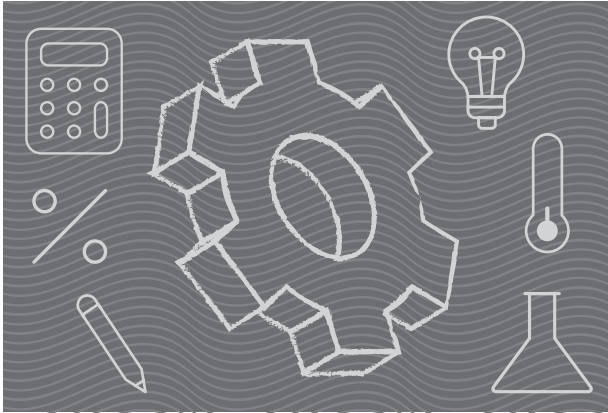


AN OVERVIEW OF RETURNERS IN ENGINEERING GRADUATE EDUCATION: DIVERSE PATHWAYS AND UNANSWERED QUESTIONS

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Introduction

In fields like education, people who pursue graduate degrees do so at varying stages of their career, including after having significant time in the workforce. In other fields, such as engineering, there is less variation in students' typical paths through graduate school, with the majority of students pursuing graduate study shortly after completing their undergraduate degree. The average age of engineering PhD students upon graduation is 30, compared to 34.2 in humanities and 38.3 in education (National Science Foundation et al., 2014).

While it is common for most engineering students to go directly into graduate studies after completing their baccalaureate degree, some people do wait until later in their life and career to pursue a graduate education (either a master's degree or a doctorate). We define those who choose this path as "returning students" or "returners," in contrast to "direct-pathway" students who have little or no gap between their undergraduate and graduate education. Returner status exists on a continuum, but for our work we defined the boundary between the two groups as

a five year gap. Five years would allow a person to establish a professional identity, to forget things that had not been used since graduation, to learn new skills, and for the academic environment to evolve as well. There are several key thresholds that are at or near this time span and further support this number: GRE scores are good for five years before the test needs to be re-taken, the Professional Engineer designation requires at least four years' work experience in addition to the two required tests, and engineering programs are re-accredited by ABET on a six-year cycle.

Returner status is not a tracked demographic in engineering graduate programs, so the exact number of returners is not known. From our research and data on average age of graduate degree completion, it appears returners are a relatively small portion of the engineering graduate student population. Despite this, returners can have a large impact on the field, as they can add to the diversity of thought and perspectives in their graduate institutions based on their work and life experiences (MacFadgen, 2008; Schilling, 2008; Strutz, Cawthorne Jr., Ferguson, Carnes, & Ohland, 2011). Returners' on-the-job experience gives them a unique perspective not only on curriculum but also on the real world applications of their graduate work and research.

In this paper, we describe our research on United States domestic returners. In an initial pilot study, conducted at a single major Midwestern university, we explored the experiences of a diverse group of 10 returners in various STEM disciplines, in both master's and doctoral programs. In a second study, with a large national pool of participants, we examined issues surrounding

returners in engineering doctoral programs. Our third study, which is currently ongoing, focuses on the differences between direct-pathway students and returners in engineering master's programs. These studies, although just a beginning, show that work experiences supplement and enhance formal learning experiences. Returners' work experiences provided them with motivation for their further education and gave them a different perspective on what they saw in the classroom. After presenting a summary of the findings from these studies, we discuss several questions for future study.

Pilot study

The initial pilot study was conducted in 2010-2011 with participants from a major Midwestern research university (Peters & Daly, 2011; 2012; 2013). The goal of this study was to explore the experiences of returners with a focus on why they chose to return, what challenges they faced, and how they overcame them. We interviewed 10 returners. Interviews lasted approximately one hour. The interview protocol covered five areas:

- Demographic questions;
- Preparations for returning to school;
- Differences and challenges;
- Contributions to success; and
- Closing remarks.

The participants included 4 females and 6 males and ranged in age from 27 to 45. They had been out of school for a minimum of 5 years, with the largest gap being 18 years.

There are four types of perceived task value described in Expectancy Value Theory (EVT): utility, interest, attainment, and cost, with cost functioning as a disincentive that counters the three incentivizing values.

Several analyses were conducted on the data from these interviews; an initial analysis focused on identity and looked at transitions in participants' identity as they went from professional to student (Peters & Daly, 2011). A further analysis was conducted using Expectancy Value Theory (EVT). In EVT, decisions are a function of a person's

expectancy of succeeding in a given task along with the perceived value an individual associates with that task. There are four types of perceived task value described in EVT: utility, interest, attainment, and cost, with cost functioning as a disincentive that counters the three incentivizing values (Eccles, 2005; 2009; Wigfield & Eccles, 2000). In EVT, utility is defined as the person's perception of what advantages they will have from achieving a goal. Interest is their anticipated enjoyment of the things they will be doing to achieve that goal, and attainment is their perception of how it contributes to who they are at a fundamental level.

