

Content and Choices: An exploration of career goals in undergraduate engineering students

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ABSTRACT

The careers that students pursue after graduating from engineering programs are a central component to engineering education. However, we lack perspective on how students, the main stakeholder of the engineering education system, describe the goals they have for their post-graduation careers and make choices related to those goals. As a first step in closing this gap, I explored the different types of career goals that students have, investigated how students connect different types of goals to choices they make in engineering programs, and developed a survey instrument for future research on career goals. My sequential mixed methods study consisted of three phases. In the first phase, I analyzed interview data via the constant comparative method to explore the different types of career goals that students described. In second phase, I used the types of goals identified in phase one to analyze how students described connecting their career goals to choices they made as undergraduates in longitudinal interview data. In the final phase, I adapted the ideas from phase one and phase two into a quantitative survey instrument, which I piloted for validity and reliability. My study produced four main outcomes. The first outcome was identifying two distinct types of career goals held by students including goals about the jobs students want post-graduation and goals relative to job attributes rather than specific jobs. The second outcome was that students connected both types of career goals to choices they make in the present academic context. The third outcome was that career goals and their connection to choices students make could be measured in a valid, reliable survey instrument. Finally, my results suggest that there may be differences in the ways that male and female students describe their career goals and the ways that career goals are connected to choices. These outcomes have broad implications for students, educators and researchers in the engineering education system.

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GENERAL AUDIENCE ABSTRACT

The careers that students pursue after graduating from engineering programs are a central component to engineering education. However, we lack perspective on how students, the main stakeholder of the engineering education system, describe the goals they have for their careers after graduation and make choices related to those goals. As a first step in closing this gap, I explored the different types of career goals that students have, investigated how students connect different types of goals to choices they make in engineering programs, and developed a survey instrument for future research on career goals. My study had three phases. In the first phase, I conducted an open-ended analysis of interview data exploring the different types of career goals that students described. In the second phase, I used the types of goals identified in phase one to analyze how students described connecting their career goals to choices they made as undergraduates. In the final phase, I adapted the ideas from phases one and two into a survey instrument, and performed the initial distribution of that survey. My study produced four main outcomes. The first outcome was that there are two distinct types of career goals that students have: those that are about the jobs and career choices students want to make, and those that are independent of job and career choice. The second outcome was that students connected both types of career goals to choices they make in the present academic context. The third outcome was that career goals and their connection to choices students make can be measured using my survey instrument. Finally, my results suggest that there may be differences in the ways that male and female students describe their career goals and the ways that they are connected to choices. These outcomes have broad implications for students, educators and researchers in the engineering education system.

Dedication

When you work towards something, and then work *on* that thing, for such a huge chunk of your life, the feeling of relief you get when you *finally* put your struggles and uncertainty behind you is indescribable. I did not always think I would finish, but I often thought of what putting this behind me would feel like. In something that takes so long and has so many challenges, it is hard for one to look back after leaving, take everything in and say for sure, “I made the right choice.” All that you can say is “I made a choice.” If, after saying that, you can say, “I am happy,” try not to think back on anything else with regret. You made it to a place that can be hard to reach, regardless of whether or not you can call yourself “doctor.” To all of the graduate students who struggle in so many ways, this is for you. There is light at the end of the tunnel, and there are many paths to reaching it. No matter which path you choose, be sure it makes you happy.

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Glossary of Terms

Goal content – A desired outcome that somebody has.

Post-graduation career goal content (PGCG Content) – A desired outcome that an undergraduate engineering student has for their career after graduation

Job goal content – A desired outcome about a job or type of job a student wants

Ambiguity – Considerations that make stating job goal content more complicated or difficult

Attribute goal content – Desired outcomes about careers that are independent of a job to type of job

Specificity – The level of detail somebody uses to describe his or her goal content

Goal Commitment – How important the accomplishment of a goal is to somebody

Mechanism – The means by which somebody moves towards achieving a goal

Deciding – A mechanism of involvement with a task

Persisting – A mechanism of continuation with a current task

Planning – A mechanism of considering a future task

Connection – A described relationship between PGCG content and a mechanism choice

PGES – Post-graduation career Goals of Engineering Students (survey instrument), designed to measure job goal content, ambiguity, connection and goal commitment

1. Dissertation Overview

As engineering educators, we often tell our students that we are preparing them for their post-graduation careers. Consequently, our curricula include outcomes about preparing students for professional engineering settings. But how does the student perspective about these career possibilities influence the choices they make? My dissertation research investigated how students consider post-graduation career goal (PGCG) content and the mechanism choices students make to reach those goals. Goal content is the desired outcome that an individual wants to achieve, and mechanisms represent the actions that individuals take towards achieving those outcomes. A goal is a PGCG if it has to do with a student's professional life after graduating from an undergraduate program. **The purpose of my dissertation research was to explore and operationalize the student perspective on PGCG content, and how that content is used to choose mechanisms.**

To accomplish this purpose, I conducted three studies within a sequential mixed methods design (Creswell, 2013; Creswell & Clark, 2011). In Study 1, I examined how students described PGCG content, of which I identified different subtypes. In Study 2, I used longitudinal interview data to explore the connection between PGCG content and mechanism choices. In Study 3, I used outcomes from these qualitative studies (i.e., Study 1 and Study 2) to create a quantitative instrument that can be used to measure the connection between post-graduation career goal content and mechanism choice. The first two studies produced outcomes that included constructs and theory that characterize PGCG content, while the outcomes from the third study provided a tool for operationalizing this characterization in future research and practice. Combined, these three studies constitute a significant contribution to the field of engineering education.

1.1 Need for Research

The need for research on PGCG content has root in both the need for more exploration of the theoretical construct of PGCG content within the setting of undergraduate engineering education. Through research, we have evidence that PGCG content relates to important outcomes in engineering education, yet we do not yet have research that provides theoretical grounding for understanding its impacts. Within undergraduate engineering education specifically, engineering educators often point to student careers as a crucial consideration in engineering programs, yet we know little about students' goals. Filling the need for this research has potential implications for three groups of stakeholders including students, engineering educators, and researchers.

1.1.1 Students, goals and choices

Students enter undergraduate engineering programs with PGCG content. Some students have PGCG content about jobs or career paths that they want to pursue. Other students lack goals about jobs and career paths, but still describe desired outcomes for their careers such as monetary benefits and work-life balance. (Hilpert, Husman, & Carrion, 2014; Pierrakos, Beam, Constantz, Johri, & Anderson, 2009; Sheppard et al., 2010). These studies suggest that different kinds of PGCG content exist, and that they may play a role in student outcomes such as major choice or learning. However, PGCG content is not the focus of these studies: researchers did not explore what it is, or place it in a theoretical context in which its effects can be explored and grounded for future use.

Beyond PGCGs, existing research has explored many different goal-related theoretical constructs. For example, orientation, or perspective that students take in setting course-level academic goals, can affect learning outcomes (Ames & Archer, 1988). Additionally, the presence of some goals, such as the goal to graduate with an engineering degree, is a predictor of that

goal's achievement (Lent, Brown, Schmidt, et al., 2003). Finally, we know that past experiences and personal beliefs play an important role in the student's choice of academic and career goals (Lent, Brown, & Hackett, 1994; Lent, Brown, Nota, & Soresi, 2003). Previous research on goals is informative for PGCG content research, as it also shows that goal-related constructs can relate to educational outcomes. However, the usefulness of previous goal research to the study of PGCGs is limited due to lack of research on goals of similar time frames to PGCGs. Most goal research focuses goals of a more proximal (short-term) nature, as opposed to the more distal (long-term) PGCG content.

Proximal and distal are relative terms. As for the time frames of goals in existing research, the goals that I describe as proximal are those that are over the time frame of a few days to those that are over the course of an entire academic term. The goals that I describe as distal are over the course of multiple academic terms, or apply to events that will occur after graduation (e.g. graduating with a degree, PGCGs). Research on proximal goals has explored different theoretical constructs (e.g. orientation, specificity) in different settings (e.g. course-level academic settings, program-level academic settings, experimental settings, work-place settings) (Elliot, Murayama, & Pekrun, 2011; Hollenbeck & Klein, 1987; Locke, Chah, Harrison, & Lustgarten, 1989; Locke & Latham, 2013; Morisano, Hirsh, Peterson, Pihl, & Shore, 2010; Seijts & Latham, 2000; Senko, Hulleman, & Harackiewicz, 2011). Theoretical constructs that were developed in goal-related research provide both a lens for understanding goals, and a reference point for future research. However, the exploration of more distal goals has been limited in the constructs explored to the presence or absence of goals, e.g. Lent et al. (2008); Pierrakos et al. (2009), and in a more limited number of settings. This leaves room for more

research on distal goals, especially research that explores theoretical constructs to provide both a lens for more understanding and theoretical grounding.

1.1.2 Goals are central to engineering education outcomes

The need for understanding PGCG content also stems from the needs of engineering educators, administrators and policy makers. From a national perspective, engineering educators often point to the expectations of industry stakeholders when determining the target outcomes for our engineering programs. How we prepare students for their futures in industry, and how we provide industry with the future employees, have been the topics of research studies (Lang, Cruse, McVey, & McMasters, 1999; Prados, Peterson, & Lattuca, 2005), and often-referenced reports on the current and future states of engineering education (Clough, 2004; Olson & Riordan, 2012; *Rising above the gathering storm: Energizing and employing America for a brighter economic future*, 2007). The skills and perspectives needed by future engineers working in industry have also shaped the highest-level outcomes used to evaluate engineering programs, as defined by ABET accreditation. For example, the need for engineers with more well rounded professional skills led to the development of the ABET 2000 and the a-k outcomes. The ABET a-k outcomes are used in the assessment of every accredited engineering program in the United States. (Commission, 2003; Fromm, 2003; Passow, 2012)

Many engineering programs also state their own outcomes related to preparing students for future careers. For example, some programs describe the specific careers for which they are preparing students ("Biology & Biomedical Engineering," 2014) . Others aim to introduce students to career possibilities through career services and counseling in order to guide them towards degree programs and their place in the post-undergraduate world ("Career Information," 2014). Still others aim to help students reach their own career goals ("Engineering at Union,"

2014; "Our Majors," 2014) or advertise the employability of those who obtain engineering degrees ("Career Outlook," 2014).

These national and programmatic needs show that the careers of engineering students are important to the enterprise of engineering education and to the assessment of outcomes on both a national and institutional level. The importance of preparing students for careers also relates to the needs of researchers at the theoretical level as to the manner in which PGCG content influences student mechanism choices and outcomes: choices and outcomes that directly influence whether and how students enter engineering careers.

The exploration of PGCG content in my dissertation fills research needs on two levels. Within the setting of undergraduate engineering education programs, it provides more insight into the careers that students want to pursue after graduation, a topic of value to engineering educators at different levels. Theoretically, it provides an exploration of a theoretical construct, goal content, that could be related to engineering education related outcomes, for goals of a more distal time frame than those normally studied in goal research.

1.1.3 Needs of stakeholders

As argued, we do not have a good understanding of how distal goals like PGCGs impact engineering student mechanism choices in the present. Understanding how students consider PGCG content when making near-term choices is important for three groups of stakeholders. These stakeholders, and the research implications from my dissertation related to each are outlined in Table 1.

1.1.3.1 *Students*

The research in this dissertation directly impacts students by implicating that students who have more self-awareness about their own PGCGs might help themselves develop an

Table 1.1

Implications for stakeholders

<u>Stakeholder</u>	<u>Why they care about PGCG content</u>	<u>Implications from dissertation</u>
Students	Goal content helps guide students in choosing mechanisms	This dissertation provides the insight for students to build upon their intrapersonal foundation and self-authorship by being aware of how PGCG content factors into their choices (mechanisms).
Engineering Educators	Use careers in their program outcomes and in the advertisement of their programs	<p>The ways that engineering programs present potential careers to students could specifically address job goal content, attribute goal content and ambiguity in job goal content that students might have.</p> <p>Within the classroom, educators could connect material to relevant future careers.</p> <p>My survey instrument could be used to assess PGCG related outcomes that programs have.</p> <p>Educators could consider the meaning and implications of our students being ambiguous about their careers.</p>
Researchers	Goals are related to often-researched outcomes like learning, persisting with an engineering major, and major choice	<p>The emergent concept of ambiguity in job goal content is related to the existing GST construct of specificity.</p> <p>An example of how researchers can explore content for distal goals in future research.</p> <p>Career decision-making researcher gain a new perspective on how individuals make choices about careers.</p> <p>Researchers studying differences between students by gender gain an important consideration on potential differences between male and female students.</p>

intrapersonal foundation, and achieve self-authorship (Magolda & King, 2004). The exploration of the different kinds of PGCG content from this dissertation, combined with examples of how they are used by students to choose mechanisms, could be used as a lens for individual students to understand their own goals and how they factor into their own mechanism choices.

1.1.3.2 Engineering Educators

My dissertation also has implications for engineering educators: the faculty, graduate students, and staff who develop, assess and administer curricula in engineering programs. The outcomes of my dissertation provide engineering educators with a new way of viewing the possible career goals that students have, and how they use those goals to choose mechanisms like major choice or persisting with a major. This new understanding could help engineering educators set or modify career-related outcomes, and encourage more connection between classroom material and student PGCGs. Engineering educators could also use the survey instrument developed in this dissertation to assess PGCG-related outcomes.

1.1.3.3 Researchers

The final group of stakeholders in this dissertation is researchers in education and engineering education. There are implications for users in goal setting theory in the exploration of the construct of goal content, and the connection of the new concept of job goal content ambiguity to the existing construct of specificity. Researchers who investigate distal goals now have an example of how they can expand the construct of goal content within a certain context. There are also implications for researchers who study gender in engineering programs, as the results of this dissertation suggest that there may be differences in the ways that women and men perceive their PGCG content. Note that, even though some students were asked to report their

“sex” as part of data collection in this study, I discuss all results of this nature gender due to best practices suggested by the American Psychological Association (Association, 2012).

1.2 Defining a framework

My investigation requires a multifaceted framework that places both the makeup of goals and the choice made using goals in context. Goal Setting Theory (Locke & Latham, 1990, 2002, 2013) provides a framework that fits this need. Goal Setting Theory (GST) describes the interactions between three things: a *goal core* containing a desired outcome (the goal itself); *mechanisms*, which are the means through which goals are achieved; and beliefs called *moderators* that individuals take into account when choosing mechanisms. The interactions between the goal core, mechanisms and moderators lead to performance results related to goal achievement. The individual’s interpretation of these performance results leads to updated beliefs. This cycle is show in Figure 1-1.

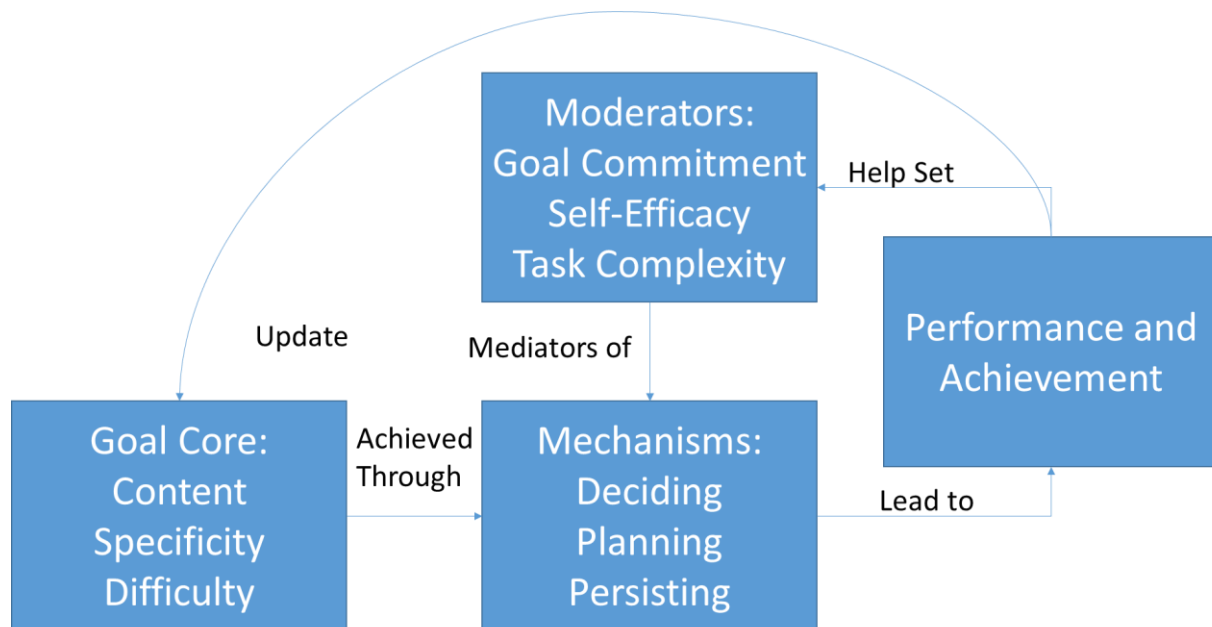


Figure 1-1: The representation of a goal, moderators, mechanisms and performance in GST. Adapted from Locke and Latham (2002)

1.2.1 Goal Setting Theory concepts

In GST, a goal is characterized by a *goal core* that is comprised of three elements: content, specificity, and difficulty. The *content* corresponds to what the term goal typically means in everyday usage: it defines the desired outcome (e.g. having a job designing spacecraft). *Specificity* characterizes the level of detail provided in defining the content (Locke & Latham, 1990, 2002, 2013). Specificity helps differentiate between the two examples: “I want to design parts for spacecraft” and “I want to design navigation systems for spacecraft.” The latter example has another level of detail and, thus, is an example of goal content with higher specificity. *Difficulty* characterizes the perception of how hard the goal core goal is to achieve (Stedry & Kay, 1966). Each goal held by an individual has its own content, specificity and difficulty.

Mechanisms are the means to achieve goals that individuals choose. Examples of mechanisms include setting smaller goals related to achieving a larger goal, persisting with a task related to achieving a goal, and deciding to take part in tasks related to achieving the goal (Locke & Latham, 1990, 2002, 2013). For PGCGs, planning might consist of considering possible internships, persisting might be remaining enrolled in the engineering program, and deciding to take a certain class.

Moderators are beliefs and perceptions about achieving the goal. The beliefs and perceptions can either be about a goal or about the mechanisms used to achieve it. Moderators identified in GST include: goal commitment, self-efficacy and task complexity (Neubert, 1998; Schmidt & DeShon, 2009). *Goal commitment* characterizes the strength of the desire to accomplish the goal (Hollenbeck & Klein, 1987; Hollenbeck, Klein, O'Leary, & Wright, 1989; Klein, Wesson, Hollenbeck, Wright, & DeShon, 2001; Locke, Latham, & Erez, 1988; Seijts & Latham, 2000). *Self-efficacy* characterizes one's own perception of his or her ability to achieve a

goal or perform a mechanism (Bandura, 2010; Bandura & Cervone, 1983; Schmidt & DeShon, 2009). *Task complexity* characterizes the perceived level of challenge and cost associated with mechanisms that could be used to achieve a goal (Campbell, 1988; Wood, 1986).

Note that some constructs classified as moderators are directly related to constructs classified as part of the goal core. Goal content is a descriptive constructs defining the desired outcome of a goal. Commitment is a moderator construct bound to that description. One cannot have commitment to a goal without content for a goal (i.e. without the existence of a goal). What makes commitment a moderator in Locke and Latham's GST theory is, in part, its use as a global construct applied to multiple different goal cores (Hollenbeck & Klein, 1987; Klein et al., 2001; Locke et al., 1988; Seijts & Latham, 2000).

During formative GST research, there was also a contextual difference between the constructs of the goal core and the constructs defined as moderators in how they were used, in practice. In that research, goal content was assigned to individuals in experimental settings, with varying levels of specificity and difficulty as independent variables (Locke, 1996; Locke et al., 1989; Locke & Latham, 1990, 2002, 2013; Locke et al., 1988). Moderators, on the other hand, were internally held beliefs of individual participants that could not be controlled. Instead, moderators had to be measured separately, usually using self-reported measures. These are the determinants of how individuals choose mechanisms and achieve goals: the dependent variables within these experimental designs.

Within the GST framework, *performance and achievement* related to goals are the final component of the model, representing the end point of the goal setting process. The individual's successes or failures in performance and achievement related to goals help to set new beliefs and

update the goal core itself. This completes the cycle of goal setting: new or re-affirmed goals are set, and the process begins again.

Using GST, researchers have explored the effects of goal cores and moderators on both mechanisms and performance. The relationship between a goal and performance is strongest in goals to which people are more committed (Hollenbeck & Klein, 1987; Locke & Latham, 2002). Self-efficacy affects the mechanisms that people choose; people will generally gravitate towards the types of tasks at which they believe they are most likely to succeed (N. E. Betz, 1986). This means that self-efficacy has an effect on how people choose mechanisms. . When setting their goals, people with higher self-efficacy in a domain often set more ambitious goals (Locke, Motowidlo, & Bobko, 1986). For instance, somebody with higher self-efficacy in engineering might set a goal of graduating with an engineering degree *cum laude*, or within four years, while somebody with lower self-efficacy might set the goal of simply graduating with an engineering degree.

