineering doctoral study. Our team's prior work^{7, 29} suggests Eccles' expectancy-value theory is a useful lens for examining the differences in returning and direct-pathway students' decisions to enroll and persist in engineering PhD programs. Consistent with this literature and recent calls for a more in-depth theoretical focus on the dimensions cost within the EVT model and how cost relates to a number of student outcomes, in this paper we focus exclusively on the cost component of expectancy value theory. Specifically we ask: a) how returning students differently perceive the costs associated with an engineering PhD and b) how, if at all, these costs shape their PhD work. We explore these questions using a mixed methods approach that draws on quantitative findings from a survey of returning and direct pathway students in conversation with qualitative findings from interviews with returning and direct-pathway students. Our choice of a mixed methods analysis in this paper is motivated by our research questions, as we employ both a triangulation strategy to understand how returners may differently experience the costs associated with a PhD through both quantitative and qualitative data, as well as an explanatory strategy to understand how returners' academic work may be shaped by these costs, using quantitative data to understand the role of returner status and cost on research productivity, supported by qualitative data of returners' accounts that provide additional insight into the relationship between returner status and their academic work³⁰.

A. Development and Content of Measures

Quantitative data for this study come from the Graduate Students Experiences and Motivations Survey (GSEMS), developed by our team explicitly for the purpose of exploring the experiences of returning and direct-pathway students. Our development of the GSEMS built on findings from an earlier qualitative study⁷ that suggested Eccles' expectancy-value theory was an appropriate framework for understanding returners' achievement-based choices to pursue and persist in an engineering PhD. The instrument development process was also guided by literature on returning students in a variety of disciplines, literature on survey development best practices^{31, 32, 33, 34}, and the first-hand experiences of our diverse team as advisors to returners, industry professionals, and a former returner herself. We conducted think-aloud interviews to check for the interpretability and promote greater validity of our initial survey draft and revised it to reflect feedback from these sessions³¹. With the goal of gaining a better understanding of the specific experiences, backgrounds, and perceptions of returning and direct-pathway students, the GSEMS instrument covered a number of questions related to 11 primary topics:

- demographic information,
- academic background information,
- current academic information,
- pre-PhD activities and career,
- decision to pursue a PhD,
- expectancy of success in the doctoral program,
- values of the PhD,
- costs of the PhD,
- cost reduction strategies,
- advising relationship, and
- post-PhD plans.

Additional information about our survey development process can be found in our team's earlier papers^{29, 35}.

Building on the survey phase of our study, we developed a follow-up interview protocol with the goal of gaining a more in-depth understanding of returning and direct-pathway students' decisions to pursue a PhD, pre-PhD experiences, processes of choosing a research topic, and the ways their past experiences shaped their PhD experience. Our interview questions were intended to expand upon some of the areas explored in our quantitative phase and were also shaped by the graduate education literature and findings from our team's earlier work^{7, 36}. We looked to literature on best practices for interview design and conduct^{37, 38, 39} to guide our process. We piloted our interview protocol with several returning and direct-pathway engineering PhD students or recent graduates who were not a part of our survey sample. Feedback from participants in our pilot interviews helped us to test and refine our protocol.

Our final interview protocols addressed seven primary topics: 1) an introduction to the interview and basic background information about a participant's current position in their PhD program, 2) a characterization of their pre-PhD work and research experiences, 3) their process in deciding to pursue a PhD, 4) characterization of academic experiences and their doctoral research, including the progression of their research agenda, 5) students' plans upon completing their PhD, 6) a hypothetical research scenario aimed at capturing various elements of their research process and related past experiences, and 7) how students believe their past experiences shaped their doctoral work. Data for this paper primarily come from students' characterizations of their academic experiences and research and their perceptions of how their past experiences shaped their doctoral experience, but we drew on information across all areas of the interview protocol in our analyses.