This analysis revealed that the primary motivation for the participants to return to graduate school was utility, followed by interest. Attainment was the least significant component of the value of their graduate degree (Peters & Daly, 2013). The utility they perceived took different forms: to transition from an industry career pathway to an academic career pathway, to change the focus or direction of an industrial career into a new specialty area, or to advance in a current career path (Peters & Daly, 2012).

Returners felt that they were able to succeed at the degrees they had started but had questions about whether their studies were worth it—cost, both financial and non-financial, was a major concern. The costs they experienced were analyzed and categorized, and we found that these costs could be broken down into four major categories: financial, intellectual, balance, and cultural/environmental. The degree to which these costs affected different people varied, as did the strategies they used to deal with the costs. As an example, some people had a working spouse or partner who was able to support them during their degree program while others made lifestyle changes or drew on other financial resources.

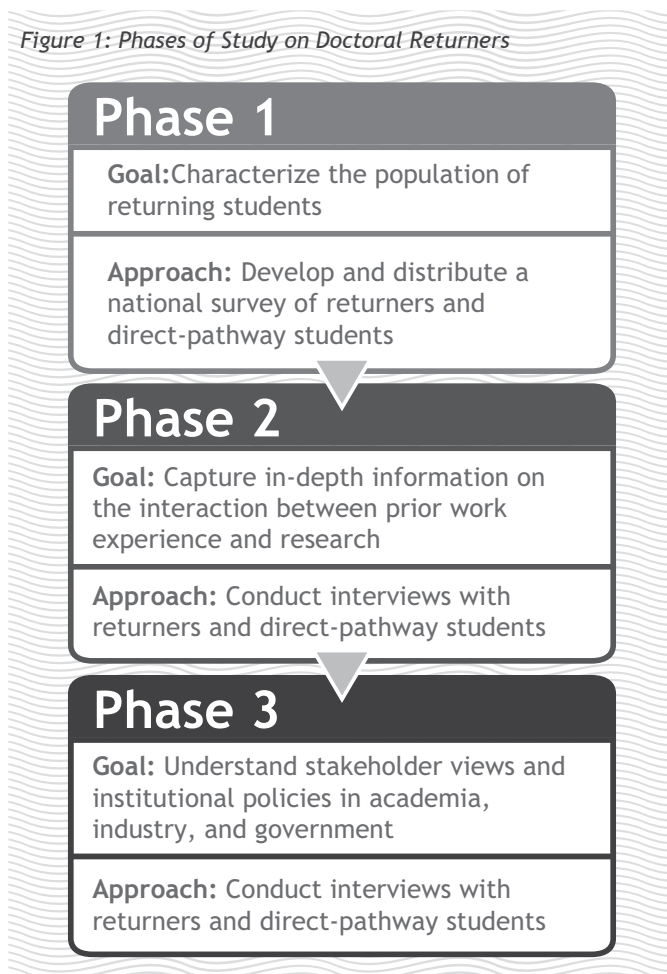
One of the intellectual costs that returners faced was the fact that they had forgotten some material while out of school. The degree to which this cost was a problem varied based on how long they were out of school and what material they actually used in their jobs. Returners took two basic approaches when faced with material they had forgotten: some participants studied intensively to recover that material, others chose degree programs that drew more on their

current knowledge and strengths and avoided the need to do as much to recover past knowledge.

Returners in PhD Programs

Building on findings from our pilot study, we designed a multi-phase study of both returners in engineering doctoral programs as well as their direct-pathway peers. This study, launched in 2012, included three phases: characterizing the population, capturing in-depth information, and understanding stakeholder views, as shown in Figure 1.

Figure 1: Phases of Study on Doctoral Returners



In the first phase, we developed and deployed the Graduate Student Expectancy and Motivation Survey (GSEMS), covering 30 states and 61 universities (Mosykowski, Daly, Peters, & Skerlos, 2013). We used a rolling recruitment strategy in an effort to get approximately equal numbers of returners and direct-pathway students. Ultimately, the respondents included 179 returners and 297 direct-pathway students. The survey questions covered 11 topics:

- Demographic information;
- Academic background;
- Current academic information;
- Pre-PhD activities/career;
- Decision to pursue a PhD;
- Expectancy of success in PhD;
- Values of the PhD;
- Costs of the PhD;
- Cost reduction strategies;
- Advising relationship; and
- Post-PhD plans.