1.2.2 Limitations of prior Goal Setting Theory research

Previous GST research has investigated the relationship between different constructs in GST, and how the time frame of goals can affect outcomes. However, there are limitations to how previous GST research can inform current PGCG research. These limitations stem from differences in time frame and context between previous GST research and research on PGCG content. With respect to time frame, the goals investigated within previous GST research were of a more proximal time frame than the more distal PGCGs that I am studying. Contextually, GST research has investigated goals in experimental, work-place and academic achievement (i.e. performance on academic tasks) settings (Locke & Latham, 2013). Both of these differences are

discussed as this section continues, as well as the use of ideas from another framework, Social Cognitive Career Theory (SCCT), more fully inform my dissertation research.

Within GST research, the time frames of goals have been shown to affect performance. The more proximal a goal is to a task, the more strongly correlated are the goal achievement and the task performance (Latham & Seijts, 1999; Manderlink & Harackiewicz, 1984). For example, a person working on a puzzle is more likely to finish the puzzle quickly if he sets a goal of completing the puzzle in a certain time, as opposed to a goal about solving a series of puzzles including the target puzzle. The former is a more proximal goal; it relates directly to the task at hand. The latter is a more distal goal; it is further from what is being done, but is nonetheless related.

Significantly, people can have both proximal and distal goals for a task, and these goals interact. The presence of both proximal and distal goals leads to improved performance over exclusively having proximal or distal goals (Latham & Seijts, 1999; Seijts & Latham, 2001). Other research found that while proximal goals predict immediate performance, distal goals predict persisting in longer-term tasks, like pursuing an undergraduate degree (Lent, Brown, Schmidt, et al., 2003; Lent et al., 2005).

While GST provides a robust set of constructs for studying goals, the published GST research only provides limited information about distal goals. A literature review of studies related to goals showed that the vast majority of goal-related studies address relatively proximal goals (Klein et al., 2001). Even GST research investigating differences between proximal and distal goals generally focused on activities that are of rather short duration (Latham & Seijts, 1999; Locke & Latham, 2013; Manderlink & Harackiewicz, 1984; Seijts & Latham, 2001). Thus while the goals measured involve different time frames, all the time frames considered are still

comparatively proximal to goals such as PGCG content. For example, the goals may relate to a task that is happening five minutes from now versus the culmination of multiple iterations of that task one hour from now. Such studies provide limited insight with respect to the relatively distal post-graduation goals.

Moreover, many studies on goal time frames involve experimental setups, with activities such as performing a word search puzzle, proximal goals related to specific instances of the puzzle, and distal (but still near-term) goals for knowing how to do the puzzle (Manderlink & Harackiewicz, 1984). For studies conducted over a short time frame (e.g. solving puzzles), you can run an experimental setup that controls for the goals given to participants. However, for distal goals that are years away it is impractical to control for content. For these reasons, I have looked to other theories to help me contextualize PGCGs within GST.

For insight into distal time frames and non-experimental setups, I turn to research based on Social Cognitive Career Theory (SCCT) (Lent et al., 1994). Both SCCT and GST emerged from the same lineage of inter-related theories emergent from social cognitive theory (Bandura, 2010; Bandura & Cervone, 1983). Theories in this lineage contain similar concepts, such as self-efficacy and proximity. However, where GST explores how goals relate to behaviors and performance, SCCT focuses on how goals develop through previous experiences and social moderators.

It is likely that this difference in focus causes GST and SCCT research to differ in the time frame of goals being investigated. As GST sets out to describe the interaction of goals, mechanisms, and goal achievement, it makes sense that the research around the theory's development is focused on proximal situations that allow for the control of those constructs. SCCT, on the other hand, focuses on how goals develop. SCCT research explores how people

take their experiences and beliefs into account when setting goals. As SCCT research looks at the development of career goals, it makes sense that the time frame of goals investigated using SCCT is of a more distal nature. These studies usually explore how goals develop in K-12 students over time, considering the influence of experience, socializers and upbringing.

Research using SCCT provides insight into distal goals. With SCCT, the presence of distal goals has been shown to be a predictor of their ultimate achievement. Some of these studies investigate the development of pre-graduation and graduation-level goals in undergraduate engineering students, though not the more distal PGCGs. (Lent & Brown, 2006; Lent, Brown, Schmidt, et al., 2003; Lent et al., 2005) Through these studies, we know that the presence of distal goals is important in relation to the realization of those goals. For example, the presence of a goal to obtain an engineering degree predicts the attainment of that degree.

SCCT also provides insight into how goal content is developed. SCCT suggests that people interpret their upbringing, personal traits and past experiences in developing career goals and actions. Research supports these theoretical ideas. Studies have shown, for example, that if individuals in underrepresented groups have negative experiences in math, science and engineering that relate to their gender or ethnicity, those experiences will affect subsequent choices that they make about enrolling in those areas of study as undergraduates and the career goals they set related to those areas (Bell, Spencer, Iserman, & Logel, 2003; Hackett, Betz, Casas, & Rocha-Singh, 1992; Lent et al., 2008; Schmidt & DeShon, 2009; Spencer, Steele, & Quinn, 1999). Other studies have shown that socio-economic status, geographic location and the higher-education experiences of parents have similar influences on goal development (Boynton, Carrico, Matusovich, Paretto, & Taylor, 2013; Boynton, Carrico, Paretto, & Matusovich, 2013; Carrico, 2013).

Nonetheless, SCCT-based research on distal goals is also limited in that it focuses mainly on identifying the important mediating factors in goal development (Lent et al., 1994; Lent, Brown, Nota, et al., 2003; Lent et al., 2005). For example, someone's upbringing and developmental experiences can play a large role in the goals that they set.

What existing research does not explore in as much detail are the connection between the content of goals and mechanism choices individuals make towards the achievement of goals. Recall that I am investigating how PGCGs are considered mechanism choices. GST is a more appropriate framework for this study because it considers the factors mediating the presence of goal content and the mechanism choices that individuals make and SCCT does not. It is for this reason that I chose GST as my framework. My dissertation does, however, consider the implications of ideas from SCCT research that reflect the potential effects of more distal goal time frames.

1.3 Research questions and methods

The overarching question for this study is, **“What is post-graduation career goal content, and how do undergraduate engineering students use it to choose mechanisms?”** I have explored this overarching question through the following research questions, each of which corresponds to one of the bullet points above:

RQ1: What are the characteristics that undergraduate engineering students describe about their post-graduation career goal content?

RQ2: How do undergraduate engineering students consider different kinds of post-graduation career goal content when they choose mechanisms throughout their undergraduate studies?

RQ3: How can the connection between post-graduation career goal content and mechanism choices be measured separately from other goal-related constructs?

Each of these questions represents a step towards understanding PGCG content in undergraduate engineering students. As noted earlier, I answered these questions separately in a sequential mixed methods study, with each question corresponding to the three studies in this dissertation (Borrego, Douglas, & Amelink, 2009; Creswell, 2013; Creswell & Clark, 2011).

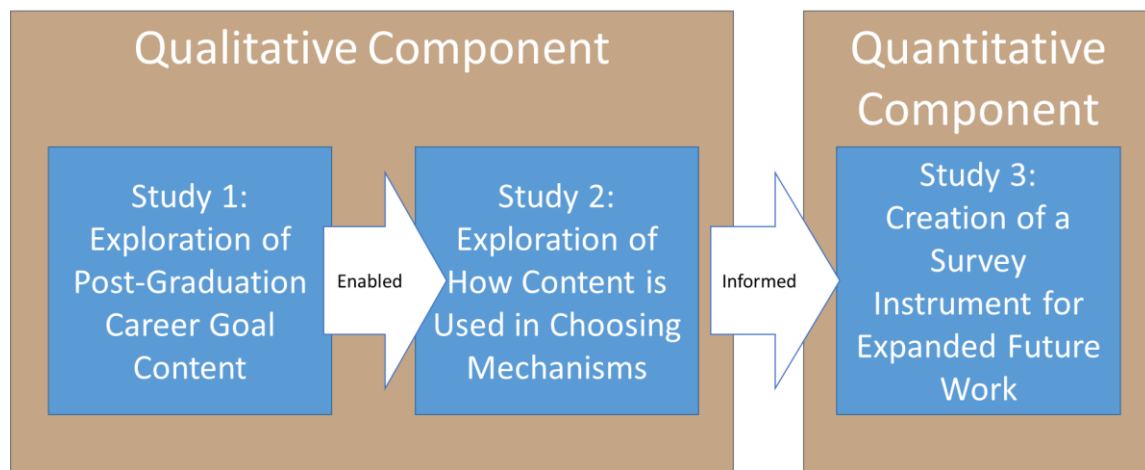


Figure 1-2: An overview of the studies in this dissertation.

1.3.1 Overall National Science Foundation Study

The existing data used in this dissertation was collected as part of a National Science Foundation-funded study (Award #0936704). The NSF study investigated the effect of different first-year engineering pedagogies on the motivation and retention of female engineering students (Jones, Osborne, Paretti, & Matusovich, 2012; Matusovich, Jones, Paretti, Moore, & Hunter, 2011; Matusovich, Paretti, Jones, & Brown, 2012). There were two sites for the study, University 1 (U1) and University 2 (U2). Both schools are large, public universities with engineering programs. The U1 course used a problem-based learning approach exclusively, while the U2 course used a more traditional engineering design approach.

Data collected for the NSF study included observations of students and facilitators, interviews with students, and quantitative student survey data. My dissertation involved a secondary analysis on a subset of the interview (Glass, 1976; Heaton, 2008). Within interviews, interviewers specifically asked students about their plans after graduation and how they related to their current undergraduate career, thus making the data relevant to my study.

The target population for my dissertation consisted of undergraduate engineering students with no restriction on academic year, traditional vs. non-traditional students or demographics. To this end, the existing NSF data provided access to interviews with students who fall within that target population across multiple academic years and programs of study.

1.3.2 Study 1: Methods and results summary

I used a total of 32 participant interviews in Study 1— 18 from site U1 (10 male, 8 female), 14 from site U2 (3 male, 11 female). The coding methods used for this study borrow from the constant comparative method developed by Strauss and Corbin (1990). The analysis resulted in the identification of two main types of PGCG content. PGCG content divided into two main types: job goal content and attribute goal content. Job goal content included descriptions of PGCG content that has to do with specific jobs or types of jobs. Job goal content also included descriptions of ambiguity regarding the specific job they might have in the future. Attribute goal content included descriptions of PGCG content that are independent of a specific job or type of job. This included things such as wanting job security, wanting to help others in a career and wanting to enjoy the work that you do.

1.3.3 Study 2: Methods and Results Summary

For investigating how students considered PGCG content when considering mechanisms, Study 2 included a sub-population of the Study 1 participants who were also interviewed after

two and three years of undergraduate study. The population for Study 2 included six students from U1 (2 female and 4 male) and seven students from U2 (6 female, 1 male). I used case study methods (Miles, Huberman, & Saldaña, 2013) where each student's sequence of three interviews was an individual case. I used both an *a priori* code book containing the codes from Study 1 and additional *a priori* codes related to mechanisms and mechanism choice. Each individual case provided examples of PGCG content and their connection with mechanism choices. From these examples, I found that mechanism choices connected with different types of PGCG content. There were multiple cases in which students described job goal content, attribute goal content, and ambiguity in job goal content as reasons for choosing a mechanism. Throughout the three years they were interviewed, some students chose mechanisms based only on job goal content, but most chose mechanisms based on more than one type of content.

1.3.4 Study 3: Methods and results Summary

The objective of Study 3 was to create an instrument that quantitatively operationalized the connection between PGCG content and mechanism choices. To begin doing so, I considered the results from Study 1 and Study 2. To make the survey easier to complete in a timely manner, I narrowed the focus of my survey to job goal content, and asked students only about the career choice that students will make *immediately* following completion of an undergraduate program. I then administered the survey to a focus group of four undergraduate engineering students and used their feedback to revise the instrument. After revisions, I distributed the survey instrument to engineering students at five institutions, which resulted in 288 completed surveys.

After piloting the survey, I performed an exploratory factor analysis of survey items. My goal was to see whether items regarding the connection between PGCG content and mechanism

choices loaded onto different factors from items intended to measure other goal-related concepts.

This resulted in four factors:

1. A factor containing items asking about Specificity and Ambiguity in job goal content
2. A factor containing items asking about Goal Commitment
3. A factor containing items asking about the connection between wanted job goal content and mechanism choices
4. A factor containing items asking about the connection between ambiguity in job goal content and mechanism choices

Each of these factors had an acceptable Cronbach's α internal consistency score (>0.70) after the removal of some lower-performing items. This validated that the survey design is able to explore the connection between PGCG content and mechanisms distinctly from other GST constructs. I elaborate on this meaning in Chapter 4.

1.3.5 Limitations

There are limitations to my dissertation study that affect the implications of this study. These limitations extend to the conclusions that can be drawn from the data collected, the populations to which these conclusions apply, and the manner in which stakeholders will be able to use the results of this study.

One limitation is the use of secondary analysis. As I neither created the interview protocol nor conducted the interviews, I had no control over the direction and focus of those interviews. This means that I was not able to explore some pertinent topics that I could have explored in a protocol designed specifically for this study. For example, I might have directly asked students about how their goals connected to the mechanisms they chose. A second limitation is that the results presented are not generalizable to engineering students as a whole.

The findings of the first two studies are qualitative and of an exploratory nature. Qualitative studies, by their nature, are not meant to generalize results to a large population, but rather to describe the experiences of a specific selection of that population to generate new ideas for inquiry. Furthermore, the population used for the pilot data collection in the third study was not intended to be a statistically representative sample of the overall undergraduate engineering student population. Thus, any preliminary results from this survey may not generalize to the overall population of undergraduate engineering students. However, the results do show that the survey is valid and internally consistent, and further our understanding of hour ambiguity and specificity might relate to one another.

While the above-mentioned considerations limit the potential usefulness of the results of this study, the findings and contributions still provide a significant contribution to education and engineering education research, and have benefits to stakeholders in both research and practice.

1.4 Summary of contributions from this dissertation

While I support the development of the outcomes of this dissertation in the following four chapters, I will briefly summarize the main contributions of my dissertation in this section. In the context of undergraduate engineering students, my study provides:

- A theoretical grounding for different types of PGCG content;
- A theoretical grounding for descriptions of the ways that PGCG content is used to choose mechanisms;
- A tool that can be used for future research and assessment needs around PGCG content; and

- Initial results suggest that there may be differences in how frequently male and female students described ambiguity in their job goal content, and how frequently they made choices in connection to that ambiguity.

As a result of my study, there is now a theoretically grounded distinction between two types of PGCG content for undergraduate engineering students: the jobs they want (job goal content) and the more general outcomes that students want from their careers (attribute goal content). Within job goal content, some students describe ambiguity: factors that make describing that content more complicated. This outcome lays the groundwork for future research on PGCGs, and provides educators with a new way of understanding the goals that students in their programs have.

The second contribution of my study is an understanding of how PGCG content relates to the mechanism choices of undergraduate engineering students. Participants whose interviews were analyzed in Chapter 3 could be grouped based on the different types of content that they used to choose mechanisms. Notably, some students connected their mechanism choices to only their job goal content, while the majority of students used a combination of different kinds of content.

These groupings also corresponded to specificity in their job goal content: Students with high specificity made more mechanism choices considering their job goal content, whereas students with low specificity made more mechanism choices when considering ambiguity in their job goal content and their attribute goal content. These patterns suggest that different kinds of PGCG content, along with the specificity of some PGCGs, are related to engineering education outcomes like the choice to persist and major choice.

To facilitate continued research on PGCG content, I created a survey instrument capable of measuring some types of PGCG content and the connection of that content to mechanism choice. Initial validity and reliability tests show that this instrument can measure ambiguity in job goal content as well as the connection between mechanism choices and both wanted job goal content and ambiguity in job goal content. It can also be used to qualitatively poll students on their job goal content. This instrument can facilitate future work to confirm and generalize the findings of this dissertation, and could also be used as a tool for assessing PGCG-related outcomes.

Finally, a pattern of differences was observed across gender in the first two studies of my dissertation. In Study 1, more female students reported ambiguity in job goal content when compared to male students. In Study 2, more female students chose mechanisms that they connected to their ambiguity in job goal content when compared to male students. Female students also had lower specificity in their job goal content. These patterns may be of importance to researchers and educators interested in the experiences of women in engineering programs.

2. What are you going to do next? Understanding post-graduation career goals in undergraduate engineering students

2.1 Introduction

In engineering education, we place a great amount of importance on preparing students for careers. However, the process of preparing students for careers is not complete without a full understanding of how students perceive their future careers. One lens we can use to understand how students perceive their careers is that of goals. However, we know less about career goals than we do about other kinds of goals. Other kinds of goals, like shorter-term goals about coursework and academics, have been directly connected to outcomes like learning and persistence in majors. While research has suggested that career goals may also relate to these outcomes, we lack research that explicitly explores career goals and their connections to outcomes. The purpose of this study is to begin the exploration of career goals of undergraduate engineering students.

The need for career preparation in engineering programs is described on multiple levels. Nationally, there has been a call to prepare the education system to produce more graduates who are prepared to embark on careers in STEM fields (Olson & Riordan, 2012). When engineering schools describe their recruiting methods in publications, authors highlight the importance of career-related opportunities that they provide for prospective students (Davis, Yeary, & Sluss Jr, 2012; Yates, 2012). When we look at how individual programs and departments advertise themselves, we see examples of programs citing the career possibilities for the degrees they award, the guidance they provide in achieving career goals, and their success in preparing students for specific careers ("Biology & Biomedical Engineering," 2014; "Career Information," 2014; "Career Outlook," 2014; "Engineering at Union," 2014). These advertisements assume that students plan and set post-graduation goals. Ultimately, when viewed from different levels, the

message is the same: we want students to be prepared for engineering careers, and we want our academic programs to provide needed guidance and preparation. However, we cannot provide the proper guidance and preparation if we do not fully understand how students perceive their future careers.

One way we can approach students' perceptions of their future careers is by considering their career goals. A goal is a desired outcome held by a person. Goals can be a lens for understanding how people perceive a future outcome like a career. Goals are also useful because existing research has linked them to outcomes such as learning and persisting with a major.

However, there are gaps in our understanding of goals. Goals can be for desired outcomes of different time frames. Within those time frames, we know less about longer-term (distal) goals like career goals than we do about shorter-term (proximal) goals. This is pertinent to investigating how students view careers, as the goals that students will have about their careers are of a more distal nature.

Existing research on proximal goals highlights the conceptual usefulness of goals as a theoretical lens to understand careers. Research has linked some goals related to academics and coursework to the ways that people approach learning activities, with some approaches correlating to deeper learning. For example, different rationales, or orientations, for setting goals led students to choose different learning strategies and ultimately learn subject matter in different ways (Ames & Archer, 1988; Elliot, McGregor, & Gable, 1999; Senko et al., 2011). Research also shows that encouraging students to set goals can be beneficial. For example, Morisano et al. (2010) conducted an intervention that helped university students set academic goals. When compared to students in a control group, students who received the intervention were more likely to remain enrolled as full-time students, and had a significant increase in their GPAs.

While the presence of distal goals, such as the goal of obtaining an engineering degree, predicts the achievement of said goals (Lent, Brown, Schmidt, et al., 2003), we know less about students' career-related distal goals. Understanding the post-graduation career goals (PGCGs) that students have in a similar way that we understand goals that are more proximal, could help researchers and educators investigate and understand the ways that PGCGs affect outcomes of importance to the engineering education community, such as persisting and major choice. I argue that we should be asking directed questions about the content of PGCGs to help establish a detailed, theoretically grounded description of PGCGs.

Existing research supports this argument, as findings suggesting the importance of PGCG content have emerged from other studies. For example, the multi-institution Academic Pathways Study (APS) demonstrated that more than half of the students who responded to the survey reported that they would pursue an engineering career (Sheppard et al., 2010). Another 17% of students indicated plans to enroll in engineering graduate school. This understanding is simple, but still important: many of our students are planning to pursue engineering careers.

Similarly, research also indicates that PGCGs are about more than just the types of jobs that students want. In APS, more than half of students listed financial benefits and the ability to benefit society as a reason for persisting with their degrees (Sheppard et al., 2010). In the Engineering Pathways Study (EPS), Winters (2012) found that some undergraduate students factored balance in their personal and professional lives in choosing their career, and that such considerations only became more important as they entered their post-graduation careers. Finally, Hilpert et al. (2014) describe student goals related to financial benefit, improving their communities and other kinds of professional achievement.

