Career Goals, Self-Efficacy and Persistence in Engineering Students

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***Abstract*— Research connected on both career goals and self-efficacy has linked each to the persistence of undergraduate students in engineering programs: self-efficacy through numerous qualitative and quantitative studies, and career goals through a recently conducted study. Additionally, research suggests that self-efficacy plays a role in the goals that individuals set, and whether they persist towards the accomplishment of those goals. In this work in progress study, we focus on how those relationships can provide researchers and educators with new ways of considering factors related to persistence in engineering programs. In this paper, we discuss results from a piloted survey, and their meaning for continued research. Initial results revealed a relationship between career goals and self-efficacy. Self-efficacy for persistence correlated significantly ($p < 0.05$) to ambiguity that students have about their career goals. The next investigative steps in this study will include the collection of additional interview data. New interview data will help us build more of an understanding of how self-efficacy and career goals relate. After an interview protocol has been created, future work will focus on comparing career goals and self-efficacy to persistence data.**

Keywords—Undergraduates, Self-Efficacy, Goals, Careers, Persistence

I. Introduction

Persistence is a central focus of the engineering education system. Educators want to know the rates at which students are completing engineering programs, and the factors that cause students to either persist or withdraw. Researchers have worked to discover more about factors that relate to persistence [1,2,3,4,5,6], and put persistence in engineering programs in perspective with other disciplines [7].

At a higher level, persistence is one of the key concepts we consider when assessing engineering programs. One way to view the purpose of engineering programs is as the means by which they prepare a sufficient number students for engineering careers in order to meet needs of industry and calls to increase the numbers of STEM graduates [8,9]. In this case, the key considerations for assessment are whether our programs are giving students the skills they need to move on to industry (ABET a-k and technical outcomes), and whether we are producing enough of those students (admissions and persistence) [10]. With this in mind, making persistence a focal point of engineering education research makes sense. While we have guidelines for addressing and assessing both technical and professional skill outcomes through accreditation standards, persistence presents more of a challenge as, in addition to being a complex, multifaceted phenomenon, it does not have a set of best practices or guidelines for investigation, interpretation, and reaction to data we collect around it.

While previous research has investigated the demographic trends within persistence in engineering programs [1,2,3,4,7], we have a more limited understanding of how student beliefs and values inter-relate, and how they collectively contribute to persistence. Individual studies have suggested that self-efficacy [11], career goals [12], identification with engineering [13,14], and cognitive beliefs and values [15,16,17] relate to persistence. Although theories like Expectancy Value Theory [18] postulate that many of these concepts are inter-related, and thus have a collective effect on choices like persistence, less research has been conducted to investigate both how these concepts inter-relate, and how they collectively influence persistence. In our overall study, we explore the research question: What can the relationship between career goals and self-efficacy tell us about how students choose to persist in engineering programs? In this work in progress paper, we describe two constructs that relate to persistence: self-efficacy and uncertainty in career goals, discuss some preliminary results comparing those two constructs and outline a plan for continued research on self-efficacy and career goals, including how they might collectively contribute to the persistence of students through undergraduate engineering programs.

II. Background

In this section, we discuss the potential value of understanding how multiple constructs inter-relate and contribute to persistence through a theoretical framework based on Goal Setting Theory (GST) [19,20,21] as adapted recently to career goal research [12].

In the representation of our theoretical framework, shown in Fig. 1, we describe a system of related constructs, with career goals, persistence in engineering programs, self-efficacy, experiences, and interpretation of experience. Each numbered arrow represents a research finding that has connected those two constructs. Arrow 1 was identified in

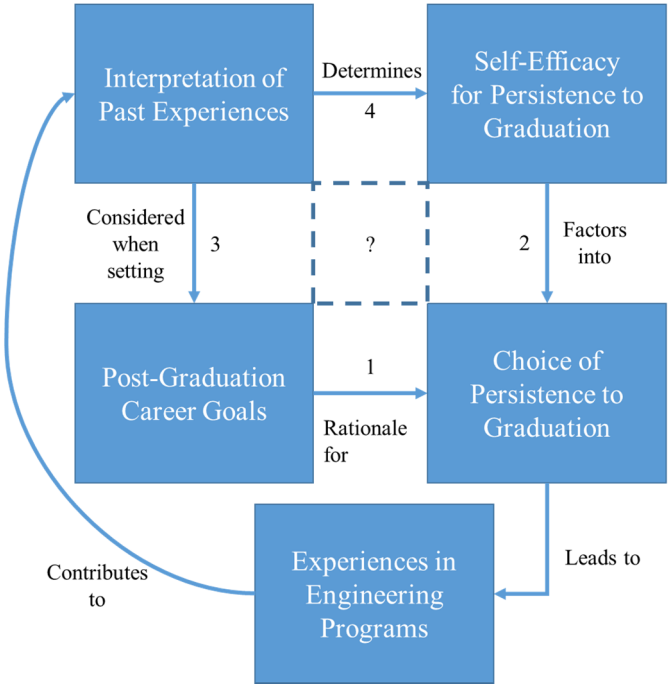

Fig. 1. The inter-relation of constucts related to persistence, career goals and self-efficacy.

career goal research [12]. Arrow 2 has been established through research on self-efficacy of students in engineering programs [17]. Arrow 3 stems from research on goal development grounded in social-cognitive career theory [11,15]. Finally, the relationship represented by arrow 4 has been investigated in previous studies on self-efficacy and persistence [11,17].