B. Participants and Data Collection

The GSEMS was distributed to domestic returning and direct-pathway students in several waves from October 2012 through February 2013. Because returning students are not typically a tracked demographic at U.S. institutions, we used several purposeful sampling strategies that allowed us to recruit a roughly balanced pool of returning and direct-pathway students. We began our data collection efforts with institutions in the Midwest and gradually expanded to schools across the country, emphasizing institutional diversity but also targeting those institutions with sizable engineering doctoral enrollments. Ultimately, we contacted engineering graduate chairs from 84 universities asking them to distribute an initial screening survey that

included questions about students' undergraduate and graduate degree completion and start dates. Thirty-one of the graduate chairs contacted agreed to distribute our screening survey. Of the students who completed our screening survey, we surveyed all returning students and an approximately equally sized random sample of direct-pathway students from each institution (rounding to the nearest 5). We also identified individual students from the NSF Graduate Research Fellows database and distributed screening surveys to all fellows and semi-finalists who began doctoral study in engineering within 3 years prior to our data collection. Finally, we engaged in limited snowball sampling to identify additional returning students. Early waves of our survey included a question at the end of the instrument asking individuals to identify returners who might be interested in participating. We then reached out to those students directly.

In total, the survey yielded 476 complete responses, 179 of which were from returning students. Females accounted for approximately 35 percent of our total survey responses (compared to 22.2 percent nationally) and 14 percent of respondents were underrepresented minorities (defined as those students who identified as Hispanic/Latino/a, African American or Black, American Indian or Alaska Native, and/or Hawaiian Native or Pacific Islander), compared to 11.9 percent nationally⁴⁰. Most students had a bachelor's degree in engineering, though 20 percent had a background in another field, including other STEM fields and even social science and humanities fields. We elected to survey only domestic engineering doctoral students, as we did not believe we would be able to effectively account for the wide range of "typical" paths to degree internationally.

We recruited interview participants from a pool of GSEMS participants who indicated they were willing to be contacted for an interview about their experiences. We selected several institutions with large numbers of willing interview participants to recruit participants for in-person interviews. We emailed all survey participants who indicated their willingness to be contacted at each site and provided several days and times that a member of our team would be on their campus conducting interviews (at a specific location of their choosing). The majority of our participants (39 of 53) were recruited this way and we conducted in-person interviews at 9 different institutions. However, to ensure we captured student experiences at a wide variety of institutions, we supplemented these interviews with an additional 14 conducted via Skype. One researcher conducted all interviews over 6 months. The majority of interviews ranged between 45 and 90 minutes, with the longest interview lasting 2 hours.

In our interviews, we sought to capture the experiences of a diverse array of students, not only in regards to institution, but in returner status, gender, race/ethnicity, and academic field. Approximately 40 percent (n=21) of our participants were female and approximately 15 percent (n=8) were underrepresented minorities. Interview participants came from a range of engineering fields, including mechanical, electrical, civil, biomedical, and aerospace engineering, computer science, and engineering education.

C. Analysis

Our quantitative analyses involved several ordinary least squares regression models. The first three of the analyses reported in this paper are regressions exploring how of a number of academic and personal traits, including returner status, relate to students' perceptions of three types of costs. These cost analyses come from our teams' prior work²⁹ on the returning and direct-pathway students' expectancies of success and serve as the impetus for our current in-depth exploration of the costs returners experience and how their experiences, including costs,

shape their academic work. In these regressions, we use previously derived regression factor scores from our validated²⁹ academic, financial, and balance cost scales as continuous outcome measures. Independent variables in each of these three models include returner status, other demographic characteristics, and a number of variables informed by literature that suggests possible complicating factors of students' graduate experiences, including workload, necessity to self-fund, academic background, academic performance, and research spending as a proxy for institutional type and resources^{1, 4, 5, 6}. For the purposes of our analyses, returner status was defined as having a total, though not necessarily continuous, gap of five or more years not enrolled full-time in school between completing their first undergraduate degree and beginning their current PhD program. More information on these analyses can be found in Mosyjowski et al.²⁹.

Our other quantitative measure, new to this paper, is an ordinary least squares regression analysis of students' research productivity as related to a number of personal and academic traits, including returner status, time in degree program, prior degrees, and students' perceived academic costs. Research productivity, our dependent variable in this model, is measured by a 13 item index (minimum score 0, maximum score 13) totaling a number of research milestones and is treated as a continuous variable. Sample items in this index include data collection, presenting at a conference, and having a journal article accepted for publication. A full list of items that comprise this index is included in the footnotes of Table 2. Regression diagnostics (a Breusch-Pagan/Cook-Weisberg test, in this case) suggested likely heteroskedasticity in our regression model, which we accounted for by using robust standard errors.