There is also some indication from existing research that PGCGs relate to outcomes such as learning and persisting with an engineering major. Hilpert et al. (2014) found that students' PGCGs were connected to a deeper understanding of material and a connection of the material to their future careers. Additionally, Sheppard et al. (2010) found that most students listed their future careers as reasons to persist in engineering programs, and that more than half the of students listed the monetary benefits of graduating with an engineering degree. This research points towards the content of PGCGs as a valuable topic for continued research.

Accordingly, this study investigated the following research question: **What are the characteristics of post-graduation career goal content that undergraduate engineering students describe?** Note that, in my framework, goal content is the desired outcome that somebody has, or the concept that people would normally associate with the word "goal". My study explores this research question by analyzing interviews in which students describe their future careers. The analysis uses a constant comparative method and expands the construct of career goal content to incorporate the ideas that emerge from those descriptions.

2.2 Framework

The characterization and representation of career goals is central to this study, and I have adopted the framework of Goal Setting Theory (GST) for this purpose (Locke & Latham, 1990, 2002, 2013). GST provides a useful set of connected ideas about goals that provide a valuable lens for looking at PGCGs. These ideas include: a *goal core* containing a desired outcome (the goal itself), the means of goal achievement called *mechanisms*, and beliefs called *moderators* that are taken into context when choosing *mechanisms* (Locke and Latham, 1991). The interaction of the *goal core*, *mechanisms* and *moderators* leads to performance results related to

goal achievement. The interpretation of these performance results leads to updated goal content. This cycle is shown in Figure 2-1.

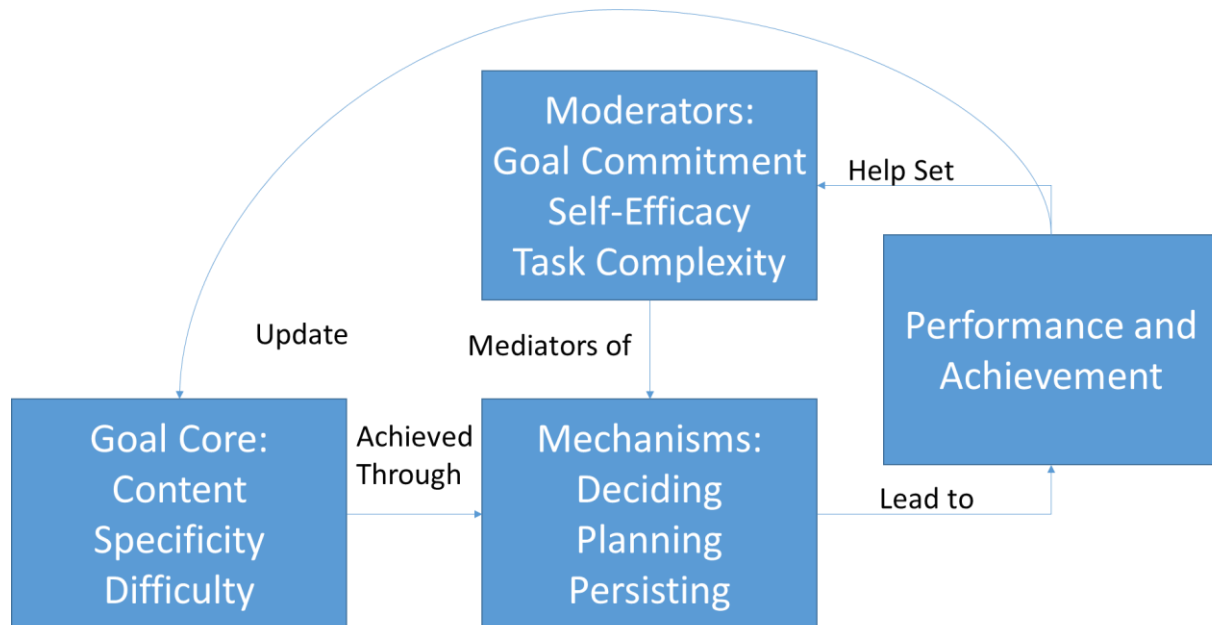


Figure 2-1: The representation of a goal, moderators, mechanisms and performance in GST. Adapted from Locke and Latham (2002)

GST is most commonly used as a framework for highlighting the effects of setting goals on performance and achievement. The concepts of GST were developed by conducting experiments where individuals were given goals of different levels of *specificity* and *difficulty* for different tasks, e.g. Hollenbeck and Klein (1987); Hollenbeck et al. (1989); Locke et al. (1989). Subsequent work has shown that helping individuals to set appropriate goals in workplace and academic settings produces beneficial results (Locke & Latham, 2013). Morisano et al. (2010), for example, highlights how encouraging students to set academic goals can influence students persisting academic major, and learning outcomes.

Within GST, the goal core comprises three components: goal *content*, goal *specificity*, and goal *difficulty* (Locke & Latham, 1990, 2002). Goal *content* is the desired outcome that one intuitively thinks of when using the word goal. *Specificity* and *difficulty* describe properties of goal *content*. *Specificity* is the level of detail that a person uses to describe a goal, and *difficulty* is how hard a person thinks a goal will be to achieve.

Establishing an appropriate model of how students characterize the outcomes within *content* is an important aspect of this research. In most GST research, goal *content* is an independent variable in an experimental setup, assigned to the study subject prior to the performance of the task (Latham & Seijts, 1999; Manderlink & Harackiewicz, 1984; Seijts & Latham, 2001). An experimental approach requires a priori knowledge of the goal *content*, which I do not have in this study: I am studying *PGCG content* that students already have. It is not possible to have knowledge of that *PGCG content* without asking students, nor does this study aim to assign *PGCG content* to students in any way.

Goal *content* is the focus of this study, but not the only pertinent idea. We must understand what *content* is before we can explore its *specificity* or its perceived *difficulty*. I acknowledge that similar ideas to *specificity* and *difficulty* may be present in exploring *content*. In my discussion section, I compare and differentiate some new concepts from the existing constructs of *specificity* and *difficulty*, and describe how future work can examine whether they are the same or different, in practice. Mechanisms are also pertinent to this study, though they are not an area of focus. An exploration of different kinds of PGCG content will be useful for future investigations of how PGCG content relates to mechanism choices.

2.3 Methods

In this study, I used a secondary analysis (Glass, 1976; Heaton, 2008) of previously collected interview data to identify different types of PGCGs discussed in the interviews. I analyzed 32 semi-structured interviews with undergraduate engineering students from two different universities. Interviewers asked participants directly about their PGCGs, how those goals related to the courses they were enrolled in at the time of the interview, and how goals related to the choices they had made about their academic careers.

I used the constant comparison method (Strauss & Corbin, 1990) as my main analytical method in this study. The constant comparison method allowed me to explore, inductively, the concept of PGCG content. By starting with a single, broad concept of PGCG content, finding examples of it, and then comparing those examples to each other, I was able to develop ideas about different types of PGCG content.

2.3.1 Data and collection

The NSF funded study (Award #0936704) for which this data was originally collected investigated the effect of different first-year engineering pedagogies on the motivation and retention of female engineering students. The two research sites and overall methods are described in detail elsewhere (Jones et al., 2012; Matusovich et al., 2011; Matusovich et al., 2012). However, all information relevant to my analysis is included in this document.

The data were a valuable source of information about PGCG content. There were a large number of interview participants, and every participant was asked about their career goals, thus the data set contained a variety of individual perspectives from which I could explore PGCG content. Students were also at two different sites: one in which students were in a department specific program (University 1, U1) and another in which students were enrolled in a general

engineering first-year program (University 2, U2). This provided an opportunity to look at whether the PGCG content that students described was noticeably different between these two sites.

Table 2-1

Participant demographics

<u>University 1</u>		<u>University 2</u>	
<u>Name</u>	<u>Gender</u>	<u>Name</u>	<u>Gender</u>
Dee	F	Alice	F
Lenae	F	Cathy	F
Haley	F	Erin	F
Hayfa	F	Grace	F
Jane	F	Harmony	F
Lia	F	Heidi	F
Sadie	F	Jena	F
Shreya	F	Maya	F
Alexie	M	Nicole	F
Dustin	M	Valerie	F
Frank	M	Doug	M
Ira	M	Eliot	M
Peter	M	Kevin	M
Serge	M		
Simon	M		
Trent	M		
Zavier	M		

Interview participants were first-year undergraduate engineering students. The research sites were both large public land grant universities in the southeastern United States. A total of 32 participant interviews were used for this study, 18 from U1 (10 male, 8 female), and 14 from U2 (3 male, 11 female). The high number of female participants was due to the original study intentionally oversampling for women (Matusovich et al., 2011; Matusovich et al., 2012). Table 2-1 is an overview of all of the participants for this study, including their pseudonym, university and gender.

Each interview was approximately an hour in duration and conducted by a faculty member or one of two graduate student research assistants. Interviews were audio recorded and transcribed verbatim. The interview protocol contained prompts about students' current academic life, their first-year engineering coursework, and their career plans after graduation. While I analyzed each interview in its entirety, the following prompts and follow-ups produced most of the relevant responses for this study:

- 1) Why have you chosen an engineering major?
 - a) Follow-up: The specific things that are appealing about engineering.
- 2) Why did you choose your specific major? (Or how will you choose your major?)
 - a) Follow-up: The specific things that are appealing about that major (Or considerations for a major)
- 3) Considering what you described about choosing an engineering major, what keeps you majoring in engineering?
- 4) How confident are you that you can succeed in earning an engineering degree?
- 5) Do you plan to graduate with a degree in engineering?
 - a) Why or why not?
 - b) If not, what degree will you pursue?
- 6) What do you plan to do when you complete your undergraduate degree?
- 7) What is your ideal job?
 - a) What do you think that job entails on a daily basis?
- 8) Is your degree preparing you to do this job? If yes, how so? If no, why not?

In addition to these prompts and follow-ups, students were asked to elaborate on responses that were short, lacked detail, or did not address the prompts directly. There was no variation in the implementation of the interview protocol across sites or between students of different gender.

2.3.2 Analysis

The purpose of the analysis was to explore how students characterize their PGCGs. For this analysis, I relied on the constant comparative method, which is typically used in grounded theory research with the purpose of constructing theory (Strauss & Corbin, 1990). The constant comparative method is also an appropriate method for exploring existing theoretical concepts in detail, as I have done in this study, because it provides methods for inductively exploring and developing ideas from data. Using the constant comparative method in this way is consistent with suggestions by Case and Light (2011) for uses of this method beyond grounded theory.

I used multiple coding passes through the data, starting with open coding. The process of open coding started with one code (one concept) defining the type of information that I wanted to explore. That code was:

- **Post-graduation career goal content** – this code was associated with an interview any time a participant mentioned what they wanted their career to be like after obtaining their undergraduate degree.

Open coding began by identifying any segment of the interview matching this code definition. For example, consider the statement “[An] ideal job would be to work outside of the office but also in an office, because I don’t want the kind of job where you would have to work past five-thirty, six o’clock and more on the weekends.” This segment gained the code “post-graduation career goal content” in the open coding process because it is an instance of a student discussing what they want their career to be like after graduation.

I analyzed the coded segments for PGCG content and compared them to identify emerging ideas that arose from the application of the initial code. I then created new categories of codes within PGCG content. For example, if multiple students described wanting a job that involved working outside, I created the category code of “work outside” underneath PGCG content. Once a new category code was created, it was added to the codebook, and all previous coded segments were analyzed to see if they, too, should have that category code applied.

I checked category codes against definitions from other categories through *axial coding*. This was done to both refine the definitions of the category codes and to look for similarities within and relationships between the ideas expressed by those category codes. This led to the final organization of my codebook.

The chart in Figure 2-2 shows the steps I took in analyzing data, starting with my code for PGCG content and evolving to two overarching sub-codes containing the variety of content that emerged throughout my analysis.

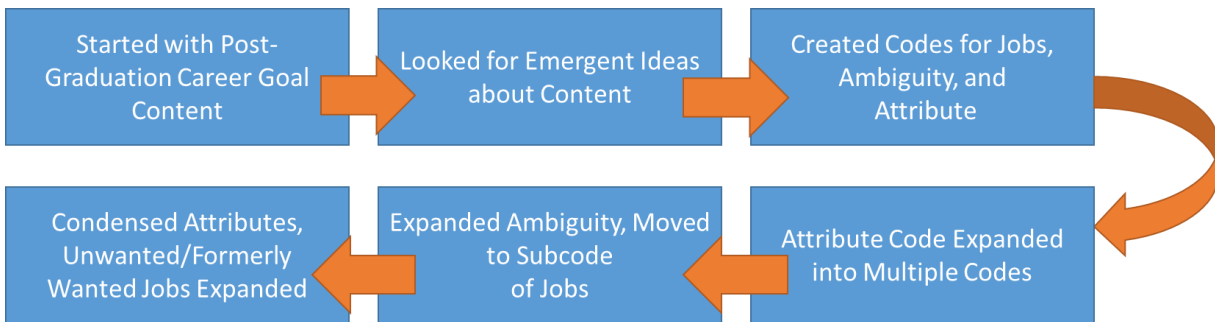


Figure 2-2: Flow chart of analysis process

The resulting codebook from my analysis is shown in Table 2-2 below, which gives specific definitions of the final codes that emerged from my analysis.

Table 2-2

Final codebook

<u>Code/Category Code</u>	<u>Definition</u>
Post-Graduation Career Goal Content	Any time a participant mentions what they want their career to be like after obtaining their undergraduate degree
Job Goal Content	Any discussion of their future career in terms of jobs
Job Mentioned	Discussion of future career in terms of a job or type of job
Wanted Job	The student mentions a job they want
Unwanted Job	The student mentions a job they do not want
Formerly Wanted Job	The student mentions a job they used to want
Ambiguity	Considerations that make stating job goal content difficult or complicated
Fluidity	The student describes multiple kinds of content, that their content might change, or that there are some aspects of their content they are not sure about
Lack of Content	The student expresses not knowing what they want to do for their career explicitly
Attribute Goal Content	Any discussion of their future career that does not apply to particular jobs
Task Oriented	Attributes that are about the tasks they would like to perform in their future career
Challenge	The student describes wanting a career that is challenging or that challenges them
Creativity	The student describes wanting a career that lets them be creative
Enjoyment	The student describes wanting a career they can enjoy or have fun with
Variety	The student describes wanting variety in the things they will do in their career or not wanting to do the same thing

Help Others	The student describes wanting a career that lets them positively affect other people
Problem Solving	The student describes wanting a career that involves designing solutions to problems
Life-Related	Attributes that are about how their career fits in with other life goals
Flexibility	The student describes wanting a career that lets them do other things they would like to do in life
Financial Security	The student describes wanting a career that pays well and/or is easy to find a job within
Environment	Attributes that relate to the type of place students at which they would like to work
Work With Others	The student describes wanting a career that involves working closely with other people
Location	The student describes wanting a career in a specific location or type of location
Setting	The student describes specific aspects they would like for the professional setting of their career

2.3.3 Trustworthiness

Throughout my analysis, I took steps to ensure the trustworthiness of the study results. In this section I overview how I established this trustworthiness using the criteria of confirmability, dependability, credibility, and transferability as established by Miles et al. (2013). Miles et al. (2013) suggest these criteria for any qualitative research, which includes the methods I have adapted from grounded theory.

Confirmability characterizes how the study can be framed in a neutral manner, “free from unacknowledged researcher biases.” (p. 312) Using methods suggested by Miles et al., I established confirmability by being explicit about the methods of my study. I interpreted framing

my study in a neutral manner as being clear about the need for and purpose of the study in the context of existing research findings. I provided a detailed overview of this study's purpose and how its need stems from previous research in this document. The purpose of this study was to explore a construct (PGCG content) that has had limited development in existing research, yet has potential value in engineering education and beyond. I interpret being "free from unacknowledged researcher biases" as being clear about how the study was conducted, methodologically, and stating the limitations of those methods and the role that the researcher played. I have described the methods of research for this study, my role in those methods, and the limitations of those methods. As a researcher, I was not involved with the data collection process, but conducted the analysis for this study in full. I describe the limitations of conducting research in this way in the next section.

Dependability characterizes the stability of the study across time, researchers and methods. To establish dependability, I taught another research associate my final codebook and had him independently code some of my interview data. This research associate was a peer graduate student who was trained in educational research methods prior to participating in this study. The process involved both of us reviewing the codes, definitions and applications together using a single interview. Subsequently, the research associate coded seven other interviews on his own. We then compared codes and discussed discrepancies until those discrepancies were reconciled, thus establishing *inter-rater reliability* (Gwet, 2001).

Credibility characterizes whether "the findings of the study make sense." (p. 312) I interpreted this as giving detailed examples of raw data, the analysis of that data, and outcomes derived from them. I interpret this form of trustworthiness as needing to give appropriate levels of detail about the context of the study, the data used, how and why the data was collected, and

what the data contained. Providing detail gives readers the information they need to make their own judgement of the credibility of the subsequent conclusions derived from the data. In this paper, I have provided detailed information about interview protocols, the initial purpose of those protocols, and examples of raw data that resulted from them.

Transferability characterizes how the study results can be placed within a larger context and their importance to this larger context (Miles et al., 2013). I established transferability by connecting my results to established theory while acknowledging the limitations inherent in applying the ideas that emerge from this study's population to the population of undergraduate students as a whole. In an example of the former, I have described how I used GST as my study's framework, and related how constructs in GST have been used in the past to how I have used them in this study. In an example of the latter, in the population of participants for this study, there were some differences between how male and female students described their PGCG content. However, I acknowledged that these differences might not be reflected in the overall population of undergraduate students. Doing these things has provided context by which readers and evaluators of the study can interpret ideas and transfer them to other contexts.

2.3.4 Limitations

This study has three primary limitations. First, the consequence of using secondary analysis was that I was not able to ask follow-up questions or tailor the interview to explore specific concepts in more depth. In some places, it would have been beneficial to ask targeted follow-up questions based on the research needs of this study. For example, asking students directed follow-up question about the goal content they described. This would have been useful in describing emergent ideas more completely.

Second, the types of content identified in this study cannot be considered exhaustive, nor can they be considered to reflect the general goal content of all engineering students. Instead, they are examples of the types of goal content that engineering students similar to those in this study might have. Both universities in this study are large, public land grant universities, thus, students who enroll at smaller universities and colleges in different areas of the United States, or who are from different backgrounds than the students interviewed in this data set, might have different goal content. Even while considering the limits of the present study, I have shown that there is a variety of goal content, and students might use it to make a variety of choices. Future work could identify how the types of goal content vary across different sub-populations of engineering students.

The third limitation of this study was that it involved only data from first-year engineering students. This means that some perspectives on PGCG content that are more prevalent in more advanced students may have been missed. Some of this limitation is addressed in a follow-up study (Brown, In Preparation), which examines similar data from students who are between their first and third years. In this follow-up, students discuss their career goal content in a similar way all three years.

2.4 Results

There were two findings from this study. The first finding was that post-graduation career goal content consisted of two distinct types of content: job goal content and attribute goal content. Job goal content described the participant's discussion of their future career in terms of jobs. Attribute goal content represented the desired (or undesired) aspects of a career that are not related to a specific job or type of job. Within each of the two types of content, there were multiple descriptive categories. The second finding was that there are patterns in the types of

content that students described: female students described certain types of content more frequently than male students did.

2.4.1 Job goal content

Job goal content comprised any discussion of a participant's future career in terms of jobs. Within job goal content, there emerged two category codes: job mentioned, and ambiguity. Within job mentioned, there were three additional category codes: wanted job, unwanted job, and formerly wanted job. In this section, I expand upon each of the category codes within job goal content.

Wanted jobs were very common for students to describe. In the following quote, Emma describes job goal content that falls under the category of wanted job:

I guess my ideal job would be, I guess working at an environmental firm and just a small, have a small team to work with, and I guess that's basically, I don't know.

Emma, U2

Emma mentioned that she would like to work at an environmental firm. In another example, Eliot, another student from U2, talked about his goal of designing bikes:

I really enjoy biking, especially mountain biking, and I thought that would be a fun career path, maybe. So, engineering type, you know, designing bikes, things like that. Um, so that was, that was another thought that went into it.

Eliot, U2

Some students, like Eliot, described specific types of firms, actual companies, or entities for whom they would like to work. These cases also coincided with students describing the type of work they would do at that company. For example, Emma later described that she would "work with energy or, I guess, materials." I handled the mention of a type of workplace, or specific company, as job goal content, distinct from the attribute goal content of location, which deals with geography.

Within job goal content, I coded for jobs that participants used to want and do not want. These fell under the categories of formerly wanted jobs and unwanted jobs, respectively. More female students than male students talked about both of these kinds of content. For example, Nicole from U2 talked about her formerly wanted job goal content of being an orthopedic surgeon:

I actually was going to do, I was dead-set on pre-med because I wanted to be an orthopedic surgeon, but then after volunteering at the hospital, I realized that the doctor's hours weren't really quite for me, so I wanted more like a nine-to-five kind of job. So I got interested in biomedical engineering, which is what I want to do after I graduate with a mechanical degree.