In a system of connected constructs like the one represented in Fig. 1, there may be more relationships between constructs than the ones that have already been established. Theories like Eccles' Expectancy-Value Theory hypothesize that there is a complex web of experiences and ideas that ultimately determine how individuals make choices like persistence [18]. These possible interconnections are represented by the dashed box with a question make inside. In this work in progress study, we begin exploring the interconnections of such a system by examining the relationship between post-graduation career goals and self-efficacy, setting up future research examining the entirety of the system shown in Fig. 1.

A. *Defining Self-Efficacy*

Self- efficacy is one's belief in their ability to perform a task or participate in a behavior [22]. Because of this, the use of self-efficacy is always in reference to a particular task or behavior. For instance, in this paper, when we discuss self-efficacy, we refer to self-efficacy for persisting to graduation in an engineering program. By persisting to graduation, we mean completing all degree requirements and obtaining an engineering degree.

B. *Defining Career Goals*

In this paper, the term career goals is short-hand for post-graduation career goals: the desired outcomes that students want for their professional life after college. Recent research on career goals shows that they are complex in two ways. First, there are multiple types of goals that students can have. Brown (2016) [12] found that students had career goals about particular jobs they wanted *and* a number of job independent goals like financial security, enjoyment in their work, the desire to help others and work-life flexibility. Most individual students had multiple types of goals, and each type of goal contributed to decisions they made. For example, Brown describes one student, given the pseudonym Simon, who had career goals for both working in a field related to medicine (a job) and for doing work that benefits society (a job-independent goal). Simon considered his desire for a job in medicine when choosing to major in biomedical engineering. Later in his academic career, Simon chose to leave biomedical engineering because he thought that a different major, public policy, would lead him to his goal of helping people more quickly. This is an example of how career goals can affect persistence choices in engineering programs.

Brown [12] also found that students described things that they were uncertain about in their job-related career goals. Uncertainty also related to decisions that students made when in engineering programs. For example, Sadie (another pseudonym for a student in Brown's study) described not knowing what she wanted to do in her post-graduation job. Because of this, she chose to remain enrolled in her mechanical engineering major, as she had already put in a considerable amount of effort into the degree, and thought it had broad enough career possibilities.

Brown developed a way of quantitatively measuring the uncertainty that students have in their job-related career goals [12]. This, along with an existing persistence in engineering self-efficacy survey, forms the basis of the methods in for this study.

III. Methods

The method for this study consisted of the concurrent distribution of two survey instruments. The first was the Post-graduation career Goals in Engineering Students (PGES) survey [12], which was used to measure how uncertain students were about their job-related career goals. The second was the Engineering Self-Efficacy survey (ESE) [23]. Each of the survey instruments were distributed to 281 students at 5 different sites.

A. *Career goals instrument*

The PGES survey measures uncertainty about job-related career goals by asking students to first think about the career choice (job) they want after graduation, and then respond to a series of 7-point Likert-scale prompts (1 is strongly disagree, 7 is strongly agree) about how uncertain they are about that job. Those items are show in Table I. Responses to each item were averaged (with scales reversed for reverse-coded items) to determine the construct score. A score closer to 1 means a student is more certain about their job-related career goal, while a score closer to 7 means that a student is more uncertain about

TABLE I. ITEMS FROM PGES

Item Prompts
State your level of agreement with the following statements.
I know the specific career choice that I want to make after I graduate.[a]
I know the kind of work I want to do in my post-graduation career choice.[a]
It's quite likely that the goals I have for my post-graduation career choice will change.
I am sure of the details of what I want to do in my post-graduation career choice.[a]
I may change my mind about the post-graduation career choice I want to make.
I don't know what my post-graduation career choice will be.

[a] *Reverse Coded*

their job-related career goal. The uncertainty scale in PGES was found to have a Cronbach's α of 0.85 in this study, meaning it was a reliable instrument.

B. Self-efficacy instrument

The ESE survey measures an individual's self-efficacy for persisting to graduation with their engineering degree. Like PGES, it is a set of 7-point Likert-scale prompts (shown in Table II). Responses were averaged to determine the construct score. A score closer to 1 means a student has lower self-efficacy in their ability to persist, while a score closer to 7 means a student has a higher self-efficacy. The ESE survey was found to have a Cronbach's α of 0.85 in this study, meaning it was a reliable instrument.