Qualitative analyses reflected a systematic, multi-step process. Motivated by findings that returners perceived consistently higher levels of cost associated with their PhD, we analyzed interview data for the ways returning students perceived their experiences as returners shaped their PhD experiences, both in regard to the challenges they faced and the ways their experiences as returners positively shaped their academic experiences and work. Audio recordings of interviews were transcribed and reviewed for accuracy. After one team member provided several example passages, two undergraduate coders reviewed all transcripts, using an inductive analysis approach to identify emergent themes related to how returner status shaped students' experiences. After identifying all relevant passages and independently developing a list of themes, the two coders reviewed and combined their analyses. Their final list of themes was reviewed by the first author of this paper and refined and clarified through group discussion. This list of themes was divided into students' perceived costs and benefits of how their returner status shaped their experiences. Cost themes largely fell under the broad categories of cost identified in our team's prior quantitative analyses.

V. Findings

In our earlier analyses of our current survey data in which we compared returning and direct-pathway students' expectancies of success and the values and costs they associate with earning a PhD²⁹, we found that returners reported perceiving significantly higher balance, financial, and academic costs associated with earning a PhD, compared to their direct-pathway peers. These differences in level of perceived costs were significant in all of our three regression analyses, even when controlling for a number of other academic and personal characteristics. Our full findings are displayed below in Table 1.

Table 1: Regression of Cost factor scores on demographic and academic traits and school and work experiences

Variable	Financial Cost	Academic Cost	Balance Cost
Returner Status	0.29*	0.29*	0.48***
Age	0.01	0.00	-0.02
Female	0.02	0.28**	0.31**
Underrepresented Minority	-0.13	-0.26	-0.33*
Has Children	0.06	-0.05	0.07
Part-time Student	-0.07	0.10	0.14
Completed Qualifying Exam	-0.08	-0.30**	0.02
Inst. Research Spending per FTE	-0.01	0.06	-0.02
<i>Relationship Status (Single as control)</i>			
Married	0.04	-0.08	0.18
Divorced	-0.13	0.03	-0.40
Bachelors in Engineering	0.16	-0.06	-0.09
Currently Employed	-0.44**	-0.13	-0.03
Hours Worked per Weekend	0.02*	0.01	0.05***
Self-funded	0.30	0.00	0.14
PhD GPA (by 0.33 interval)	-0.06	-0.33***	-0.09
Intercept (Constant)	-0.12	1.863***	0.43
N	378	378	378
F	2.51*	4.32***	5.58***
R²	0.0952	0.1511	0.1688

Note: Robust standard errors applied, ~ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, Institutional Research Spending in tens of thousands of dollars per full time equivalent enrollment. Imputed results available upon request

Items loading highly onto Financial Cost factor include: Tuition, Medical Insurance, Reduced Salary, Less Financial Security, Loan Debt, Difficulty Securing Funding; Items loading on Academic Cost include: Need to Re-learn Material, Difficulty Finding Study Groups, Feeling Not as Smart as Peers, Feeling at Different Place Academically, Spend Time on Topics Already Knew, Others had Learned Information Previously, Feeling Unable to Excel on Coursework, Need to Learn New Software Programs, Can't Do Best Academically Due to Time, New Environment/Culture, Open-endedness of Assignments, Less-Structured Chain of Command, Difficulty Forming Rels. with Peers, Difficulty Forming Rels. with Faculty; Items loading highly on Balance factor include: Lifestyle Sacrifices, Less Time for Community Involvement, Less Time for Family, Less Time for Hobbies, Regret Missed Activities, Strain in Friend Relationships, Strain in Family Relationships, Limited Freedom to Try New Things, Can't Keep Up with Household Chores, Less Time for Self-Care

Building on these findings, our qualitative analyses further explored how returners perceived the costs associated with pursuing a PhD and the specific experiences that may contribute to these costs. In interviews about their PhD experiences, returners reported a number of particular experiences related to their experience of being a retuning PhD student that they identified as challenging. These cost types can be broadly classified as relating to financial, academic, and balance difficulties.