Nicole, U2

Nicole described how she formerly wanted to be a surgeon, but has since changed her goal to becoming a biomedical engineer (a wanted job). In another example, Alice from U2 discussed how she realized that a job that requires a business degree was an unwanted job for her:

I went to a business conference through the School of Business, and it was interesting to see – because a lot of the majors there were people who were in business, and the companies came were looking for business majors, so I kind of got a taste on what your job would be like if you had a business degree, and it wasn't, it definitely showed me that I liked engineering a lot better. So I guess that's, that's the reason why I feel confident in my decision?

Alice, U2

In addition to talking about the jobs that they did and did not want, the job goals code also included instances in which students discussed ambiguity in their job goal content: considerations that make describing their job goal content more complicated or harder to perform. Ambiguity had two components: fluidity in their job goal content, and a lack of job goal content. Fluidity in content was any indication that a students' described content might not be the same at a future point in time. This included stating multiple kinds of job goal content, their content might change, or that there were some aspects of their content of which they were

unsure. A lack of content was an explicit statement that a student did not know what kind of job they want in the future. More females than males described a lack of content. For instance, in the following quote, Alice from U2 discussed how she chose engineering despite a lack of job goal content:

I still don't exactly know what I want to do. I definitely liked math and science in high school, and I was thinking of all the possibilities of a career that I could do. I eventually chose engineering because I knew with an engineering degree I could fall back and go into pretty much anything from there, so...

Alice, U2

In another example of fluidity, Hayfa from U1 talked about how she did not know what she would like to do, even though she could imagine different possibilities:

Whatever I major in [laughs], whatever I end up having a major in. I probably, I mean, if, it's really murky because I'm still wondering if I'm going to major in BME for the rest of my career, if I am going to major in, if I am going to major in BME as my graduate school, if I am going to be a doctor, I mean, perhaps I could be a doctor or be a biomedical technician – that's probably not going to happen. You know, but, um, anything else, I mean, the possibilities are endless...

Hayfa, U1

There were also instances where students said that their stated goals might change, that they have multiple goals, or that they were not sure of specific details. I coded these under the fluidity in job goal content category code. Most students (81%) described some kind of fluidity. For example, Peter from U1 discussed three different jobs that he might want in biomedical engineering:

I guess the main thing is the job afterwards, but you can't just rely on that. I just enjoy engineering-type study, engineering-type academics. Biomed, I've looked at some of the classes in the future, and systems physiology and biotransport and biodynamics, all that is really interesting to me, I think I will enjoy studying it, and enjoying what you study and do is hugely important to why you keep progressing in what you're doing, and I think, because I enjoy this class and I feel like I'll probably enjoy my classes in the future, I would like to stay in engineering.

Peter, U1

Peter's example was one way of expressing fluidity in content. In another example Nicole, a U2 student, discussed her major choice in terms of the fact that her career goal content might change in the future:

I feel like mechanical will provide a better background, just in case I do change my mind, uh, mechanical's a little more versatile, I guess you could say, and I could do anything with a mechanical degree if I decide that I don't want to go on and continue to do biomedical engineering, I could get a job without, like right after I get my mechanical.

Nicole, U2

Nicole's example was another way of expressing *fluidity* in content, as she described the possibility of changing her mind.

2.4.2 Attribute goal content

Within attribute goal content, three category codes emerged: 1) task-oriented content, in which students described aspects of the tasks they would like to perform in their career; 2) life-related content, in which students described how their career fits in with other goals they had for their life; and 3) environment content, in which students described attributes related to the type of location in which they would like to work. There were also sub-categories under each of these, but examples are only be provided for the most common ones.

There was a variety of category codes within task-oriented goal content. In one example, Lenae, a student at U1, discussed how important helping others was to her, and how this went into her career goal in biomedical engineering:

Just to work with, just to help people. And I know that sounds like a generic answer, but to, like TRULY help people, like, to know that biomedical engineering is going touch other people's lives that kind of parallels people in my life. Like, my stepfather, you know, if he would have had this surgery that didn't work maybe in the future he'll have to have a heart device that will, um, transfer some sort of, you know, thing through his body to help his palpitations of his heart, some sort of serum or something that go through and like, regulate it or let him know it's time to go to the doctor, something like that. Like, I feel like, it's just ideal just to help people, that'll be my thing, just get there, be able to tell people how to use a device

when I go to hospitals, sit in the hospital and, you know, watch the doctors, you know tell them how to use it correctly, to insert it, and follow up with these patients, you know, “how, how is the device working?” And “is it really helping?” And to touch someone’s life, to be like, “yeah, the device is really working, my heart conditions really gotten better since then,” or “it’s improving slowly but surely.” I can’t wait for that to happen. I cannot wait. I can’t wait.

Lenae, U1

Task-oriented goal content related to helping others was expressed by 28% of students. Students described other aspects of task-oriented goal content that were included in other category codes. This included enjoyment of their work, which was the most common attribute content among interviewed students, with 47% of students describing it. For example, Valerie from U2 discussed the importance of enjoyment to her future career:

As part of the ideal job, I guess I would say applying what you learn in college and the ideal job would be to enjoy it and to love what you’re doing, because if you don’t what will you do, and then it’s, I don’t know, you’re lifestyle won’t be as successful as you planned or wanted, so.

Valerie, U2

Some students expressed a desire to be challenged by their career or have a career that requires them to solve problems. Others wanted a career that let them express creativity in the tasks they would perform. Still others expressed a need for variety in the tasks they would perform.

In an example of life-related goal content, Maya, a student at U2, talked about how potential financial security was important in her consideration of what she majored in, and in her future career:

Um, because I, when, I was – I, I really love math. Like, I love math – and I’ve also loved English, like, it was basically between those two things and I... I think making, making money’s not the reason I did it, but I do think, like, you, when you choose a career you have a certain obligation to, like, if you want a family you should do something that you should be able to make money in. And I thought I’d really enjoy it, I can do something with it.

Maya, U2

Financial security was a category code within life-related goal content that 35% of students expressed. In another example, Jane from U2 discussed the importance of flexibility in her future career:

I think I want a job that doesn't, is not routine, maybe. You know, maybe a job that allows you to travel – like I said, I enjoy like talking to people, so like going to conferences or something. You know, a job that doesn't have a strict like, wake up at eight o'clock, be there at nine, sit at my cubicle for an hour, answer all my emails, you know. Something that's not like routine, um, would be more like what I would like, versus like you know, just this, this, and this. Something that like, like I said, just gives me flexibility, I guess, to work.

Jane, U2

In the quote, Jane talked about having a job that allows her to travel and arrive at work at an hour of her choosing. Flexibility was another category code within life-related goal content, and was expressed by 25% of students.

In the final category of attribute goal content, students described the environment in which they would like to work. The most common kind of environment related attribute goal content was the desire to work with others, with 31% of interviewed students describing it. As an example, Peter from U1 described the importance of working with others in his future work environment:

I guess having people, the people that are working with me, just having a supportive environment, also, a nice environment.

Peter, U1

While some participants described wanting to work in a specific setting in their work environment, while others described specific geographic locations or types of locations where they would like to work.

Table 2-3

Overview of the number of participants per applied code by demographics

	<u>All</u>	<u>U1</u>	<u>U2</u>	<u>Male</u>	<u>Female</u>
Job Goal					
Content					
Job Mentioned	31	18	13	13	18
Wanted Job	27	14	13	11	16
Formerly	11	6	5	<u>3</u>	<u>8</u>
Wanted Job					
Unwanted	14	7	7	<u>4</u>	<u>10</u>
Job					
Ambiguity					
Fluidity	26	14	12	11	15
Lack of	9	6	3	<u>2</u>	<u>7</u>
Content					
Attribute Goal					
Content					
Task-Oriented					
Challenge	5	2	3	2	3
Creativity	6	4	2	3	3
Enjoyment	15	8	7	7	8
Variety	3	1	2	1	2
Help Others	9	6	3	4	5
Problem	7	2	5	4	3
Solving					
Life-Related					
Flexibility	8	5	3	3	5
Financial	11	5	6	4	7
Security					
Environment					
Work with	10	7	3	6	4
Others					
Location	3	0	3	0	3
Setting	5	3	2	1	4
	N=32	N=18	N=14	N=13	N=19

2.4.3 Patterns in goal types

I checked for patterns in *PGCG content* across the two demographic differences that were tracked in the data for this study: gender and academic site. I found that there were some notable commonalities across most interview participants. I also found that female students described

some types of content more often than male students did. Finally, I found no discernable differences across sites.

2.4.3.1 General patterns

All of the 32 students whose interviews I examined in this study had some type attribute goal content, even if they described a lack of job goal content(e.g. Alice). While attribute goal content is more general (i.e. applicable to a wider range of careers) than job goal content, it is nonetheless potentially important in the choices students make. In these interviews, many students discussed attribute goal content such as financial security, flexibility and the ability to help others as important considerations for choosing their major, or for enrolling in an engineering program.

As seen on Table 3-2, most students expressed some type of job goal content. Twenty-seven students talked in some way about a wanted job. It was also common for students to express fluidity in job goal content, with 26 students doing so.

Attribute goal content contained many additional category codes, and attributes varied by student. As seen in Table 3-2, the most common categories of were enjoyment (15), financial security (11), work with others (10), help others (9), and flexibility (8).

2.4.3.2 Demographic comparisons

Table 3-2 above shows how frequently a goal content code was applied across all participants, with each participant treated as a binary “present” or “not present” (I did not account for how many times each code was applied beyond the first application per student). One notable comparison in Table 3 is between male and female students and describing a lack of job goal content. While only two male students (14% of all male students) in this study expressed a lack of job goal content, seven female students (37% of all female students) expressed a lack of

job goal content. More females also talked about jobs that they did not want and jobs that they used to want. In comparing students from each site, there are few apparent differences in the content of goals. Types of content that were common at one site were generally common at the other site.

2.5 Discussion

The results of this study yield three points of discussion. The first is the implications of the different types of PGCG content that were identified in this study. The identification of job goal content and attribute goal content solidifies suggestions from existing research, and presents new directions for future research. The second implication is that there may be differences in job goal content by gender. Future research should investigate these possible differences to confirm if they exist. The final implication of this study is the addition of the concept of ambiguity of content to GST.

2.5.1 Different types of content

A main finding in this study is that PGCG content can be classified into two main types: attribute goal content and job goal content. It makes intuitive sense to assume that students will think about their careers in terms of the jobs they might have, and will have some goal content about what those jobs might be. Beyond this intuition, existing research also suggests that students have PGCG content about jobs, both from inventory style methods like that of Markus and Nurius (1986) and from exploratory methods like that of Hilpert et al. (2014). Like job goal content, the presence of attribute goal content also makes intuitive sense, and is suggested by research (Hilpert et al., 2014; Sheppard et al., 2010).

Intuition and previous suggestions aside, it is important for the existence of different types of PGCG content to be formally identified and grounded in theory. The formal

identification confirms intuitions and suggestions from research. The grounding in theory creates a reference point for future work, and ties our understanding of these concepts to existing knowledge (Svinicki, 2010). This creates the opportunity for future work to build on our knowledge of PGCGs.

One interesting question to ask is how attribute goal content and job goal content are connected. Perhaps attribute goal content is a precursor to job goal content: students start with general ideas about what they want to do for a career, and find specific examples related to those general ideas that become part of their job goal content. Perhaps attribute goal content and job goal content are not always directly related, and the reasons behind setting attribute and job goal content are related to other concepts that were not represented in this study. For example, maybe job goal content is set based on interest in topics related to a specific career, regardless of desired attributes. The possibility of such connections could be explored in future research. For example, a study centered on a new interview protocol that asks participants about different kinds of job and attribute goal content, and whether they are related, could explore these possibilities.

2.5.2 Patterns in content

In terms of the patterns observed within the analyzed data, the fact that attribute goal content is present even in students who express a lack of job goal content suggests that students have general requirements (represented by attributes) about what they want their career to be like. This is true even in those students who have yet to identify a job that fulfills those general requirements or have yet to consider enough information about possible future careers to know more about what they want. This finding could be useful when considering how students who have no stated career goals make choices in which career goals implicitly play a role, such as co-op and internship choices.

Another pattern seen in this study is that most students have ambiguity in their job goal content. Other research has shown that ambiguity relates to indecision about careers, which plays a role in making choices. Research on secondary school students found that indecision could affect the choices that students make about their careers (N. Betz, 1988; Gati, Krausz, & Osipow, 1996; Gati, Landman, Davidovitch, Asulin-Peretz, & Gadassi, 2010; Gati, Osipow, Krausz, & Saka, 2000). In those studies, indecision was also related to a lack of personal knowledge and consideration of different career choices. We could be observing a similar phenomenon with the students in this data set: first-year students may have had inadequate exposure to information about future careers.

I analyzed the collected data based on gender and data collection site. One notable difference was observed in gender, with more female participants expressing lack of job goal content (37% of females to 14% of males). Additionally, more female students talked about jobs they used to want or do not want. This difference could be a reflection of how society portrays gender in engineering. In a large, multi-part study, Hill, Corbet & St. Rose (2010) described the disadvantages that females face in entering STEM fields. Fewer women are represented in both engineering disciplines and STEM fields in general. Additionally, there are fewer portrayals of women in STEM disciplines in popular media. Finally, stereotypes exist about women not belonging in STEM disciplines (Hill, Corbett, & St Rose, 2010). This means that, growing up, females see fewer examples of STEM careers that they can relate to while simultaneously facing stereotypical notions that they would not fit into STEM careers, in general. What I found in this study could be a consequence of these phenomena. Some female students might enroll in engineering programs because of their interest in academic topics. However, because they have had less of an opportunity in their developing years to relate to potential STEM careers, they

might have fewer specific ideas (represented by *job goal content*) about what they will do in their future careers. Across the two sites, there was little difference between participants in terms of the PGCG content they described. Of the commonly observed types of content, none were more prevalent at one site than at the other based on the interview transcripts.

2.5.3 Connection to Goal Setting Theory

Previously conducted research has shown that undergraduate engineering students expressed goals about both the jobs that they wanted, and other aspects of their career that were important to them, such as benefiting society, or financial benefits (Hilpert et al., 2014; Sheppard et al., 2010). I found similar results in my study.

When considering other aspects of the goal core, I found that little of what students described in their content was about how difficult it would be to achieve. This makes intuitive sense: as their PGCG content relates to more distal events, most of what students describe as difficult to accomplish has to do with more proximal events, such as academic success. While this does not mean that students do not perceive PGCGs in terms of difficulty, it means that their perception of difficulty might be better captured in how they describe the more proximal events. Future work could also ask students directly about whether they view career goals as difficult.

The other concept within goal core, specificity (Locke et al., 1989), has more in common with many of the concepts that students described. Fluidity in content and lack of content are, in some ways, very similar to the idea of a lack of specificity, with some key differences. Because content was assigned in most previous GST research within experimental settings, specificity and lack of content were, in practice, not the same thing. Researchers would assign content with varying degrees of specificity (Locke & Latham, 1990, 2006, 2013). For example, in Morisano et al. (2010), where students were encouraged to set academic goal content, they were compared to

a control group that was not encouraged to set academic goal content. The control group was not described in terms of specificity, or lack thereof. The connection of specificity to fluidity in content is also not direct. For example, the case of having multiple wanted jobs in job goal content is not necessarily the same as specificity (each wanted job could be more/less specific in level of detail).

2.6 Conclusions and future work

The different types of content identified in this study are important to consider in future work on goals, and particularly PGCGs. Future work on PGCGs should examine how different types of PGCG content influence how students choose mechanisms for achieving those goals. Mechanisms include selecting a major, persisting in tasks (e.g. persisting in an engineering program), and planning for the future (e.g. planning to find an internship). Focusing on mechanisms in future work will show the ways in which goal content is important, and whether one type of content might be more important in choosing mechanisms than others.

Future work could also be conducted on two avenues to look at the relationship between the emergent ideas about PGCG content described in this study and existing GST constructs like specificity. Attribute goal content is, by nature, more general than job goal content. Is the description of attribute content simply the expression of less specificity in PGCG content? Students describe different kinds of fluidity within their job goal content, as well as a lack of content. While, conceptually, these can be differentiated from specificity, are they different in practice?

3. Why did I make that choice? An examination of the connection between post-graduation career goal content and the choices undergraduate engineering students make

3.1 Introduction

Considering the importance placed on career preparation within engineering education, knowledge of how students approach their future careers is of potential value to engineering educators and researchers. Consequently, this study investigates how engineering students describe the connection between their career goals and the choices they make in the present in their undergraduate programs. While existing educational research generally suggests that setting goals affects the choices that students make towards achieving said goals, we know little about how career goals relate to choices such as persisting in engineering programs, even though related research suggests that the goals students have may be important. Goals are a useful lens through which to view student post-graduation careers as they provide both a way of describing how students view their future careers, and how career plans, in turn, influence students' choices in the present.

Engineering education is associated with career preparation. At a national level, engineering educators, administrators, and policy makers describe the need to produce more engineering graduates to increase the national engineering workforce (Clough, 2004; Olson & Riordan, 2012; Science, Technology, Sciences, Engineering, & Medicine, 2007). At a program level, accreditation criteria encourage schools to prepare students for careers (Commission, 2003). Engineering education research promotes the importance of introducing students to careers in recruitment activities (Davis et al., 2012; Yates, 2012). All of these initiatives could benefit from a better understanding of the goals that students have about careers, and the choices that students make based on those goals. Students are ultimately agents of their own career paths;

we cannot fully understand how to prepare students for careers without understanding how students view careers.

To better understand connections between goals and actions in undergraduate engineering students, my study focuses on two central constructs. The first is post-graduation career goal (PGCG) content. Broadly, goal content is a desired outcome that an individual has and PGCG content specifically includes desired outcomes that undergraduate engineering students have for their post-graduation careers. The second construct is mechanism choice. Mechanisms are actions that individuals take towards the accomplishment of goals. I use the word “choice” in relationship to mechanisms to emphasize that they are conscious actions in which individuals have agency. In relationship to PGCG content, mechanism choices include, for example, enrolling in an engineering major, persisting in engineering programs, and deciding to take an internship.

“Mechanism” is a different name for ideas already commonly studied in engineering education. For example, numerous studies have looked at the different demographic, academic, and psychological factors that contribute to the choice students make persisting in engineering majors (Bernold, Spurlin, & Anson, 2007; Eris et al., 2010; Eris et al., 2005; French, Immekus, & Oakes, 2005; Pierrakos et al., 2009). Researchers have also compared persisting in engineering majors to other fields of study (Mendez, Buskirk, Lohr, & Haag, 2008; Ohland et al., 2008). Researchers have also looked at reasons that students choose the mechanism of deciding on certain majors, or to major in engineering in general, such as in Lichtenstein et al. (2009).

Existing research on goals, in general, demonstrates clear relationships between goals and mechanism choices. For example, setting goals affects how students approach learning-related choices (Ames & Archer, 1988; Elliot et al., 1999; Elliot et al., 2011; Nicholls, 1984; Pintrich,

2000; Senko et al., 2011) and persisting in academic programs (Lent, Brown, Schmidt, et al., 2003). Despite the recognized importance of goals, some types of goals, such as PGCG are not well understood.

Similarly, research suggests that post-graduation careers are considered by students when they choose mechanisms like persisting in their current programs (Sheppard et al., 2010). Additionally, connecting classroom activities to post-graduation careers can have an effect on how students assimilate new concepts in the classroom (Husman & Lens, 1999). However, these studies did not explicitly relate PGCG content to mechanism choices or learning.

In terms of research on PGCG content, existing research provides some knowledge as to what PGCG content entails. In the context of undergraduate engineering students, research shows that PGCG content can be divided into two categories: attribute goal content and job goal content (Brown, in preparation). Attribute goal content includes desired aspects of a future career that are not job specific, such as wanting financial security, a flexible work schedule, to help others, or a job that involves working with others. Job goal content involves the career choices students want to make after graduation (such as designing cars, going to graduate school). Job goal content can refer to, or organizations where students want to work (such as NASA or Google). Understanding that there are different kinds of PGCG content is important when investigating how students connect them to their mechanism choices, because different types of content might relate to mechanism choices in different ways.

In an effort to close the gaps in knowledge identified herein, my research answers the research question: How do undergraduate engineering students consider different kinds of post-graduation career goal content when they choose mechanisms throughout their undergraduate studies? I used a case study approach (Stake, 2013; Yin, 2014) and drew on the rich data in a

series of three longitudinal interviews with 13 participants from two different Universities to answer my research question. My investigation resulted in a set of cases that demonstrate different patterns in how students connect PGCGs to mechanism choices.

3.2 Framework

I adopted Goal Setting Theory (GST) as the framework for my study. GST, as shown in Figure 3-1, describes the process by which individuals develop, use, and modify goals in the process of making goal-related mechanism choices and achieving goals (Locke & Latham, 1990). GST describes performance and goal achievement as follows. A person starts with a *goal core*. Then, considering the goal core itself and personal *moderators*, he or she chooses *mechanisms* for goal accomplishment and proceeds with the pursuit of the goal. As the individual pursues the goal, his or her beliefs about his or her performance in the chosen mechanisms feeds back into *moderators* for choosing future *mechanisms*. In this study, I direct my focus towards the concepts of PGCG content and mechanisms, and how they connect. This section overviews those concepts, along with the overarching framework of GST.