C. Data Collection

PGES and ESE were distributed at five sites. These schools were:

1. A large, public, land grant university in the southeast
2. A large, public, land grant university in the midwest
3. A medium sized, private, technical research university in the northeast
4. A small, private, liberal arts college with an engineering program at the northeast
5. A small, private, technical college in the midwest.

TABLE II. ITEMS FROM ESE

Item Prompts
State your level of agreement with the following statements.
I am confident in my ability to complete basic math and science requirements for an engineering degree.
I am confident in my ability to excel in basic math and science requirements.
I am confident in my ability to excel in my current engineering coursework.
I am confident in my ability to excel in future engineering coursework.
Compared to other students, I expect to do better than average in my engineering coursework.
I believe I can learn the necessary skills to obtain an engineering degree.
I have the necessary skills to obtain an engineering degree.

The survey was distributed to all students in five different engineering departments at site 1, a small number of individual students at sites 2 and 3, and all engineering students at sites 4 and 5. The survey had no way of tracking students by site. Collectively, approximately 2000 undergraduate engineering students received both surveys, so the approximate response rate for this distribution was 14%. Demographics for respondents are shown in Table III. Note that students were not required to give their gender or academic year, so totals for demographics do not match the overall number of students.

IV. RESULTS

Upon analysis, we decided that a normality assumption was not appropriate for the distribution of data from responses. Accordingly, we used non-parametric tests for data analysis in this study. Spearman correlation was performed between uncertainty and self-efficacy. The Kruskal-Wallis independent samples test was performed across different groups in two demographics: gender and class year. We found that uncertainty and self-efficacy had a weak but significant negative correlation (Spearman correlation of -0.242, significance level 0.01). We also found that students in different demographics had significantly different scores for self-efficacy (significance level 0.05). When comparing gender, male students reported higher self-efficacy than female students. When comparing class-year, the Kruskal-Wallis test suggested a significant difference, collectively, across different class years.

V. DISCUSSION AND CONTINUED WORK

The work completed in this study, thus far, suggests a significant relationship between uncertainty in job-related career goals and self-efficacy for persisting to graduation in an engineering program. It also suggests that there are differences across gender and class-year in students' self-efficacy for persisting with an engineering degree. Future work will explore these relationships, their meaning, and their implications for persistence in engineering programs.

A. Understanding the co-relationship between constructs

The weak but significant correlation between uncertainty and self-efficacy shows that career goal-related constructs (like uncertainty) may be related to self-efficacy. Brown identified other career goal-related constructs that can be measured quantitatively: a comparison of measurements of those constructs to self-efficacy may reveal a similar correlation [12]. Perhaps the relationship between self-efficacy and job-related goal ambiguity is causal, perhaps it is merely incidental. Future work will use mixed methods techniques to explore these relationships: both quantitatively, to determine the strength and significance of the connection between constructs, and qualitatively, to further investigate the meaning behind these connections.

TABLE III. SELF-EFFICACY AND CAREER GOAL CONSTRUCTS BY DEMOGRAPHICS

Gender/ Year	*N*	Instrument Score			
		Uncertainty[b]		***Self-Efficacy***[b]	
		Mean	***σ***	***Mean***	***σ***
Female	95	3.2	1.1	5.9[c]	0.7
Male	183	2.8	1.0	6.1[c]	0.8
First-year	31	3.2	1.0	5.9[d]	0.7
Soph.	57	3.0	1.0	6.0[d]	0.7
Junior	101	2.9	1.1	6.2[d]	0.8
Senior	92	2.8	1.1	6.2[d]	0.8
Total	281	2.9	1.1	6.1	0.8

[b] *Weak significant Spearman correlation (-0.24). significance level 0.01,*

[c] *Significant difference in Kruskal-Wallis Test, significance level 0.05*

[d] *Kruskal-Wallis Test suggests different distributions, significance level 0.05*

B. Demographic differences

The differences found across students of different gender and class year highlights the usefulness of constructs such as self-efficacy in understanding differences in students across different demographics. Understanding that there are differences between female students and male students in their self-efficacy for persistence in engineering programs helps us to better understand how an underrepresented population of students (women) experience engineering programs differently from other students. A deeper understanding of this difference can be leveraged in efforts to increase diversity in engineering. As this study progresses towards relating these constructs to persistence in engineering programs, demographic differences across constructs will continue to be considered.

C. Future work

The next steps in this study will focus on constructing an interview protocol to investigate how students relate their career goals to their self-efficacy for persisting to graduation from an engineering program. Interviews will allow us to explore the details of the relationship found in the preliminary findings.

A longer-term plan for this study is to collect longitudinal interview and survey data on undergraduate engineering students to finish exploring our study's research question. The preliminary outline for this plan consists of the concurrent collection of interview and survey data in conjunction with student persistence data, determining whether career goals and/or self-efficacy measurements relate to persistence data, and investigating the details of that relationship through interviews.

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