Financially, returners reported concerns relating to their experiences in their programs and worry about future job prospects. Some returners reported taking a significant pay cut in order to pursue a PhD. Many had lucrative careers in industry or government and either had to reduce their responsibilities and pay at an existing role in order to pursue a PhD or leave a well-paying position and accept a PhD student stipend. John, who continued to work in a government position throughout his PhD, described taking a “major pay cut” to be able to pursue a PhD, earning nearly half of what he had previously made annually. Michelle described difficulties adapting to raising a family on a graduate student income compared to her past role:

Being in graduate school is hard work, doing it with two children and a family and a budget to worry about because your life changes when you go from a consulted salary to a stipend graduate school. There are a lot of tense moments

Zoe explained that her concerns about a reduction in her income delayed her decision to go back to graduate school and that, though she ultimately decided it was worth it to pursue a PhD, she continued to struggle with finances:

There were many reasons, but by far the main one was financial. So, I view that as making a good salary at this job. I had a nice apartment, and I had a car, and I could go on vacation whenever I wanted. And I knew that all of that was going to disappear if I had enrolled in a PhD program. And of course, it did. I was really quite scared of being so poor again. [...] Eventually, I decided that I was unhappy enough that I was willing to take that risk. But, I will say that since I've come to grad school, that is by far my number one complaint, like I'm broke all the time.

Several returners also mentioned concerns about their pay or job prospects upon completing the degree. Brandon explained: "At my age, you can do the math, it's not a good financial decision. The rate I could demand as a consultant is three or four times higher than what I will make when I finish my degree here." Diana similarly commented on her post-PhD prospects, concerned about being perceived as "over-qualified" by potential employers. She elaborated:

Finishing my PhD approaching 40 is putting myself in a position of competition with people much younger than I am now. I have experience they don't have and skills that aren't there for them because I have this practical experience. But, that automatically also brings me in as somebody who has to be higher paid than somebody who's not coming in.

Interviews with returners also provided insight into the challenges they faced related to balancing their academic responsibilities with other professional or personal demands. Some returners retained their jobs while pursuing a PhD. Walter described the challenges he faced attempting to do both full-time and compared his experiences to what he perceived to be a more traditional PhD experience:

That meant the typical graduate student when they're spending all day every day working on their coursework, I was only spending all night every night working on my coursework. I was doing my job during the day. Same thing's true writing up the thesis, same thing's true studying for the qualifying exam. So it was pretty stressful.

Another returning student, John, worked for a government agency that typically encouraged its employees to pursue advanced degrees. However, John found the agency was less supportive of his pursuit of education than he felt it was of many less senior employees. Thus, he was not able to coordinate his efforts in his career and PhD. He explained:

So some people get to do their homework or their projects or such on government time, others get paid time off to go to school. I got neither of those, and in fact was told that I am far too senior and that I should be working on things relating to branch work, and that if I choose to go to school, I will do it on my own time.

While few direct-pathway students cited family responsibilities, many returners spoke of the difficulties balancing academic and family commitments and priorities. Lorraine described feeling overwhelmed when she became pregnant as she was due to begin her doctoral study, saying "I was like, 'Oh my God, I'm starting my PhD program, and I'm pregnant,'" but explained that open communication with her advisor helped her "manage that challenge." At times, returners reported having to make difficult decisions about their priorities. Kristen described her choice to complete her PhD long-distance to stay near her son, which she described as a somewhat isolating position in regards to her academic work.

Nothing other than as much as it's wonderful to be a distance student and spend time with my son, I've been very isolated so it's challenging to get back into talking with peers and things, but that's just part of being a mom to a young child too, and I wouldn't trade it, I wouldn't do that differently, but it would be nice to maybe be closer to my campus rather than 2,000 miles away or something like that.

Walter similarly described basing academic and career decisions on his family. In his case, he described revising his post-PhD career goals, not wanting to disrupt his children's schooling in order to move to pursue a tenure-track academic position.