In GST, a *goal core* characterizes a goal and it is comprised of three elements: *content*, *specificity*, and *difficulty*. The *content* corresponds to what the term goal generally means in everyday usage: it defines a desired outcome (e.g., having a job designing spacecraft). The *specificity* and *difficulty* relate to *content*. *Specificity* characterizes the level of detail individuals provide when describing their *content*. *Difficulty* characterizes the goal-setter's perception of how hard the content is to achieve. Each set of goal *content* held by an individual has its own *specificity* and *difficulty*. For example, the *specificity* that one has for his or her goal content of wanting to become an aerospace engineer could be completely different from their *specificity* about the content related to how many friends they want to have in the future.

One aspect of *job goal content* that is different from *attribute goal content* is that students discuss ways that they are *ambiguous* about *job goal content* in addition to directly discussing *wanted jobs*. Whereas *wanted jobs* relates to the job or type of job that a student wants, *ambiguity in job goal content* consists of considerations that make directly stating *job goal content* more difficult or complicated. Some students express a lack of content, such as saying “I do not know what I want to do.” Others express having backup plans for the jobs that they said they wanted, or admit that they might change their mind about what their content is. Still others commented on the potential of having multiple jobs in their future. The ideas contained within *ambiguity* are similar to the defined concepts of *specificity*, but, conceptually, are distinct. For example, *ambiguity* includes statements about a *lack* of content. *Specificity*, on the other hand, refers to the amount of detail in content.

Mechanisms are the means by which goals can be achieved (Locke and Latham, 1991; 2002). In original GST research, *mechanisms* were for activities of a shorter time period (i.e. minutes, hours or days vs. years) than those in this study (Hollenbeck & Klein, 1987; Locke & Latham, 2002) (Lent, Brown, Schmidt, et al., 2003; Lent et al., 2005). For example, *mechanisms* in those studies include *planning* tasks or planning to set smaller goals in solving word puzzles related to achieving a larger, overall puzzle solving goal, *persisting* with goal-related tasks related to those puzzles, and any *deciding* to perform tasks relating to the goal. Though the context is different, the definitions of the different mechanisms remains the same. *Persisting* is continuing with a task. In the context of undergraduate engineering programs, the idea of *persisting* is commonly discussed in reference to remaining enrolled one’s current engineering program, or remaining enrolled in higher education. While there are different tasks in which a student could persist, note that participants were asked directly about persisting with their degree

program, and the overwhelming majority of discussion about persisting refers to that type of persistence. *Planning* is still setting shorter goals and thinking of future tasks to perform. In this study’s context, examples of how *planning* could manifest include the discussion of future internship options, and signing up professional exams required for career paths. *Deciding* refers to partaking in a task towards goal accomplishment. In this study’s context, examples of *deciding* could include deciding to enroll in engineering, deciding on a major, deciding on an internship, and deciding to switch majors.

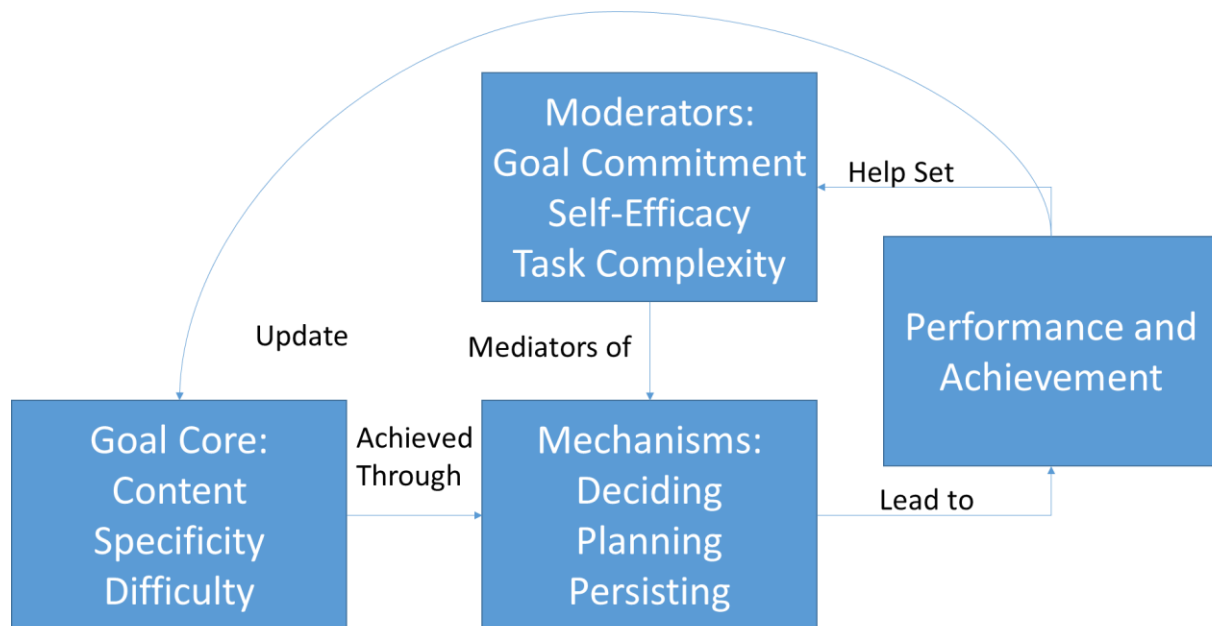


Figure 3-1: The representation of a goal, moderators, mechanisms and performance in GST. Adapted from Locke and Latham (2002)

There are components of GST that, while not a focus of this study, do play a role in the overall process of setting goals and choosing mechanisms. *Moderators* are constructs that can be related to *content* or *mechanisms* that influence *mechanism* choice (Locke and Latham, 1991; 2002). These constructs can be about a goal itself or about the mechanisms used to achieve the goal. Moderators identified in GST include *goal commitment*, *self-efficacy* and *task complexity*. *Goal commitment* characterizes the strength of the desire to accomplish the goal. *Self-efficacy*

characterizes one's own perception of his or her ability to achieve a goal or perform a mechanism. *Task complexity* characterizes the perceived level of challenge and cost associated with mechanisms that could be used to achieve a goal. Finally, there is *performance* and *achievement* related to goals. The interpretation of *performance* and *achievement* help to set new beliefs, as well as update the goal core itself. This completes the cycle of goal setting: new or re-affirmed goals are set or updated, and the process begins again.

3.3 Methods

I investigated the role of PGCGs in undergraduate student mechanism choices from the student perspective by examining longitudinal interviews (i.e., a three-interview series) with 13 participants from two universities. I used a case study approach (Miles et al., 2013; Stake, 2013; Yin, 2014), where a case comprised the combination of the set of three interviews from a participant.

3.3.1 Data collection

My study is a secondary analysis of previously collected interview data in which I used existing data to investigate a new research question (Heaton, 2008). The study for which this data was originally collected investigated the effect of different first-year engineering pedagogies on the motivation and retention of female engineering students (Jones et al., 2012; Matusovich et al., 2011; Matusovich et al., 2012). Consequently, women were intentionally overrepresented among study participants. The interview protocols for both initial and follow-up interviews included questions asking the participants to elaborate on their *PGCG content* and how that content relates to their current situation. Other sections of the interview focused more on student perceptions of their first-year engineering class, interactions with their instructors, and interactions with other students. While I examined the entirety of each interview, the majority of

pertinent student responses came from prompts in the protocol related to either mechanism choices or careers after graduation. Those prompts, and suggested follow-up questions, were as follows:

- 1) Why have you chosen an engineering major?
 - a) Follow-up: The specific things that are appealing about engineering.
- 2) Why did you choose your specific major? (Or how will you choose your major?)
 - a) Follow-up: The specific things that are appealing about that major (Or considerations for a major)
- 3) Considering what you described about choosing an engineering major, what keeps you majoring in engineering?
- 4) How confident are you that you can succeed in earning an engineering degree?
- 5) Do you plan to graduate with a degree in engineering?
 - a) Why or why not?
 - b) If not, what degree will you pursue?
- 6) What do you plan to do when you complete your undergraduate degree?
- 7) What is your ideal job?
 - a) What do you think that job entails on a daily basis?
- 8) Is your degree preparing you to do this job? If yes, how so? If no, why not?

In addition to these prompts and follow-up questions, students were asked to elaborate on responses that were short, lacked detail, or did not address the prompts directly. There was no variation in the implementation of the interview protocol across sites or between students of different gender.

At the beginning of the study, all participants were first-year students. Participants were interviewed at the end of their second semester, after completing a first-year engineering course. Some of these students were interviewed again at the end of the two subsequent academic years. Study participants attended one of two institutions, both large public land grant universities in the southern United States. In this study, these institutions will be referred to as U1 and U2. Students at U1 were involved in a discipline-specific first-year course, while students at U2 were involved in a general first-year engineering course. In all, 6 students from U1 (2 female and 4 male) and 7 students from U2 (6 female, 1 male) took part in the three-interview process. In this study, I included each of the 13 participants that were available. Table 3-1 shows the pseudonym given to each student, their university, their sex and their major.

Table 3-1

Participant Demographics

<u>Name</u>	<u>University</u>	<u>Gender</u>	<u>Engineering Major</u>
Alexie	U1	Male	Biomedical
Morris	U1	Male	Biomedical
Sadie	U1	Female	Biomedical
Serge	U1	Male	Biomedical
Shreya	U1	Female	Biomedical
Simon	U1	Male	Biomedical
Cathy	U2	Female	Civil
Doug	U2	Male	Mechanical
Erin	U2	Female	Civil
Harmony	U2	Female	Aerospace
Jenna	U2	Female	Mechanical
Nicole	U2	Female	Mechanical
Valerie	U2	Female	Industrial

3.3.2 Data Analysis

I began the coding process with two overarching codes: goal core and mechanisms. All other codes from GST constructs were subcodes of mechanisms or goal core. Within goal core, recall that PGCG content is the actual desired outcome that individuals want for their

Table 3-2

Initial codebook

Codes	Definition	Subcodes	Definition	Additional Subcodes	
Goal Core	The central elements of a goal	PGCG Content	The desired outcome within a goal.	Wanted Job	A career choice that students describe wanting to make
				Ambiguity	Discussion of not having a wanted job, that the wanted job might change, or of having more than one wanted job
				Attributes	Desired aspects of a career that are independent of a wanted job
		Specificity	The amount of detail given in description of content	High	Lots of detail
				Medium	Moderate detail
				Low	Vague or little detail
Mechanism	The means through which goals are achieved	Type	The kind of mechanism	Deciding	Partaking in a task (e.g. deciding on a major, deciding which classes to take)
				Persisting	Continuing with a task that was previously chosen (e.g. persisting with a major)
				Planning	Thinking of tasks to perform in the future (e.g. planning on a summer internship, planning to attend career fairs)

professional life after graduation; this means that any construct in relation to the goal core is in relation to some PGCG content. The organization of these codes was useful for approaching my research question. Initial codes are shown in in Table 3-2. As I investigated the connection of PGCG content and choosing mechanisms, it was useful to have the two general code categories of goal core (which includes content) and mechanisms.

Within the goal core and mechanisms, there are two types of subcodes. The first type of code was a category code (Miles et al., 2013; Strauss & Corbin, 1990). Category codes are codes that assign further descriptive information about the coded segment. Within the *goal core*, my categories include the PGCG category codes of job goal content and attribute goal content (Brown, in preparation). Within *mechanisms*, the category code was type, which can be either a deciding on a task, persisting with a task, or planning a task. Again, note that participants were asked directly about persisting with their degree program. This means that almost every time the code was applied was in reference to persistence with that task. The second form of code I applied was a magnitude code (Miles et al., 2013). A magnitude code assigns a value associated with a construct, and is always in relation to a category code. The magnitude code I used in this analysis is *specificity*, which is within the goal core. *Specificity* is how much detail somebody has when describing his or her PGCG content, and was applied across an entire interview. There are three levels, high, medium and low. The three examples below show those levels for a student talking about the same general content. Within my data, this information was spread throughout the transcripts:

- **High:** I want to become an aerospace engineer that designs parts for spaceships. Specifically, I would like to design navigation systems that can better gauge the distances between the spacecraft and other objects and avoid those objects.

- **Medium:** I want to become an aerospace engineer. I like the idea of working on things that fly or go into space.
- **Low:** I would like to be an aerospace engineer.

Note that participants generally focused on the details of their *job goal content*, while they did not necessarily focus on the details of, or were not asked to elaborate upon, their *attribute goal content*. This means that I could only consistently code for specificity of job goal content, and will only discuss specificity of that kind of content.

Connections between PGCG content and mechanism choices emerged during analysis, specifically places where PGCG content existed as a rationale for choosing a mechanism. For instance, if a student said that wanting a job with financial security was a reason for deciding on an engineering major, I noted this in a high-level memo. I kept track of these connections for each participant. Next, I analyzed for patterns within the *connections*, and finally coded for these *connections* across interviews.

To improve the quality of my analysis, I developed structured rules to analyze for *connection*. The first was to look through all segments coded for *PGCG content* that had a coinciding code for a *mechanism choice*, or segments that preceded or were preceded by segments that were coded for mechanism choice. I then re-read the segment, or segments, to identify whether the codes were applied to the same train of thought in the conversation, or whether they represented a break into a new subject in the conversation. For instance, the following segments from an interview with Alexie represent *connection*:

Interviewer: And, so what would your ideal job be? I mean, assuming the economy was perfect and you could...?

Alexie: I can't honestly say. A lot of the classes that I'm going to be planning to take later, um, like BME technical electives – one deals specifically with

neuroscience, the other with cardio science – um, I don't know what I'm more interested in as of yet. After first year I don't think I can adequately say that.

I: And it's a hard first year.

A: Yeah, and I don't have – I, there are definitely things that I am MORE interested in, but I don't know where I'll end up. I don't think I can foresee that.

I: And do you think the, um, your four years here will prepare you for a job?

A: I think it definitely will. The first one – if, if the other three are going to be anything like the first one – and I'm saying three, it's probably going to be more along the lines of four as it's expected, with me doing co-op, um things such as that, I'll definitely be trying to find undergraduate research opportunities as I go – um, I think they'll do a good job of preparing me, I have faith in the school and I have faith in the major, though it's fairly new.

Alexie talks about his *ambiguity* in his *job goal content*: how he will not really know what he wants to do for a job until after he has considered the topics in higher-level biomedical classes he will be taking in the future. He noted that he was interested in potential careers related to multiple topics, but did not know which one he would pursue, specifically. In the next segment, Alexie discussed his plan to take part in co-ops and undergraduate research opportunities to better prepare himself for his future job. Alexie continued the train of thought from his *ambiguity in job goal content* to his *mechanism choice of planning* for co-ops, which represents connection.

In another example, Nicole discussed the *mechanism* of deciding to take part in an internship and her *PGCG content* of wanting a job in sports medicine and wanting to work with others in succeeding segments, but did not connect them in the same train of thought:

Section 1

Interviewer: How long were you at [Company 2]— so it was an internship last summer at [Company 2]? How long were you there?

Nicole: I officially worked 10 weeks.

I: And like, what kind of things did you do there? What was your role?

N: I worked in the equipment innovation lab. So I worked on testing sports equipment and developing new technologies.

I: So you weren't just the coffee person.

N: No.

I: Ok, good. And [Company 1], what kind of roles will you have there?

N: I'm actually not sure. My boss called and asked what I was interested in and obviously I don't know still as a junior, but he gave me two different options. And the first option was to like, go on the shop floor, walk around, talk to the shop guys and do like more of a technical hands-on role vs. analyzing data. And I like to be around people and I like to talk, so I chose the like, getting involved in the shop floor. And I think he said I'll be doing a lot of like, modeling through computer programs. Like, I guess making engine parts. I'm not really sure what, um but then going down to the shop floor and talking about why I made it this way and kind of getting their feedback on the technical role of designing stuff.

I: Like, the manufacturing role and how that affects our designs.

N: Mm-hmm.

Section 2

I: Cool. Um, so we're kind of in this topic, but if you think about your ideal job—and I know you're kind of unsure about that— but it, even if it has a title or maybe it has some job description details. What would your ideal job be?

N: It would not involve me being by myself at all. Or like sitting at a desk all day. I like to get up and move around and talk to people. Get their inputs and thoughts. And ideally it would be for a company that is about— that does something I'm passionate about it. Like, I really like sports, um, sports medicine. Helping injured people recover, something of the sort like that.

Note that Section 1 and Section 2 are sequential in the interview: I just applied labels for convenience. Though the interviewer alludes to the internship Nicole discusses in Section 1 when asking her about her ideal job in Section 2, Nicole does not discuss the decision to take part in that internship at all when talking about wanting to work with others, or work in sports

medicine. Though they are discussed sequentially, Nicole does not connect the mechanism of deciding on the internship to stated PGCG content.

3.3.3 Trustworthiness

Miles et al. (2013) describe trustworthiness as a set of criteria that establishes the quality of qualitative research. These criteria include confirmability, dependability, credibility and transferability. *Confirmability* includes steps that a researcher takes to be free of unacknowledged bias. I interpreted confirmability as being clear about how the study's methodology and its limitations, and how I, as the researcher, fit in to them. To this end, in this document I have described the methods used in this study, provided detailed examples of the application of those methods, and the results of applying those methods. As the researcher, I was not involved in data collection, but was responsible for the analysis performed in full. I describe the limitations of conducting this form of research, as well.

Dependability is how stable the application of research methods is across a study. To establish dependability in this study, I taught another researcher my codebook and established inter-rater reliability (Gwet, 2001). This research associate was a peer graduate student who was trained in education research methods prior to participating in this study. After reviewing all of the codes, the researcher coded a single interview, and we discussed his codes together in detail. Subsequently, the researcher coded seven more interviews. We then compared his application of codes to mine on those interviews, and reconciled any differences.

Credibility is whether the findings of a study make logical sense. I interpreted credibility as providing detailed examples of data, how data was analyzed, and how I derived outcomes from the data. Evidence of credibility can be found in the description of interview data, examples of interview responses, and the alignment of those examples and my interpretation of their

meaning. Providing sufficient detail in these areas gives readers enough information to come to their own judgement of the study's credibility.

Transferability is how a study relates to other research, existing and future. I established transferability by both grounding my research in an existing framework, and by relating both the study's purpose and outcomes to existing literature. For grounding this study in literature, I describe the constructs of GST I analyzed in terms of their theoretical definitions, and the ideas those constructs have traditionally been used to represent. For relating the purpose and outcomes to existing literature, I grounded this study's purpose in the findings of a previous, related study (Brown, In Preparation A), and how this study builds upon the findings of that related study.

3.3.4 Limitations

This study has four primary limitations. First, the use of secondary analysis meant that I could not ask follow-up questions, or create interview questions to investigate some topics of interest. Consequently, I may not have explored the connection between PGCG content and mechanism choice in as much detail as I may have been able to with a custom-developed protocol. For example, each time a student talked about a mechanism choice, I could have probed regarding how that choice related to goals the student had.

Second, the patterns identified in this study should not be considered generalizable to all engineering students. Instead, they are examples of the types of effects that PGCG content can have on mechanism choice. Future work could explore the generalizability of patterns I found in this study and discover other patterns that might exist between PGCG content and mechanism choice in undergraduate engineering students.

Third, the prompts from the interviews used for this study make it difficult to draw conclusions about how prominent certain mechanism choices are because they bias student

answers towards to particular choices. Three of the prompts reference the mechanism of deciding on engineering or an engineering major, as in “why did you choose engineering?” Two of the prompts reference the mechanism of persisting with an engineering degree, as in “what keeps you in engineering?” This is likely to have increased the amount of times each of those mechanisms was discussed and, accordingly, how often they were connected to PGCG content.

Finally, though I examined longitudinal data in this study, there were few longitudinal changes in the ways that students described PGCG content, mechanism choices, or their connection. Part of this may be due to the fact that, every year, students were asked about the same mechanism choices. Since those choices, and the reasons behind them, usually did not change (save for when students left engineering), it makes sense that they would be discussed in similar ways from year to year, and obfuscate some longitudinal patterns. Despite these limitations, this study still provides valuable information about the ways that engineering students connect their PGCG content to mechanism choices, and produced outcomes with implications for future engineering education research.

3.4 Results

In the research question for this study, I asked: How do undergraduate engineering students consider different kinds of PGCG content when they choose mechanisms throughout their undergraduate studies? In answering that question, I found that both overarching types of PGCG content—job goal content and attribute goal content—are connected to students’ mechanism choices. I also found that some students connected ambiguity in job goal to their mechanism choices. When looking at these choices, globally, I found that there were patterns in the types of PGCG content that students connected to their mechanism choices. I also found that connection between PGCG content and mechanism choices related to three other outcomes.