We conducted several analyses, including a simple description of the detailed demographics of the study population (Mosykowski, Daly, Blake, Peters, & Skerlos, 2015), an analysis of participants' interactions with their advisors (Mosykowski, Daly, Peters, Skerlos, & Baker, 2014), and a mixed-methods analysis of the challenges and benefits associated with pursuing a PhD as a returning student (Mosykowski, Daly, & Peters, 2017a). The mixed-method analysis indicated that returners had significant financial concerns with pursuing a doctorate, particularly given the salaries they were able to command while working. They felt that their work experience was helpful in that it gave them a greater understanding and appreciation of real world problems, and it helped them develop non-technical skills that were useful in academic work (Mosykowski et al., 2017a). These skills included self-discipline, time management, communication, and project management, all of which allowed them to manage and complete their academic work effectively.

In the second phase of the study, we developed an interview protocol for semi-structured one-on-one interviews to be conducted by a member of the research team either in person or over Skype.

These interviews covered seven topics:

- Introduction to the interview and basic background information about a participant's current position in their PhD program;
- Characterization of their pre-PhD work and research experiences;
- Their process in deciding to pursue a PhD;
- Characterization of academic experiences and their doctoral research, including the progression of their research agenda;

- Students' plans upon completing their PhD;
- Hypothetical research scenario aimed at capturing various elements of their research process and related past experiences; and
- How students believe their past experiences shaped their doctoral work.

Participants were drawn from the GSEMS respondents. Analyses of these interviews, while still ongoing, has shown that there are considerable differences in the research process sophistication of different doctoral students (Mosyjowski, Daly, Peters, & Skerlos 2016); although, the differences between returners and direct-pathway students' research processes are not yet well understood. Nonetheless, returners more commonly report intrinsic motivation for selection of their research area, which may be derived from the perspectives and skills gained from their past experiences (Mosyjowski, Daly, & Peters, 2017b).

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Returners in Master's Programs

The third study, which is still underway, focuses on understanding knowledge construction in the master's program as well as the differences between how returners and direct-pathway students learn in the classroom. Master's degree programs may take different forms, including coursework-only programs and a "professional" master's degree intended for those in the industry. Alternatively, they may include large research components and provide a pathway to a doctoral degree. Master's degrees are also offered at a wide range of institutions, both those that offer a doctoral degree and those that do not. Because of these differences, we expected that the issues affecting returners could be different in master's degree programs compared to doctorate programs.

The study on engineering returners in master's degree programs is focused on the way in which

learning is affected by prior work experience. This project has two phases. In Phase 1, a survey was developed and deployed. This survey had several questions in common with the original GSEMS, but questions relating to the particular goals of that project were removed, such as the questions based on EVT and questions specific to the doctoral degree. Questions relevant to the new project were added.

The sections of this survey were:

- Demographics;
- Undergraduate information, including degree year and major;
- Other education, including a second or third master's;
- Family support and encouragement for the student in the master's program;
- Questions about the current master's program, including structure, advisor support, and major/focus; and
- Future plans that included choices such as consulting, remaining at current employer either with new responsibilities or in a different position, research, or pursuit of a PhD.

In Phase 2, currently being conducted, a subset of the survey respondents is being interviewed. This interview focuses on

- Prior experiences;
- Background knowledge, retention, and recovery of forgotten concepts;
- New knowledge and how learners incorporate it with what they already know; and
- Reflection on connections in their work between experience in industry/previous academic experience.

Analysis of the survey results has revealed that there are many similarities between returners and direct-pathway students in terms of their familiarity with computer tools and in their engineering skill set. While younger students may be considered "digital natives," returning students have a similar level of familiarity with modern computer tools and comfort using them. In most engineering skills, both groups are similar. In a few areas, however, returners have a higher level of self-efficacy. These areas include analyzing the tradeoffs between alternative

design approaches and selecting the one that is best for a given project, identifying the safety concerns that pertain to a current project, and synthesizing information to reach conclusions that are supported by data and needs. This proficiency is most likely due to the fact that returners have practiced these skills for years in the workplace, while direct-pathway students have not had that opportunity (Gross, Peters, Mann, & Daly, 2017). Further analyses are ongoing to determine what other key differences and similarities may exist.

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Unanswered Questions

Over the course of these research projects, we have learned a lot about returners in engineering graduate programs. We have seen that they face different types of costs, both financial and non-monetary, but despite these obstacles they are also highly motivated to complete their degrees. We know that their work experience affects their attitudes about learning; they may be even more motivated than they were in their undergraduate work (Peters & Daly, 2011). They realize how much they know but also understand that there will always be more to learn, and they are willing to put in the effort to do so.

However, there remain many unanswered questions. Some were beyond the scope of these research projects, while others have arisen in the course of these projects. They can be grouped, roughly, into seven categories.