If I had no restrictions, that's tricky, there are always restrictions, I suppose in an ideal world ... I'm a research scientist here now. In an ideal world, I guess I'd rather be a tenure-track professor. In order for me to do that in this field, I would have to go somewhere else. And even then, it's questionable. I probably could but I'd have to make the jump to leave and that's tough. One of my kids is in high school. The other one's in middle school

Ursula spoke of feeling compelled to make difficult decisions about motherhood in the PhD program and her subsequent career path. She explained that, as a returner, her age further complicated her feelings about her pursuit of the degree and her desire to have children:

And that is as a woman I went out, I worked, I came back to get the degree, and it's taking a dang long time. I want kids. There was a lot of regret ultimately associated with that, because it turned out that my husband and I decided a couple of years ago to have kids, and it didn't happen. There was a lot of regret, a lot of resentment of the degree, that kind of thing.

While Ursula happily reported she was pregnant at the time of our interview, she explained she was opting not to pursue an academic career, which she felt would "open a whole other can of awful, awful worms."

Finally, interview data provided greater insight into returners' perceptions of the academic and social costs of transitioning back into a student role. Some returners described challenges becoming reacquainted with foundational coursework after extensive time away from schooling. Travis described his challenges with this transition:

Initially schooling is way different than work in terms of there's knowledge in engineering that you need to know to take classes. Just basic knowledge of how to do math and stuff and when you don't do that for many, many years, it's gone. You have to relearn it. I very much struggled in the beginning and I had to focus all my attention on a couple of classes plus doing research on top of it

Other returners described challenges related to how they were perceived as scholars by faculty and students in their programs. Adam cited difficulties finding an advisor, as they questioned his seriousness and commitment to the program given his age. He explained:

What frustrated me is a lot of the people I e-mailed didn't really seem interested. Some of them wanted to see how I do my first semester. Some who had reservations, they thought you're-- I was in early 30s, they thought that was too old to go back to grad school. They were worried that I'd just drop out.

Similarly, Diana, who left a successful career to pursue her PhD, described many individuals not initially taking her commitment to the program seriously. Her success in industry had little positive affect in how she was perceived in her PhD program. She detailed her struggle not only with others' doubts about her, but also the ways going back to school initially challenged her own confidence in her abilities and sense of self:

I don't know that in the beginning, people really took me seriously. I don't know if maybe they thought I was a lightweight industrial person who couldn't cut it, or if I was just dabbling part-time so I couldn't be serious because I'm just doing a part-time. I don't know, but that was a little disconcerting in the beginning.

I think it presents some challenges for people who leave industry and want to come back. [...] Your great success in industry means almost zero here. [...] You're starting from ground-zero, and if you're not willing to start from ground-zero again, don't do it because it's a lot of work to re-establish your credibility. And in some level reestablish your own personal confidence, because you come into it thinking, "I've had great success. I can do almost anything. I'll be able to do this." And all of the sudden people are kind of a like sideline, knocking you down.

Despite the different types of costs returners associated with pursuing a PhD, these challenges were not necessarily reflected in their academic work. The results of our regression analysis examining students' research productivity, as measured by their completion of a number of different research activities, suggested that returners and direct-pathway students did not appear to differ significantly in regard to their research productivity. Controlling for a number of personal and academic characteristics, including time in program, past education, and perceived academic costs, there were no significant differences in the mean number of research-related activities each group had completed at the time of the survey. Table 2, below, shows full regression results.

Table 2: Regression of research productivity index on demographic traits and school and work experiences (N=403)

	Coefficient	Robust Std. Err.
Returner	0.10	0.42
Years in PhD	0.99***	0.10
Female	0.19	0.35
Underrepresented Minority	-0.82	0.44
Part-time Student	-1.02	0.64
Has children	-0.27	0.26
<i>Relationship Status (Single as control)</i>		
Married	0.45	0.39
Divorced	-0.28	1.03
Academic cost score	-0.77***	0.18
Bachelor's in engineering	0.15	0.44
Completed Masters Pre-PhD	-0.45	0.42
Currently employed	-0.61	0.46
Hours worked per weekend	0.06	0.03
Self-funded	-1.66**	0.51
Constant	1.80	0.61
F		14.07***
R²		0.33