Firstly, I found that connecting job goal content about wanted jobs and ambiguity in job goal content to mechanism choice were both related to specificity in job goal content. Secondly, I found that there was no indication of patterns in the mechanism types chosen by students based on the type of content they were connecting to their mechanism choices. Finally, I found that female study participants connected ambiguity in their job goal content more often than male students did, and generally reported lower specificity in job goal content.

In the following sections, I use the shorthand terms for the three types of content I will discuss:

- *Attributes* for attribute goal content
- *Wanted jobs* for job goal content about wanted jobs
- *Ambiguity* for ambiguity in job goal content

3.4.1 Connection between post-graduation career goal content and mechanism choice

Students discussed wanted jobs, attributes and ambiguity in connection with their mechanism choices. Figure 3-2 shows patterns in the ways that students discuss the connection of content and mechanisms. While not every student connected each type of PGCG content to mechanism choices, students as a whole connected each kind of PGCG content to mechanism choices across different academic years and across the multiple students in this data set. Most students talked about at least two kinds of connection at some point while participating in this study. The exceptions to this were one student who only discussed attribute goal content connection, and three students who only discussed wanted jobs in connection to mechanism choices. Note that this does not mean that these students did not have the other types of content, only that the other kinds of content were not described with respect to mechanism choices.

3.4.1.1 Patterns in content type connected to mechanism choice

Figure 3-2 shows the connection between mechanism choice and PGCG content broken down into different types of content and sorted chronologically for each student. In Figure 3-2, all mechanism types are grouped together; there is no representation of distinct mechanism types with respect to distinct PGCG content types. Similar figures with this breakdown are provided in Appendix A. I grouped students in Figure 3-2 based on patterns in the connection. Sadie and Harmony did not discuss a connection between wanted jobs and mechanism choice. Valerie, Alexie, Nicole, Cathy and Jenna all discussed a connection between all three types of PGCG content and their mechanism choices at some point. Simon, Serge and Erin discussed mechanism choices in connection with attributes and wanted jobs, but not ambiguity. Finally, Doug, Morris and Shreya discussed only wanted jobs in connection with mechanism choices.

Within these groupings, I noticed a clear division between the students who chose more mechanisms while considering particular types of content and those who chose fewer based on the other types of PGCG content that they connected to mechanism choices. Of the six students who chose mechanisms connected to ambiguity, all of them also connected attributes to choosing mechanisms at some point during the three years they were interviewed. Comparatively, of the seven students who never chose mechanisms connected to ambiguity, only four of seven connected attributes to choosing a mechanism. Four of the seven students who did not connect mechanism choices to ambiguity connected wanted jobs to their mechanism choices all three years they were interviewed, in comparison with only one of six students who chose mechanisms connected to ambiguity. Examples of how each of the different types of PGCG content connected to mechanism choices, in general, follows.

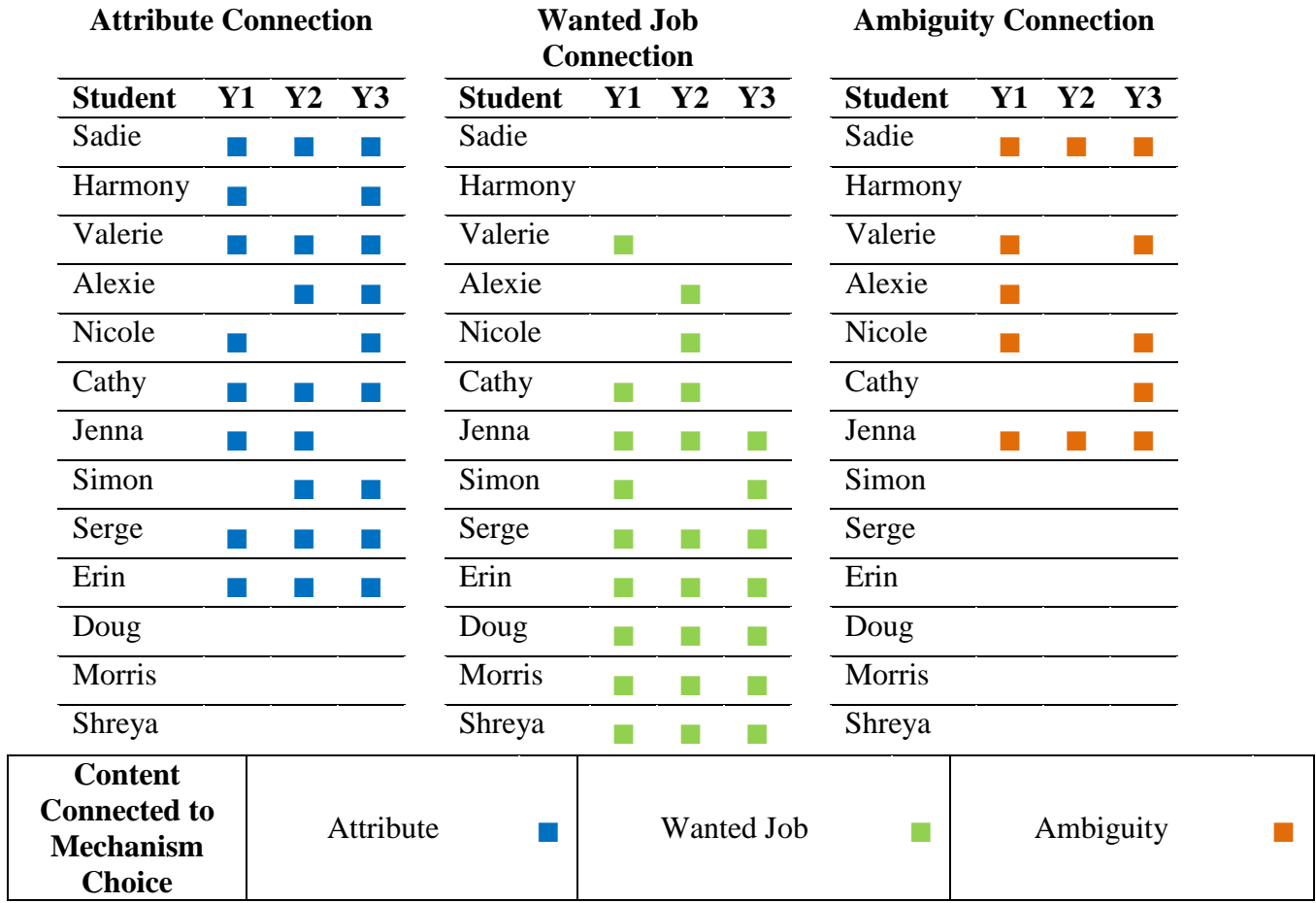


Figure 3-2: Connection between different types of PGCG Content and mechanism choices

3.4.1.2 Connecting wanted jobs to mechanism choices

The majority of participating students connected wanted jobs, to mechanism choices at some point while participating in this study. Only Sadie and Harmony did not. In the following example, Morris from U1 discussed his wanted job of researching nanotechnology and how that connects to the mechanisms of persisting with his engineering degree:

What keeps me in engineering? Well, it's the same ideas that brought me here, except with a little more rooted in reality focus. The original ideas that brought me here, were those fantasy, those sci-fi, those big grandiose ideas, but now the school has reigned me in and showed me what's possible in the field, what's impossible in the field, and how I can break into that impossible domain and really make— really be that innovator on the front... on the front edge of engineering. And I think that's really the most exciting part of engineering—doing something that's never been done before in a unique way, with your unique solution and making things better. That general idea is all that keeps me here.

- Morris, U1

When Morris describes wanting to be on the “front edge of engineering,” he is referring to his wanted job of being a researcher in biomedical engineering. Elsewhere in his interviews, he describes that wanted job in detail, discussing his plan to go to graduate school and obtain a PhD. In this statement, he connects that wanted job to his mechanism of persisting in engineering. When describing that mechanism, “What keeps me in engineering?” he talks about how his experiences at U1 have introduced him to his wanted job. Though he was always interested in the frontiers of what is possible (i.e. science fiction), he discovered that a career in research would allow him to explore those frontiers, and gives that wanted job as a rationale for persisting in engineering. Other students at both U1 and U2 had similar experiences.

Doug, a student from U2, also connected a wanted job to mechanism choices. Doug had a wanted job related to working in nuclear engineering. In his first year, he stated that he thought

that nuclear power “[was] going to be a major field later on. Like, nuclear power and stuff, I want to be involved in that.” Doug connected this wanted job to two mechanism choices. The first was deciding to enroll in a nuclear engineering concentration for his mechanical engineering major. The second was planning to receive a master’s in nuclear engineering after graduation from his undergraduate program. Throughout the rest of his interviews, he used this wanted job as rationale to justify most of his mechanism choices, including deciding to be a nuclear submarine officer through his ROTC program and persisting with his engineering major.

3.4.1.3 *Connecting attributes to mechanism choices*

The majority of participating students also discussed the connection of attributes and mechanism choices: Only Doug, Morris and Shreya did not. For example, Cathy from U2 cited her attribute for an outdoor work setting as a rationale for deciding on a civil engineering major:

I would say, like, the career choices, just because it seems like I could be outside more, and more hands-on, like visiting the sites that you’re working on. Because, like, as much as I love computers, I feel like I’d be stuck inside of an office more, and I’d rather get outside. So that was a factor.

Cathy, U2

Though Cathy admitted to liking computers, she thought that jobs related to computers would not comply with her attribute of wanting variety in her work environment, and she decided on a civil engineering major, as opposed to computer science, because it could lead to a career that complies with that attribute.

Valerie, from U2, described that attribute of wanting to enjoy what she does in her career as a reason for choosing the mechanism of deciding on an industrial systems engineering major. In her third year, when asked to expand on what would go into enjoying her career, she explained that her ideal career would be:

...something that benefits people and like I feel I'm working towards something that's just helping others and that I'm applying what you know, I've learned in college for the 4 years and just, kind of enjoying what I do... Like not dreading to go to work. Like looking forward to you know the problem solving. Or working with groups for our task or things like that.

Valerie, U2

In describing what goes into the attribute of enjoying her job, Valerie discussed helping others, problem solving and working with others, each of which are other types of attributes. In these cases, students discussed attributes in connection to mechanism choices. In many of these cases, such as Valerie's, students used attributes as rationale for making choices that even as they expressed ambiguity about their job goal content.

3.4.1.4 Connecting ambiguity to mechanism choices

In many of the cases in this study, ambiguity was also connected by students in their mechanism choices. Overall, six students connected ambiguity to their mechanism choices at some point while participating in this study. Jena from U2 talked about her rationale for deciding on an engineering program while also being pre-med:

I'm kind of in between right now. I know that I want to do engineering right now, but I'm not sure if I do want to go to med school and become a doctor, so people always ask me, "why are you an engineer? Why are you in engineering but want to go to med school?" And I always say, "because I know I want to do engineering right now, but I don't know if I want to do medical school later." So if I decide I DON'T want to go to medical school, then I have my engineering degree and I'm perfectly okay with that.

Jena, U2

In Jena's case, the mechanisms of deciding to enroll in an engineering program and persisting towards engineering degree were connected to her ambiguity around the job she wanted after graduation. Engineering was a backup plan for if she chose not to pursue a career in medicine. In

other words, her ambiguity around having a career in medicine was part of her reasoning for deciding to enroll in an engineering program.

For students like Jena, ambiguity was an active rationale for choosing mechanisms. In another case, Sadie discusses how her ambiguity connects to persisting with her engineering major:

[I plan to graduate with my degree] partly because I don't know what else I would do, at this point. But I mean, I do enjoy it, now that I am getting into mostly major classes, like I am really enjoying it. I loved all the math and sciences, but this stuff is just even cooler. I mean, I still don't know what I want to do, technically, but I don't know what else I would do at this point if I didn't finish engineering. I couldn't just switch majors without being here for another 4 years probably.

Sadie, U1

Sadie's ambiguity made her not want to decide on another academic major. While she does not know exactly what she will do with her biomedical engineering degree, she is ambiguous over what she would do with any other degree, as well, and thus finds it easier to stay where she is: she chooses to persist.

3.4.2 Specificity and connection

Figure 3-3 compares the connection of PGCG content types and mechanism choices shown in Figure 3-2 to the specificity that students had for their job goal content. Note that I could not consistently code for the specificity of attributes, as students were asked fewer follow-up questions related to attributes, and therefore did not elaborate on their attributes very often in these interviews. Each of the three sections of Figure 3-3 has the same shading pattern, but a different block representing the type of PGCG content involved in the connection to mechanisms. In general, participants who had lower specificity in job goal content reported connection with ambiguity more often and wanted jobs less often, while students with higher

specificity in job goal content had reported connection with ambiguity less often, and wanted jobs more often.

Some of the patterns in the connection that I described with the aid of Figure 3-2 coincide with some patterns in job goal content specificity that can be seen in Figure 3-3. Students who only had connection with wanted jobs (Doug, Morris and Shreya) had high job goal content specificity throughout their three years. The corollary of this is that students who had connection with attributes had lower job goal content specificity, as Doug, Morris and Shreya were the only students who did not have a connection between attribute goal content and a mechanism choice in any of the three years they were interviewed. Also note that students who had connection with wanted jobs in all of their three years (Jenna, Serge, Erin, Doug and Morris) tended to have higher job goal content specificity than students who did not.

Another finding is that there was a relationship between job goal content specificity and ambiguity connection. Students who had connection between ambiguity in job goal content and mechanism choice at some point during the three years they were interviewed tended to have lower specificity in their job goal content.

3.4.3 Mechanism type and connection

Due to the interview question focus on questions about the mechanisms of deciding on engineering, deciding on a major, or persisting with a major, the most of participants' discussion of mechanisms was around those topics. Therefore, every participant talked about them (though not necessarily in connection to PGCG content). A smaller number of students discussed deciding on internships or planning on internships. Finally, a few students discussed planning on taking graduate school entrance exams such as MCATS, or planning other academic choices.

Attribute Connection				Wanted Job Connection				Ambiguity Connection			
Student	Y1	Y2	Y3	Student	Y1	Y2	Y3	Student	Y1	Y2	Y3
Sadie	■	■	■	Sadie				Sadie	■	■	■
Harmony	■		■	Harmony	■			Harmony	■		
Valerie	■	■	■	Valerie	■	■	■	Valerie	■	■	■
Alexie		■	■	Alexie		■		Alexie	■		
Nicole	■	■	■	Nicole	■	■	■	Nicole	■	■	■
Cathy	■	■	■	Cathy	■	■	■	Cathy	■	■	■
Jenna	■	■	■	Jenna	■	■	■	Jenna	■	■	■
Simon	■	■	■	Simon	■	■	■	Simon	■	■	■
Serge	■	■	■	Serge	■	■	■	Serge	■	■	■
Erin	■	■	■	Erin	■	■	■	Erin	■	■	■
Doug	■	■	■	Doug	■	■	■	Doug	■	■	■
Morris	■	■	■	Morris	■	■	■	Morris	■	■	■
Shreya	■	■	■	Shreya	■	■	■	Shreya	■	■	■

Specificity	Low	Medium	High
Content Connected to Mechanism Choice	Attribute ■	Wanted Job ■	Ambiguity ■

Figure 3-3: A comparison of specificity in job goal content and connection

There were also some unique individual mechanism choices, such as Doug decided on a commissioned officer posting through his ROTC program.

Figure 3-4 is an overview of the mechanisms that connected to PGCG content. Note that all but one student (Alexie) chose the mechanism of persisting in their major when considering PGCG content at some point during their three years, while every student made some kind of decision when considering PGCG content. In terms of the decisions that students discussed in connection to PGCG content, many students continued to talk about their choice of major and/or their choice of enrolling in an engineering program, throughout their second and third years. Students also discussed deciding to take part in internships or undergraduate research experiences. Uniquely, Doug discussed his decision to enroll in the military and take commission as an officer after graduating in his third year. One pattern observed in mechanism choice was that, aside from Alexie, no student chose a planning mechanism in connection to PGCG content until their third year. A more detailed set of tables on how individual types of mechanism choices related to individual types of content is shown in Appendix A.

3.4.4 Patterns and demographics

When examining these results with respect to site, there was no perceivable difference between the school students were attending and the connection of PGCG content and mechanism choice, with students from U1 and U2 demonstrating a variety of patterns in connection, job goal content specificity, and the type of mechanism chosen. When examining the results with respect to gender, there was a difference between male and female students. Six female students chose a mechanism in connection to ambiguity, as opposed to just one male student. For comparison, there were four male students who did not choose a mechanism in connection to ambiguity and only two female students. Male participants had more instances of describing high job goal

content specificity, while female participants had more instances of describing medium and low job goal content specificity.

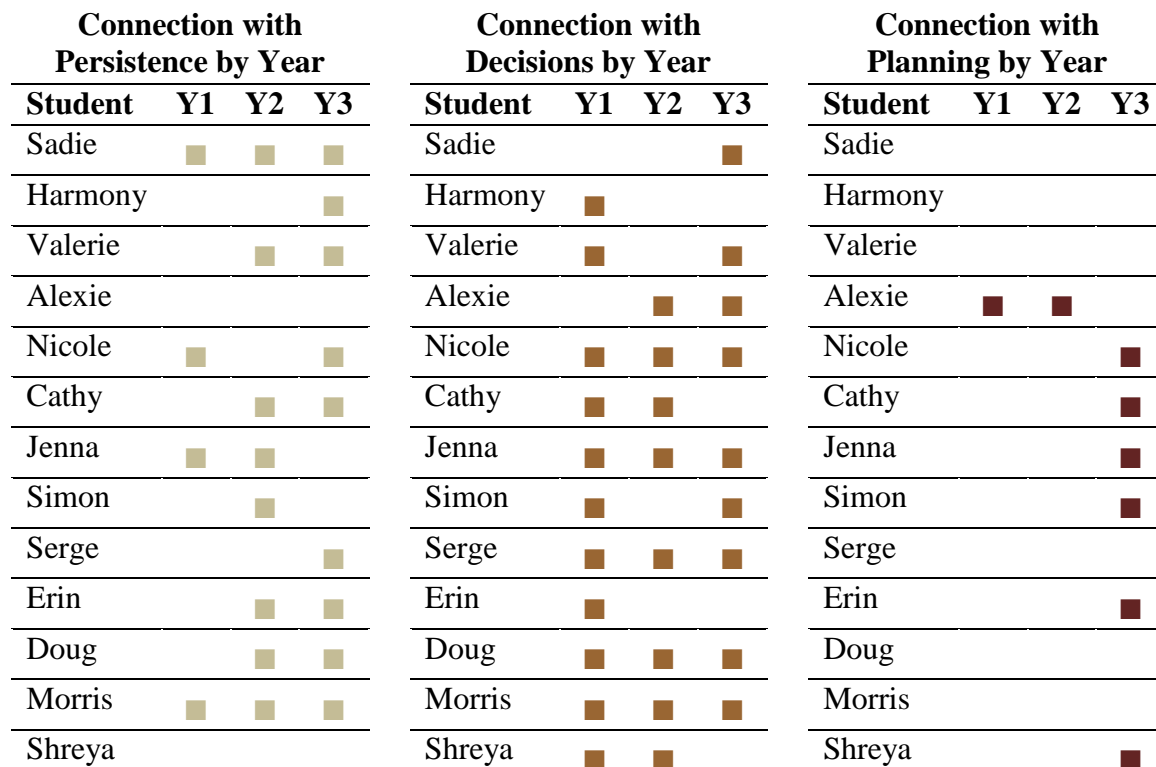
3.5 Discussion

There were meaningful results from this study that warrant further discussion. The first is the finding that different students connected their PGCG content and mechanism choices in different ways. Within the participants of this study, I have discussed “groups” of students, each group exemplifying a different pattern in connection. These groupings also related to the specificity of students’ job goal content. Another finding is that ambiguity connection and specificity of job goal content might be related concepts. This also raises the question of whether ambiguity, in general, is related to specificity.

3.5.1 Connection and the role of post-graduation career goal content

The main goal of this study was to explore how PGCG content connected to mechanism choices undergraduate engineering students made. I found that students use different types of PGCG content when considering the mechanisms that they choose. In this study, students mainly talked about the mechanism choices of deciding on an engineering major, deciding to enroll in an engineering program, and persisting with an engineering major. Additionally, there were patterns in the types of content that participants of this study connected to their mechanism choices. Some students focused on certain types of content while considering choices, while others considered a combination of different content types throughout the three years that they were interviewed.

The clearest division in these patterns was between students who had connection between ambiguity in job goal content and mechanism choice, and those who did not. Among study participants, those who had ambiguity connection had lower specificity in how they described their job goal content, and also connected more mechanisms choices to attribute goal content.



Mechanism Choice Type	Persistence	Decisions	Strategizing and Planning
	■	■	■

Figure 3-4: Different types of mechanism choice connected to PGCG content.