What Are the Demographics of Returners?

Because returner status is not a tracked demographic, we cannot be certain if these findings are generalizable to the entire population of returning students in the U.S. If returner status became a commonly tracked demographic characteristic by universities, we could have a

better understanding of common pathways through graduate school. For instance, are there particular points in individuals’ personal or professional lives in which they are particularly likely to return? Do many returners have particular personal or academic experiences that distinguish them from their direct-pathway peers? What is the gender breakdown, and how many underrepresented minorities are returners?

What Other Factors May Motivate Returners?

Some of the motivations for returning have been studied in the course of these projects. Many returners use a master’s degree as a way of attaining the level of education needed to change jobs or to consult. The additional education, potentially in a new field, allows them more choices within their current employment and in future plans. Motivation to learn in and of itself has also been shown to be an important factor with returners. However, there may be additional motivations that have not been captured at this point which might draw someone to return to graduate school for an additional engineering degree.

What Determines Whether a Potential Returner Will Return?

All of these studies have focused on those who did return to graduate school for an additional degree. However, there may be people who consider going back to school for a graduate degree but decide not to for some reason. Others may attempt to go back but are unable to find an appropriate program. Yet more people may find a program that appeals to them, apply for admission, and are rejected. We have no idea how many of these people may exist or how they differ from those who do successfully return for a graduate degree. Universities’ and employers’ policies and procedures may have a large impact on these people. Our analysis using EVT has implications for this area and points towards areas for further study.

What Additional Alternative Pathways Do Students Follow?

There is a huge spectrum of higher education pathways a person could take within the field of engineering. Some students may enter the

workforce right after receiving their bachelor's degree. Some of these bachelor's degrees represent on-the-job experience incorporated into the requirements for the degree, known as co-operative education. A student is placed within industry to experience real-world applications of their studies. A portion of these students may later decide to go back to school for a master's or PhD. Other students might proceed directly from their undergraduate studies on to a master's or PhD program. Whether engineering students go directly into a graduate program or wait, they could pursue a different field of engineering from their bachelor's or work experience. They could even earn multiple master's degrees in different areas of engineering. Further still, engineering students may opt to go to law school, medical or veterinary school, or study other professional terminal degrees. Some may choose to get a second bachelor's degree in another area of engineering or even in a totally different discipline. Each of these pathways presents its own challenges and benefits and are chosen for a myriad of reasons.

Co-operative education represents an alternative pathway because a number of universities encourage or even require a student to successfully complete a certain number of terms working as a co-op in their field in order to graduate. These students may have several years' worth of work experience by the time they graduate. Some of these students may then be employed at the place where they completed their co-op experiences. Because work in industry has been part of their undergraduate experience, are they more like returners (due to work experience), more like direct-pathway students (due to recent educational experience), or some combination? And of what influence is the gap experienced by returners?

How Do International Educational Experiences Intersect with Returning?

All of these studies have focused exclusively on domestic students—those who are United States citizens or permanent residents, with their undergraduate degree from a university in the United States. Students from foreign institutions, or United States citizens or permanent residents

who study abroad, would face language and cultural issues that would impact their learning. Further, any issues would vary based on the countries involved. Additionally, other countries have different typical paths through postsecondary education that could shape the experiences of returning students.

How Can Educational Institutions Attract and Facilitate Returners?

What attracts returners to certain institutions over others? Undoubtedly, geography can play a role for those who are tied to a particular location for family and personal reasons. Beyond that, however, what makes a university attractive to returners, and able to support their success? It might be informative to identify policies, programs, and initiatives that are more attractive than others for returners. We do have interview data about students' decision making and quantitative data about who students consulted, which could provide the basis for further investigation.

Questions About the Long-Term Effects of Returning

All of the studies on returners have recruited from the population of current graduate students and are not longitudinal. Thus, the long-term effects on their lives and careers are not yet clear. We don't know what returners' long-term career progression looks like compared to those without any graduate degree or compared to those who pursued their graduate degree earlier in their lives. Are they satisfied with their decision as they look back over their careers? What were the long-term effects?

In addition to all of these questions, there are undoubtedly new questions that will arise through additional studies.

Summary and Conclusions

Over the course of these projects, we have learned a great deal about engineering returners in graduate programs, both in master's and in doctoral programs. We have learned that returner status affects graduate students in many different ways, including student motivation, the value of a graduate degree, and the personal and professional costs of pursuing a degree. We are beginning to understand how learning is affected by returner

status and, specifically, how that affects knowledge construction. Many questions remain to be answered, however, and it is our hope that future studies will address these questions and provide a more complete picture of engineering graduate student returners and the diversity they bring to the graduate student population.

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