Note: Robust standard errors applied, ~ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Research productivity index comprised of following items: Collected data or developed material for a manuscript, Gave a presentation at home university on research, Wrote manuscript, Submitted a journal paper, Submitted a conference paper, Submitted a conference abstract, Presented at a conference, Journal paper accepted for publication, Conference paper accepted, Submitted multiple journal papers, Submitted multiple conference papers, Multiple journal papers accepted for publication, Multiple conference papers accepted

Providing a more nuanced understanding of how returner status shapes engineering students' PhD experience, interviews with returning students revealed not just elements they identified as challenges, but the ways pursuing a PhD after significant work experience differently, often

positively, shaped their perspectives and approach to their academic work. This interview data may provide some insight into why, despite higher reported costs, returners' research productivity and other academic outcomes may not necessarily be negatively affected by their experiences as returners.

A number of returners reported that they had a greater understanding and appreciation of how their research work related to real-world problems. Many explained they had both a better understanding of the technical elements of engineering work given their contextual knowledge, as well as an ability to assess the relevance of particular engineering solutions. Karen described how her experiences shaped her understanding and perspective related to her academic work:

I see all these tools and techniques that they teach, lane processing, location, facility location designs, and stuff like that that I keep ... in my head, I see all these examples of how it could have been used or how it should have been or was used from that perspective. I think it gives me a different perspective as far as understanding how the information can be used in the real world and also a better appreciation for what I'm doing and where I'm at.

Similarly, Quincy expressed that he felt his past experience provided him with valuable technical skills and perspectives he applied to his engineering work. He explained, "I had a lot of technical skill coming in that was stuff that I learned far beyond or after my undergraduate work, so that gave me a lot of perspective and skills, things that I could bring to the table to attack problems." Victor described how his own attention to the practical implications of his research work set him apart from his younger peers: "I think the real world applicability which was always forefront in my mind, everything I did I was thinking about that, a lot of kids don't, because they just don't really know how it fits in and stuff like that." Michelle felt so strongly about the benefits of the perspectives and skills she brought with her from her past career, that she argued it would almost be preferable that students took a path similar to her own, rather than going directly from undergraduate studies to the PhD. She described some of her more theory-oriented classes taught by faculty without non-academic work experience:

Theoretically, it's very interesting but it has absolutely nothing to do with how I'm going to be able to use it in the field. I think having some practical experience coming back in was, "I need to know this because I need to use that to understand this over here.

Other returners described how their past work experience helped them develop a variety of non-technical skills central to academic work. They described a number of ways their professional experience better prepared them to manage many project elements and communicate with others in the field. Quincy, for example, explained "I learned how to manage people and manage managers, long before I came to grad school." He observed how important managing relationships was for conducting academic research, but expressed frustration that he felt many in academia, including faculty, lacked these skills. Zoe also described developing interpersonal skills as a key takeaway from her professional experience that is relevant to her PhD experience:

I think working for 6 years was really a decent chunk of time, and I've learned so much about businesses, and the way people operate, and how to work with people to get things done and not aggravate them, and how to respond to an email professionally, and how to talk on the phone professionally, and how to manage my time. Just an innumerable amount of little things just about life, I feel like, have been really helpful to me.

Victor explained that the communication skills he developed proved to be most valuable in his academic work:

Presenting was huge. I did it a lot working, I used to get in front of the clients a lot, kind of talking to clients, kind of understanding their problems was helpful, coming back to read and, just talking to other people and talking to people at conferences that was just a kind of a comfortable environment for me. I interacted with adults, kind of on their level, I had a few years of that, wearing suits, that whole kind of, that's a big part of research you forget when you go out, it is a lot of just kind of like business-y type stuff you do. That was really helpful. Presentation skills and writing skills were something that I just got hammered in in engineering and that really came in handy in grad school

Like many others, Travis described how the interpersonal skills he developed in his previous career helped him in his academic work, describing himself as “much more people-based” than he had been prior to working, and explained he felt that relationships with others was key to success. However, he contrasted these benefits of his time working with the challenges of adapting to the academic rigor of a PhD program:

I see people that are coming in but also unsure where they want to work [...] and they can struggle a little bit because of that. My work experience helped me in terms of that. It's all the soft skills, the external skills, because you get hurt more on the academic side. It's much harder academically, but it's easier in terms of motivation, managing, and stuff like that.