Those who did not have ambiguity connection connected more mechanism choices to wanted jobs, and had higher specificity in their job goal content. In simpler terms, students who had more specific ideas about the jobs that they wanted after graduation made more academic choices based on their goals for those jobs (e.g. Morris, Doug). Students who had less specific ideas about the jobs they wanted made more choices based on general ideas of what they want in their career (attribute goal content) and more choices based on ambiguity (e.g. Sadie). Career related divisions between different groups of students have been reported in previous engineering education research: Pierrakos et al. (2009) found that students who stayed in engineering described more knowledge of the engineering profession than those who left engineering. This suggests that a future research direction would be to examine whether there are differences in PGCG content between students who do and do not stay in engineering and whether the type of PGCG content they connect to their mechanism choices has any relation to whether they left. Within this study, three students left engineering: Simon, Shreya and Harmony. Looking at Figure 2 and Figure 3, there are not any common factors that separate those three students based on PGCG content. However, a study with a larger number of students who left engineering could be more informative in identifying such patterns.

In terms of the type of content connected to mechanism choices, I argue that there is evidence that all three content types examined in this study, wanted jobs, ambiguity and attributes, can be of high importance when students consider choosing mechanisms. The level of importance depends primarily on the individual student. Morris and Doug were clearly driven to decide on and persist with engineering programs by their wanted jobs (biomedical researcher and nuclear engineer, respectively). Sadie persisted with her engineering degree program mostly because she did not know what she wanted to do and, by her third year, had put a lot of time and

effort into her engineering degree. Cathy was driven to decide on a civil engineering major because of how perspective jobs coming out of that major related to her attribute of wanting a varied work environment. In these individual cases, we can see individual types of content as more “important.” Across cases, there is not a type of content that is clearly of more important in mechanism choices.

3.5.2 The meaning of specificity and ambiguity

The results of this study suggest that specificity of job goal content and ambiguity connection may be related. Figure 3-3 shows that students who had lower job goal content specificity also connected more mechanism choices to ambiguity in their job goal content. This, in turn, raises the question of whether ambiguity in content, in general (as opposed to its connection with mechanism choices) is related to specificity. Logically, it makes sense that a student who can describe fewer details of what they want to do (having less specificity) would also be more ambiguous about their goals related to the specific jobs they want. The relationship demonstrated between the two ideas in this study suggests that their relationship should be considered further. Specificity of content is part of the original GST framework developed by Locke and Latham (1990). Ambiguity in goal content is a concept developed inductively through Brown’s (in preparation) exploration of the construct of PGCG content. It could be that the specificity present in PGCG content is integral to how students describe it, and that ambiguity is just a lack of specificity manifested through student descriptions of their goal content. Future work with PGCG content should further compare these constructs and determine if they represent two parts of the same concept, or are simply related.

3.5.3 Demographic patterns

In the students participating in this study, more female students had more connection between the ambiguity of their job goal content and the mechanisms that they chose than male students (5 females, 1 male). Additionally, more female students than male students expressed medium or low job goal content specificity at some point during their three years of participation (5 females to 3 males). This echoes the results of Brown (in preparation), which found that more female students expressed ambiguity in their job goal content than their male counterparts.

This demographic difference is supported by years of foundational research about why females are less likely to enroll in STEM undergraduate programs, particularly engineering. Hill et al. (2010), a large, multi-part study on the challenges of females in STEM fields, notes that, in addition to being underrepresented, females face negative stereotypes related to STEM career possibilities, along with less representation within STEM disciplines in popular media. While stereotype and lack of representation are causal in the low enrollment of females in STEM programs, they could also explain a potential difference in how females who *do* enroll in STEM programs view their post-graduation careers when compared to males. Future research should continue to explore potential differences in PGCG content between male and female students to confirm the patterns seen in this study and Brown (in preparation), and search for further meaning if such a difference does indeed exist.

3.5.4 Longitudinal patterns

Though there was a limitation in how this data could be interpreted longitudinally due to students being asked about the same mechanism choices every year, there were some mechanism types that were not part of interview prompts that students still discussed, particularly planning mechanisms. This mechanism, in particular, provided the most apparent longitudinal pattern.

Participants (with one exception) did not connect planning mechanisms to their career choices until their third year. This could be due to the fact that many of the planning mechanisms, like taking the MCATS or considering internships that could turn into post-graduation careers, are not as prominent in students' early academic careers as they are later, closer to the time in which they happen.

3.6 Conclusions and future work

This study explored the ways that students connected their PGCG content to their mechanism choices. In doing so, I found that students connected multiple types of PGCG content to their mechanisms, and that there were patterns in the types of content that students connected. I also found that there were differences between the kinds of content male and female students connected to their mechanism choices.

Future work should investigate whether any of the patterns identified in this work are repeatable or generalizable to larger populations. This work could be accomplished on two fronts. The first is continued qualitative research on PGCG content. The second is the development and application of quantitative instruments that can measure constructs that have been developed and analyzed in this study, and in Brown (In preparation).

Future work should also continue to look at longitudinal data, and collect new data that avoids some of the limitations described in this study. In particular, future interview-based studies might consider not steering students towards discussion of specific mechanism choices, and instead ask students to describe choices that they have made in more general terms. This could allow for a better understanding of how the connection between PGCG content and mechanism choices changes over time.

3.7 Appendix A: Additional data on mechanism types and post-graduation career goal content

Deciding									
Content	Attribute			Wanted Job			Ambiguity		
Year	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Sadie			■					■	
Harmony	■								
Valerie	■			■			■		■
Alexie		■	■		■				
Nicole	■		■		■		■		■
Cathy	■			■	■				
Jenna	■			■	■	■	■	■	■
Simon			■	■					
Serge	■	■	■	■	■	■			
Erin	■	■		■					
Doug				■	■	■			
Morris				■	■	■			
Shreya				■	■				

Figure 3-5: PGCG content connection for deciding.

Persisting									
Content	Attribute			Wanted Job			Ambiguity		
Year	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Sadie	■	■					■	■	■
Harmony			■						
Valerie		■	■						
Alexie									
Nicole	■		■						
Cathy		■	■						
Jenna		■			■	■		■	
Simon		■							
Serge			■						
Erin			■		■	■			■
Doug					■	■			
Morris				■	■	■			
Shreya									

Figure 3-6: PGCG content connection for persisting.

Planning									
Content	Attribute			Wanted Job			Ambiguity		
Year	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Sadie									
Harmony									
Valerie									
Alexie					■		■		
Nicole									
Cathy									■
Jenna						■			
Simon						■			
Serge									
Erin									
Doug									
Morris									
Shreya						■			

Figure 3-7: PGCG content connection for planning

The figures above are organized similarly to Figure 3-2. They show the connection between mechanism choices and different kinds of PGCG content that individual students described throughout the three years they were interviewed. The difference here is that each table shows connection for *only* one type of mechanism. Figure 3-5 shows connection to deciding. Figure 3-6 shows connection to persisting. Finally, Figure 3-6 shows connection to planning.

4. The development of an instrument for analyzing the connection between post-graduation career goals and student choices.

4.1 Introduction

Qualitative research within engineering education shows that the goals that students have for their post-graduation careers relate to choices that they make in undergraduate engineering programs, including the choice of persisting in their majors (Brown, in preparation B).

Persistence in engineering has also been a significant topic of inquiry and we as researchers know a great deal about patterns in and factors contributing to persistence (Eris et al., 2010; Eris et al., 2005; French et al., 2005; Mendez et al., 2008; Ohland et al., 2008; Pierrakos et al., 2009). Research also informs our understanding of student career goals (Hilpert et al., 2014; Sheppard et al., 2010) What is missing is a quantitative measure of relationships between future career goals and choices students make in the present. Such an instrument could enable future research on how goals influence student choices that are important in engineering education, like persistence. Additionally, this tool could have potential uses as in assessment of program outcomes related to career goals. In this study, I describe the development of a quantitative survey instrument that measures constructs related to post-graduation careers in order to meet the potential needs of researchers and educators.

There are two constructs that are central to understanding the focus of this study. The first is Post-Graduation Career Goal (PGCG) content: the desired outcomes that students have for their post-graduation careers. The second is mechanism choices. Mechanisms are the actions that students take towards achieving goals. Students might choose mechanisms like persistence in their engineering majors to advance towards the achievement of goals they might have. In this study, I further examine the connection between PGCG content and mechanism choices while

answering the research question “How can the connection between post-graduation career goal content and mechanism choices be measured separately from other goal-related constructs?” The process of answering this research question is relayed through the remainder of this paper, where I overview the development and piloting of the Post-Graduation Career Goals of Engineering Students (PGES) survey.

4.2 Theoretical Framework

In developing PGES, it made sense to look at existing theoretical constructs related to PGCG content and mechanisms and how they have been measured in the past. Goal Setting Theory (GST), originally developed by Locke and Latham (1990, 2002, 2013), describes the interactions between the goals that people set, the mechanisms that they choose to achieve those goals, personal beliefs called moderators, and the attainment of said goals. Figure 4-1 is an adapted overview of the constructs in GST.

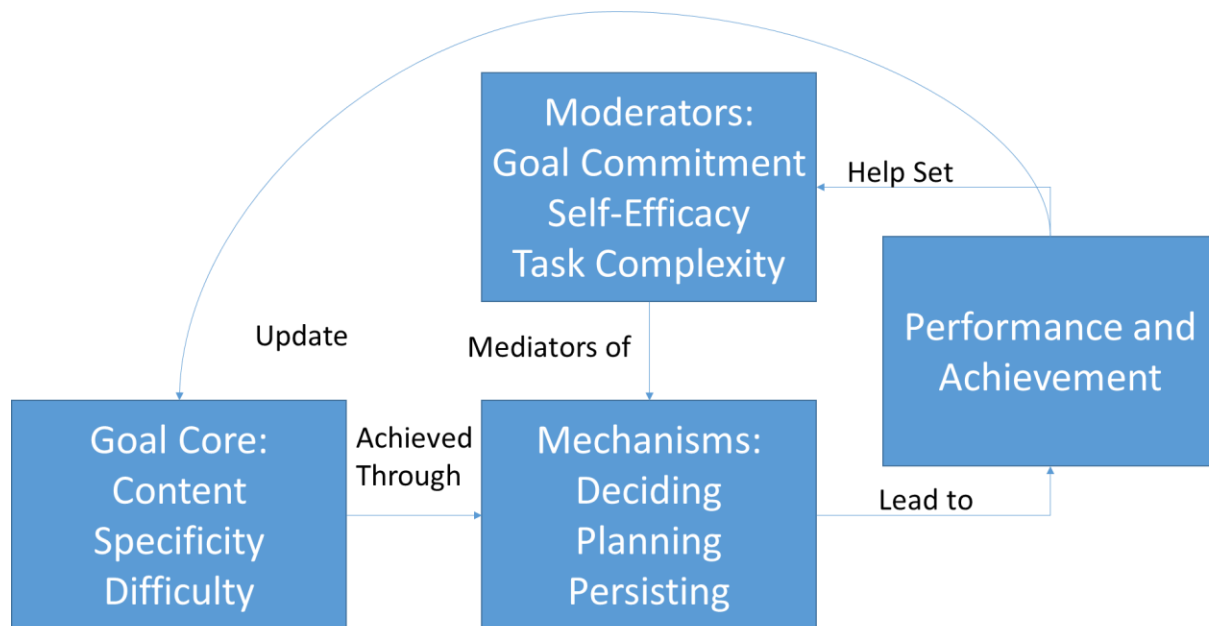


Figure 4-1: The constructs of GST adapted from Locke and Latham (2002)

Goal content is part of the goal core in GST, and is the desired outcome that somebody wants to achieve (Locke & Latham, 1990, 2002). The constructs of the goal core are considered by individuals when they choose mechanisms: the actions that lead to the accomplishment of goals. During these choices, individuals also consider moderators: constructs that represent other personal considerations that individuals have. The mechanism choices that students make lead to performance in tasks and the eventual achievement of goals. Experiences in goal achievement then feed back to updating and setting new goals, and to changing moderators.

4.2.1 Choosing constructs for PGES

In developing PGES, I considered which constructs its items should measure. Constructs considered included: PGCG content and its different types, specificity, difficulty, goal commitment, self-efficacy and the connection between goal content and mechanism choice. I considered whether existing research suggests that certain constructs are pertinent to PGCG research, and whether there are existing examples of how to measure constructs in a self-reported survey instrument. At the conclusion of this process, I decided to measure PGCG content, specificity, goal commitment and connection in this survey instrument while excluding other constructs.

4.2.1.1 Post-graduation career goal content and specificity

In this study, I am focusing on PGCG content, a specific type of goal content that refers to desired outcomes that undergraduate students have for their post-graduation careers. Goal content is part of the goal core in GST. The other constructs in the goal core are defined in relation to goal content. Specificity describes the amount of detail a person has in his or her goal content (Locke et al., 1989). Difficulty is the perception of how challenging goal content is to achieve (Locke & Latham, 1990, 2002). I focus on specificity in this study and not difficulty, as

existing research has linked specificity of PGCG content and how students choose mechanisms (Brown, in preparation B). Additionally, existing research gives examples that can be used to quantitatively operationalize specificity in the context of undergraduate engineering programs. Difficulty has not yet been suggested as an important construct in PGCG research. (Brown, in preparation B)

In previous research, different types of PGCG content were identified (Brown, in preparation A). PGCG content further divided into two main types. Job goal content is a description of a job or type of job students want after graduating, and ambiguity about that job. The other type is attribute goal content. Attribute goal content includes any desired aspects of one's future professional life that are not specific to a job or type of job. For example, attribute goal content can include wanting job security, wanting a career to involve helping other people, or wanting to enjoy what one does for a living.

Brown (in preparation B) also identified that specificity of job goal content was related to whether job goal content was connected to mechanism choice. First, Brown noted that students discussed varying levels of specificity for their job goal content. Within job goal content, students who expressed higher levels of specificity described choosing mechanisms with respect to their job goal content on more occasions than those who had low specificity. Students who had less specificity described choosing mechanisms when considering ambiguity in their job goal content on more occasions than students who had high specificity. This suggests that there may be a relationship between specificity and ambiguity in job goal content.

4.2.1.2 Post-graduation career goal content connection to mechanism choices

Individuals consider different types of PGCG content when they choose mechanisms. Mechanisms are actions that individuals take towards achieving goals. These can include making

a decision, persisting with an activity, or planning to take an action in the future. In previously conducted research, undergraduate engineering students connected different kinds of PGCG content to mechanism choices (Brown, in preparation, B). There were patterns in the types of content that students used when considering their mechanism choices. Students who had more connection between ambiguity in their job goal content and mechanism choices had less connection between the job goal content about jobs that they wanted and mechanism choices, and vice versa. Some students who chose mechanisms in connection with job goal content about jobs they wanted did not choose any mechanisms in connection with attribute goal content, while all students who chose mechanisms in connection with ambiguity in their job goal content also chose mechanisms based on attribute goal content. For example, one student discussed his choice of persisting with his degree only in connection to a wanted job of being researcher in biomedical engineering. Another student discussed her choice of deciding to major in environmental engineering in terms of her wanted job of wanting to work with infrastructure in third world countries, and her attribute goal of wanting to help others.

4.2.1.3 Goal commitment

Outside of the goal core, some moderator constructs are also defined in relation to goals. Those constructs are goal commitment and self-efficacy. Goal Commitment is how important the pursuit and attainment of goal content is to somebody (Hollenbeck & Klein, 1987; Locke et al., 1988; Seijts & Latham, 2000). Self-efficacy is an individual's belief in their ability to perform a task. Self-efficacy can be related to mechanisms that individuals are choosing, or it can also be related to the achievement of a goal itself. I chose to focus on goal commitment and not goal self-efficacy in this study. Existing research demonstrates that goal commitment can be

measured through self-reported survey instruments in a way that is adaptable to different types of goals (Hollenbeck et al., 1989).

4.2.1.4 *Constructs not used in PGES*

I chose not to include the GST constructs of attribute goal content, self-efficacy, goal difficulty, or task complexity in this survey's design and analysis. The rationale behind the exclusion of these constructs is a combination of two factors. The first is whether constructs were goal related. The second was survey fatigue. Some constructs with pre-existing instruments were distributed with PGES, like a previously existing instrument for self-efficacy for persisting with an engineering degree (Brown & Matusovich, 2013), were excluded from analysis due to not being goal-related. In the development of new items, PGES was kept to a certain length to avoid the phenomenon of survey fatigue, which can affect the number of completed responses, or the number of students who decide to begin taking the survey (Porter, Whitcomb, & Weitzer, 2004). Avoiding survey fatigue led to the exclusion of other constructs that were not goal-related from item development, altogether. Some goal-related constructs were also excluded to keep the survey to a reasonable length.

The research question for this study asks whether the connection between PGCG content and mechanism choices can be measured separately from other *goal-related* constructs. For this study's purposes, a construct was considered goal-related if goals are directly referenced in that construct's definition. For example, specificity is a goal related construct because it involves the level of detail used to describe a *goal*. By contrast, the construct of task complexity is how much effort it takes to perform a *task*. While that task might be one performed in service of achieving a goal, its complexity is not goal related. For this reason, task complexity was excluded from this survey.

Self-efficacy falls partially under this first point. Self-efficacy is a construct that references another idea. It is one's belief in their ability to do *something*. As there are practically an infinite number of "somethings", when we discuss self-efficacy, we are clear about which "something" to which it is referencing. In terms of this study, there are two potential reference points for self-efficacy. The first is self-efficacy for certain mechanisms like persisting with an engineering degree. This falls under the category of not goal-related. Though an existing instrument for measuring self-efficacy for persisting with an engineering degree was distributed with PGES, it was not considered in analysis for this study. The second is self-efficacy for achieving a goal. This construct *is* goal related. However, there is a different reason for its exclusion from PGES: A combination of lack of information to base new items on, and the need to avoid survey fatigue.

In the research conducted in Brown (In Preparation, B), the researchers found few in the way of examples for how students describe their self-efficacy for achieving a PGCG. This lack of discussion made it more difficult to formulate new survey items, as there are few examples of how students describe this kind of self-efficacy with which to base items. This is also true for goal difficulty. As I was attempting to reduce the number of items in PGES, and I had fewer examples to base items for these constructs on, self-efficacy for achieving a PGCG and goal difficulty were excluded from PGES.

Attribute goal content was excluded from PGES to avoid survey fatigue because of large number of subtypes it contained. Brown (In Preparation, A) found 11 different subtypes of attribute goal content in three main categories. To ask about all of them would inflate the length of the survey, especially if the connection between attribute goal content and mechanism choices was also included. Furthermore, there were no types of attribute goal content that were as

pervasive as job-goal content about wanted jobs or ambiguity in job goal content. While most students in Brown (In Preparation, A) described wanted jobs and ambiguity, even the most common type of attribute goal content was described by less than half of students. Therefore, while I suggest that future research focus on quantitatively operationalizing attribute goal content, I chose to focus this survey on job goal content in order to make the survey shorter and easier for students to take, while appealing to constructs that more students describe.

4.2.2 Summary of constructs used in PGES

In developing new items, I focused on constructs related to job goal content, including specificity of that content, ambiguity in job goal content, the connection of that content to mechanism choices, and the connection of ambiguity of job goal content to mechanism choices. I focused on job goal content instead of both job and attribute goal content because previous research suggested that students describe the different subtypes of job goal content (i.e. content about wanted jobs, ambiguity in job goal content) more often than the different types attribute goal content (i.e. wanting job security, wanting to help others in their work) (Brown, in preparation A). Additionally, there was more variation in how students connected job goal content to mechanism choices when compared to attribute goal content (Brown in preparation B). There are also fewer constructs to measure within job goal content (two, job goal content about wanted jobs and ambiguity in job goal content) versus a larger number in attribute goal content (eleven), means that an instrument measuring job goal content would be potentially more informative and easier to implement than one measuring attribute goal content.

Additionally, I adapted the goal commitment instrument from Hollenbeck et al. (1989) for this study's purposes. Hollenbeck et al. found these items to be to be reliable. The wording of the items that Hollenbeck and colleagues used for these items makes them easily adaptable to

different kinds of goal content. Adapting these items allowed me to include another goal-related construct, and compare newly created items to established, validated items during my own validation process.

The considerations of which PGCG-related constructs to measure, and existing, adaptable instruments for GST constructs, resulted in the final list of constructs measured by PGES shown in Table 4-1. This table also compiles all of the definitions of these constructs, for reference.

Table 4-1

Constructs measured by PGES

Name	Definition
Job Goal Content – Desired Job	Goals that students have for the specific job or type of job they would like in their post-graduation professional life.
Job Goal Content – Ambiguity	Student acknowledgement of not being sure about the specific job or type of job they would like.
Specificity of Job Goal Content	How much detail a student has in thinking about the job or type of job they would like.
Wanted Job Connection	The job or type of job that students want, and how it is considered when choosing mechanisms.
Ambiguity Connection	Ambiguity about what job or type of job a student wants, and the consideration of that ambiguity when choosing mechanism.
Commitment	How important the attainment of a job or type of job is to a student.