Despite data suggesting that returner status is associated with a number of challenges in pursuing a PhD in engineering, our findings suggest a more complicated picture; returners also perceive their past experiences to contribute positively to their academic experiences in a number of ways and provide a distinct perspective in their work.

VI. Discussion and Implications

Scholars increasingly focus on cost as a distinct dimension within Eccles' expectancy-value framework motivating individuals' achievement-related decision making. Recent literature on cost suggests it is a multidimensional construct and that perceived costs may be related not only to individuals' decisions to select or continue in a particular academic area, but also to a number of outcomes related to their performance of that task. We previously conducted a factor analysis of our cost scale developed for this study which suggested a multi-factor solution, consistent with recent literature²⁹. Given findings from our earlier analyses of our survey data, included also in this paper, that returners perceived higher levels of costs on all three dimensions represented in our scale (academic, balance, and financial costs), we sought to better understand returners' perceived costs through an examination of our interview data. Interviews with returners revealed a number of challenges that were well-aligned with the emergent cost types in our quantitative analyses. Collectively, these findings are consistent with existing literature on returning students (which primarily focuses on returning students at the undergraduate level or in other fields) that suggests returners may experience distinct costs given their choice to return to school.

Expectancy-value theory would suggest that, given higher levels of perceived costs, would-be returners may be less likely than their younger peers to pursue a PhD in engineering or, in the case of those students who do return, to persist in their doctoral programs. Our data only includes those students who successfully enrolled in PhD programs and does not capture these students' persistence and performance over time. Thus, we are unable to make any concrete claims about how cost relates to students' decision-making. However, we did examine if the costs associated with the experience of returning for a PhD were associated with negative academic outcomes. Our findings complicated the notion that higher costs necessarily relate to poor academic outcomes. Our regression model of research productivity suggested a significant negative relationship with academic cost, but returner status was not significantly related to research

productivity. Further, while qualitative findings suggested returners experienced a number of challenges adapting to their doctoral programs, they also named a number of ways their extensive prior work experience benefitted their academic work. A mixed methods study allowed for a more nuanced exploration of our research questions about the costs returners associated with pursuing a PhD and how these costs do and do not manifest in their academic work. Holding the quantitative and qualitative data in conversation with one another offered a deeper understanding of the different types of costs returners experience and how they experience them.

Our findings raise questions both about the experiences of returners specifically and the role of cost in shaping the outcomes associated with a particular choice more broadly. Do the different perspectives returners bring to their academic work compel them to succeed in their academic work, despite perceiving higher levels of costs related to pursuing their degrees? How does one's framing of cost and value relate to their decision-making and the outcome of those decisions? Prior analyses of our survey data²⁹ revealed no significant differences between returning and direct-pathway students in regard to the three types of values identified by Eccles¹⁷: utility, attainment, and achievement. However, like the costs described in our study, these values are typically rather self-oriented. Some of the ways returners spoke about their work in our qualitative findings suggested they were considering how their work helped to address real-world engineering problems. Do returners' perspectives related to the broader social value of the work they do impact the burden of the costs they are willing to shoulder to pursue their work? Do returners' past experiences better equip them to deal with greater levels of challenges associated with their PhD experience? Future work will explore the relationship between students' past experiences and their approach to problem solving in greater depth.

Our findings suggest several implications for research and practice. First, they point to a need for further study that examines the relationship between costs, values, and outcomes related to a particular task, specifically exploring how a certain type or framing of costs and values (whether related to a particular personal struggle or broader societal implications) relates to outcomes like performance and persistence. An example study might include a longitudinal exploration of how particular types of personally and socially-oriented types of costs and values relate to persistence and academic outcomes over time. Our findings also suggest practice implications for better supporting returning students. Both our quantitative and qualitative findings suggest returners experience a number of costs, including those related to career impact, family responsibilities, and adapting to the academic and social aspects of PhD programs. Some universities already have resources that may help students with such concerns, including career counseling, university-based childcare, and academic support services. It is important to ensure advisors of returning students are aware of such resources and can refer them as needed. Universities may also consider facilitating the development of a community or organization for returning graduate students as a way to help students develop positive relationships with peers in similar situations and share resources that may help in adapting to an academic environment once again.

VII. References

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