4.3 Methods

Gall, Gall, and Borg (1999) outline suggested guidelines for those developing a quantitative instrument in order to ensure validity and reliability in measurement and implementation. These guidelines have been used both within and outside of engineering

education. For example Lee, Matusovich, and Brown (2014) used these guidelines to develop a survey that measures inclusiveness in engineering programs and Horton et al. (1993) used them to study the effectiveness of concept maps as an instructional tool. For ease of implementation, I combined Gall et al's guidelines into three larger sequential steps (Table 4-2). Step 1 was the creation and adaptation of items for the survey instrument. This included the creation of items that were representative of the constructs that I wanted to measure, and the consultation of a survey development expert. Step 2 was a focus group with undergraduate engineering students. In this focus group, students took the prototype survey. Afterwards, and investigator asked them questions about the meaning of each group of items. This step resulted in the refinement of the survey instrument. Step 3 was a pilot distribution of PGES survey instrument. This led to a quantitative analysis of items in the instrument, including an exploratory factor analysis and internal consistency measurements for item groupings.

Table 4-2

Gall's methodological guidelines as related to my survey development sequence

<u>Gall's Guidelines</u>	<u>Development Sequence</u>
Define the constructs being measured.	Step 1
Define the target population	Step 1
Review related measures	Step 1
Develop a prototype	Step 1
Evaluate the prototype	Step 2
Revise the instrument	Step 2
Collect data on validity and reliability	Step 3

4.3.1 Step 1: Defining a population and creating a prototype

PGES is an instrument for examining how the PGCG content undergraduate engineering students have relates to choices they make in the present. Undergraduate engineering students of all academic years comprised my target population. In places where student data was collected, I

will discuss how I sampled from this target population, and in which ways my sampled population may differ from the overall population of engineering students.

I began by reviewing the concepts of GST, both from its original development (Locke & Latham, 1990, 2002, 2013) and its use in the context of PGCG research (Brown, In preparation, A, B). I considered how each study defined concepts, and how one might go about measuring them. To that end, I also consulted existing self-reported survey measures for GST constructs, and found an existing tool for measuring goal commitment (Hollenbeck et al., 1989).

When I began developing the initial survey instrument, I consulted best practices for preserving validity and reliability for quantitative measurements, e.g. (Borrego et al., 2009; Creswell, 2013; Rea & Parker, 2012). In developing initial items, I took measures to ensure construct validity by developing new items congruent with the definitions of the constructs I intended to measure with those items. Studies by Brown (In development, A,B), wherein the constructs of job goal content, ambiguity in job goal content, connection with mechanisms, and specificity of job goal content were defined, were consulted extensively. I also consulted previous GST-related research in order to determine whether there were any best practices recommended by researchers for the measurement of GST constructs, through which I found the goal commitment scale described above.

In developing the initial set of items, I consulted with a survey design expert. This expert has experience developing and evaluating survey instruments as a researcher and an instructor in higher education. During the interview, I went through initially developed items and the constructs I intended them to represent. I conducted this interview to provide a source of face validity, as I established that the wording of each item made sense in comparison with its intended meaning, and that the flow of the survey made logical sense.

The resulting initial survey items are in the left-hand column of Appendix B. There were 22 Likert-scale questions and 1 short response question. The short response question asks students about their job goal content for a desired job. As there was a large variety in the actual jobs that students described in the previous studies by Brown, asking close-ended questions about certain kinds of jobs was intractable for this survey. The short response also gives context to the questions that follow: the survey prompts students to answer Likert-scale questions about specificity, commitment, ambiguity job goal content, job goal connection and ambiguity connection in relation to the job goal content they describe.

4.3.2 Step 2: Evaluate and revise the prototype

After creating the initial survey, I conducted a focus group (Hesse-Biber & Leavy, 2010) with four undergraduate engineering students at a large public university with an engineering program. I recruited students by soliciting voluntary participants from an existing summer program. I recorded the focus group and later had it transcribed. The focus group lasted approximately one hour. To protect participant's identities, I assigned them pseudonyms. Their demographic information is shown in Table 4-3.

In the focus group, I asked students to complete the survey. Once the survey was completed, I asked students to describe their perceived meaning of each item. Finally, I asked whether they thought the survey made sense, whether any of the questions were difficult to answer, and whether they found the wording of any of the questions confusing. I used student responses to update the survey in order to improve face validity and content validity (Gall et al., 1999).

The focus group resulted in one change in terminology, which resulted in a minor update in of the wording in each of the survey items. Originally, I asked students to think of the job they

wanted after graduating from college in each question. Students in the focus group noted that wanting a job was a narrow idea, and suggested that I consider the different possibilities that they and other students might think about. In the focus group, Jessica asked:

Also, this kind of refers to the whole survey in general. If we're going to grad school after college, not into a job straight away, does this even apply?

- Jessica

Continuing in the conversation, Ryan had the following suggestion:

Maybe, based on what she just pointed out, rather than about the job, you could say about your career path after college. So then, that way, post-grad can be included on that a little bit easier.

- Ryan

From this conversation, I decided on “career choice after graduation” as a replacement phrase for “job after graduation”, and explicated what I meant by this in the new version of the short response question (labeled SR in Appendix B). I used this phrase in each of the updated Likert-scale items, as well, sometimes altering the phrasing of an updated item to make it easier to read. Another notable change was the creation of items 20 and 21 in ambiguity connection to parallel the line of questioning about job goal connection in items 14 and 15, as students found the original single item to be vague in its wording. Finally, other questions received minor word changes. For example, students noted that the word “very” had little purpose in the initial version of item 8, and I removed it in the updated version.

In addition to suggested changes to the survey, the focus group generated positive feedback from students. They noted that, in general, the items were easy to read and understand. Additionally, the meaning that students derived from items matched their intended meaning, in general. The items resulting from changes based on focus group feedback are shown in the

middle column of Appendix B. I use the item numbers in the right hand column to reference items throughout the rest of this paper.

Table 4-3

Focus Group Participant Demographics

<u>Pseudonym</u>	<u>Gender</u>	<u>Race/Ethnicity</u>	<u>Academic Year</u>	<u>Major</u>
Jessica	Female	White, Not Hispanic	Junior	Industrial Engineering
Ryan	Male	White, Not Hispanic	Senior	Ocean Engineering
Jason	Male	White, Hispanic	Sophomore	Aerospace Engineering
Trevor	Male	Black, Not Hispanic	Sophomore	Mechanical Engineering

4.3.3 Step 3: Establishing validity and reliability

Validity and reliability are crucial components to the usefulness of quantitative research and instrument development (Borrego et al., 2009; Creswell, 2013; Gall et al., 1999; Rea & Parker, 2012). I measured both in developing this instrument. Table 4-4 provides an overview of the types of validity and reliability I have established for PGES, and the methods I used to do so. Note that some of the methods have been described in Steps 1 and 2.

In Step 3, I conducted a pilot with the instrument for construct validity and internal consistency (reliability) purposes. The resulting survey instrument was implemented online using Qualtrics. I distributed the survey at five sites, including:

- State Tech (ST) - A large public land grant institution in the southeast
- State University (SU) - A large public institution in the midwest,
- Research Tech (RT) - A medium-sized private technical school in the northeast,
- Teaching Tech (TT) (RHIT) - A small private technical school in the midwest,

- Liberal Arts College (LAC) - A small, private liberal arts school with an engineering program in the northeast.

My definitions for small, medium and large come from the Carnegie Classification System (McCormick, 2001). I recruited students for participation via contacts in faculty and administration at each site. At TT and LAC, my contacts were at the college and engineering program administration level, and had the ability to distribute the survey to all engineering students at each site. At ST, my contacts were administration within the following individual engineering departments: Electrical and Computer Engineering, Industrial Systems Engineering, Biological Systems Engineering, Chemical Engineering, and Computer Science. These contacts were able to send the survey to all students in their respective departments. At SU and RT, I had individual faculty contacts who were able to send the survey to a few dozen of their students, each.

Table 4-4

Validity and Reliability Definitions and Methods

<u>Step</u>	<u>Type</u>	<u>Definition</u>	<u>Determined By</u>
Step 1, Step 2	Content Validity	The instrument measures the concepts it was intended to measure (Gall et al., 1999)	- Creating items based on theory - Student focus group
Step 1, Step 2	Face Validity	The items of the instrument make sense on subjective inspection (Gall et al., 1999)	- Student focus group - Expert consultation
Step 3	Construct Validity	The instrument measures its theoretical constructs adequately (Gall et al., 1999)	Exploratory factor analysis
Step 3	Internal Consistency	The items for each construct consistently produce the same results on repeat applications (Gall et al., 1999)	Cronbach's α measurement

Given the enrollment numbers of each site and/or department, and the distribution time of the survey between the end of summer sessions and the beginning of the fall term at each school, I estimate that the survey was distributed to approximately 2000 to 2500 engineering students. All students were contacted via email by faculty and administration contacts. At SU and TT, contacts agreed to send a follow-up email to students. At all other sites, contacts agreed to send one email to students. In total, 281 students responded to the pilot survey and completed all of PGES items. This represents an approximate response rate between 11% and 14%. Reviews of survey response rates note that there is a wide range of potential response rates for online surveys, and these numbers fall within that range (Shih & Fan, 2008). I have included Demographics and Academic information for these students are in Tables 4-5 and 4-6 below.

I used exploratory factor analysis to examine the pilot data. Factor analysis consists of the process of dividing individual items into factors that each explain a portion of the total variance of results (Cudeck, 2000; Duda, Hart, & Stork, 1999). Specifically, I performed factor analysis using principal axis factoring with a direct oblimin rotation, and used a scree plot (Figure 4-2) to determine the number of factors. I implemented these methods in SPSS.

Reliability measurements were conducted through the Cronbach's α test for internal consistency. A widely accepted measure in self-reported Likert-scale survey instruments (Bland & Altman, 1997). Scores above 0.8 are most desirable, while scores below 0.7 suggest that items for that construct may need to be revised or cut to increase the internal consistency score (Bland & Altman, 1997).

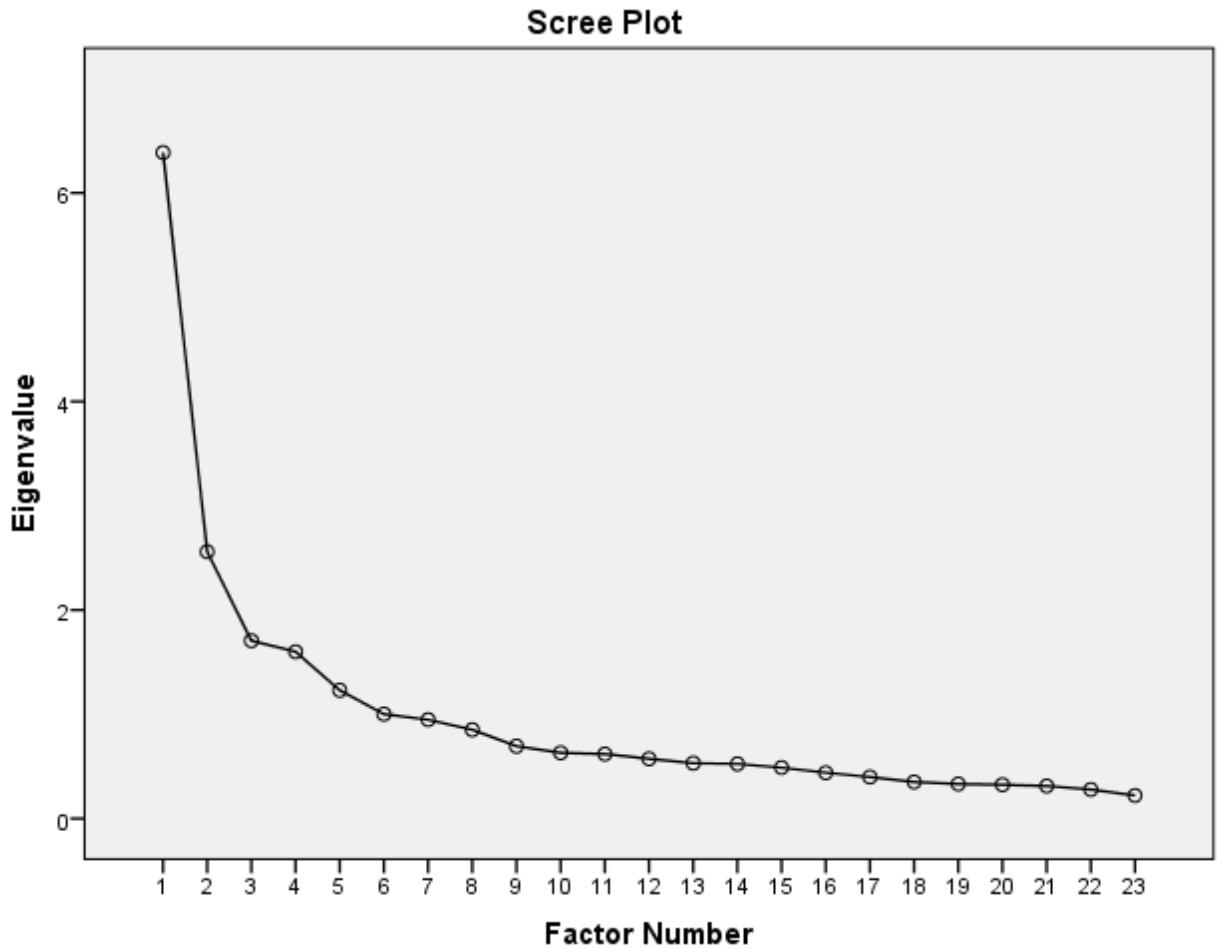


Figure 4-2: Scree plot used to choose number of factors. Note the indicative “kink” at 4 factors.

4.3.4 Limitations

This study has one main limitation around student recruitment and response rates. While the students recruited to take part in the survey pilot were all members of the target population for this study, the sample collected may not be demographically representative. I was also not able to directly supervise the recruitment process at each institution, and could therefore not ensure that recruitment across sites was completely consistent in format. This meant that some sites received follow-up emails, while others did not. This could affect the response rate between sites. Higher response rates are preferable, as they allow one to determine whether you have

representative sample of your study population, and potentially make generalizations from results. While the results collected from this survey may be informative while analyzing the constructs in question within undergraduate engineering students, I am not able to use the data within this study to make generalizable claims about trends in the PGCG content of all engineering students, or of different demographics within engineering students.

Table 4-5

Pilot Respondent Demographics, N = 281

<u>Gender</u>	<u>N</u>	<u>Race</u>	<u>N</u>	<u>Ethnicity</u>	<u>N</u>
Male	183	White	233	Not Hispanic or Latino	267
Female	95	Asian	23	Hispanic or Latino	13
Prefer not to say	3	Multiple and Other	18	Prefer not to say	1
		Black	3		
		Native American	1		
		Prefer not to say	4		

Table 4-6

Pilot Respondent Academic Information, N = 281

<u>Academic Year</u>	<u>N</u>	<u>Major</u>	<u>N</u>
First-Year	31	Mechanical Engineering	83
Sophomore	57	Computer Science	36
Junior	101	Electrical Engineering	33
Senior	92	Chemical Engineering	31
		Computer Engineering	24
		Biomedical Engineering	20
		Biological Systems Engineering	20
		Civil Engineering	16
		Environmental Engineering	3
		Aerospace Engineering	1
		Petroleum Engineering	1
		Materials Science	1
		Other	13
		Not Given	1

Table 4-7

<i>Pattern Matrix</i>				
Item	Factor Number and Loading			
	1	2	3	4
1				.793
2				.659
3*	-.685			
4*	-.554			
5*	-.361			-.469
6*	-.664			
7	.485			
8*	-.583			
9	.331			
10				-.490
11*				.577
12	-.303			-.540
13				-.777
14			.793	
15			.755	
16			.620	
17			.344	
18	.434			
19	.329			
20		.709		
21		.739		
22		.590		
23*		-.329		

*- Item reverse coded.
Principal axis factoring with oblimin rotation.

4.4 Results

I conducted two main quantitative tests to measure validity and reliability: an exploratory factor analysis and Cronbach's α internal consistency test. Using a scree plot, four factors were chosen for exploratory factor analysis. This resulted in the pattern matrix shown below in Table 4-7. Factor loadings below 0.3 are not shown. Factors are linear combinations of items, and the

loading within the pattern matrix is how much of that item goes into the linear combination. The factor loading number multiplied by the numerical value of the response to an item, summed together with the weighted numerical values for other items, results in the numerical value for each factor. Table 4-8 shows the Cronbach's α internal consistency score for each factor, along with information on the items contained.

Table 4-9 is a comparison of the mean score from each factor by gender. This analysis was performed for all constructs. Because previous research suggested differences in ambiguity and ambiguous content connection by gender, I checked for differences by gender across all constructs. Scores ranged between 1 and 7. For goal commitment, a higher score means *less* commitment. For ambiguous content connection and job goal connection, a higher score means the student agreed that those types of goal content connected to their choices. For specificity/ambiguity, a higher score means the student agreed more with statements about their goal content being more specific, and agreed less with statements about their job goal content being more ambiguous. Because data was non-normal, the non-parametric Kruskal-Wallis independent samples test (Kruskal & Wallis, 1952) was performed to determine whether the sampled populations of male and female students differed based on any of the factors of PGES. None of the differences in factor means had a significance level below 0.05, which would suggest such a difference. The difference between male and female students in job goal content connection was the closest to the threshold of significance, at 0.07. None of the other scores was below 0.17.

Table 4-8

<i>Reliability of Factors</i>			
Factor	Item Constructs Contained	Items	A
1	Goal Commitment; Job Goal Connection with Strategizing (18)	3, 4, 5, 6, 7*, 8, 9*, 18*	0.804
2	Ambiguous Content Connection	20, 21, 22	0.722
3	Job Goal Content Connection	14, 15, 16	0.787
4	Specificity (1, 2); Ambiguity (11, 12, 13); Goal Commitment about Changing Goals (5)	1, 2, 5*, 11, 12*, 13*	0.851

*- Multiplied by -1 for reliability score.

4.5 Discussion

The implications from this study stem from the four factors that resulted from factor analysis. The four factors are goal commitment, ambiguity and specificity, connection to job goal content and connection to ambiguity in goal content. Factors generally aligned with preconceived item organization. A notable exception was the combination of specificity and ambiguity into one factor. This combined loading has implications for the relationship between these two constructs.

Table 4-9

<i>Factor mean comparison by gender</i>							
Factor	Factor Name	All (N=278)		Male (N=183)		Female (N=95)	
		Mean	σ	Mean	σ	Mean	σ
1	Goal Commitment	2.58	0.83	2.58	0.83	2.57	0.84
2	Ambiguous Content Connection	5.26	1.11	5.34	1.10	5.09	1.13
3	Job Goal Content Connection	5.75	1.01	5.81	0.99	5.64	1.06
4	Specificity/Ambiguity	3.49	1.08	3.40	1.03	3.66	1.15

4.5.1 Ambiguity and specificity

One finding was that the questions designed to measure specificity and ambiguity in job goal content loaded onto the same factor, factor 4. This factor also had a very high internal consistency. These items were joined in the factor by item 5 from the adapted scale for measuring commitment. That item reads, “It is possible that I will abandon my goals for my post-graduation career choice,” which is very similar in wording to the ambiguity item 8, which reads, “I may change my mind about the post-graduation career choice I want to make.” The similar wording, and the concurrent loading of item 5 onto a factor with other commitment scale items, suggests that that item may ask about commitment *and* ambiguity/specificity.

While Specificity is a construct that existed in goal setting theory prior to the PGCG research conducted in Brown (In preparation, A, B), ambiguity of content was a new construct developed in that research. Brown (In preparation, B), when comparing specificity and ambiguity in content, found that students who had less specific job goal content connected ambiguity in job goal content to their mechanism choices more often than students with high specificity in one’s job goal content. Brown also noted that, conceptually, ambiguity in content is not simply the opposite of specificity. Ambiguity includes ideas like having multiple wanted jobs in their job goal content. These jobs can each have their own specificity: it does not mean that their job goal content is less specific. This conceptual difference, combined with the loading of specificity and ambiguity items onto the same factor with high internal consistency, suggest that they may be two components of a larger overall construct.

4.5.2 Goal commitment

Factor 1 is comprised of items from the adapted goal commitment scale, and a single item designed to measure an aspect of job goal connection, item 18, which states, “I have a plan that

will allow me to make my desired post-graduation career choice.” This question attempts to connect job goal content to a planning mechanism. Planning is the action of considering future decisions. However, it loaded with the goal commitment items, which have similarly future-referencing prompts, such as “The goals I have for my post-graduation career choice are good to work towards.” Item 19, also a job goal content connection question about strategizing, loaded onto the same factor but reduced the internal consistency of that factor, and was discarded for that reason. Factors 2 and 3 included items about different kinds of mechanism connections, but none about connection with a strategizing mechanism.

The factor loadings described above suggest two things about commitment and connection with strategizing mechanisms. The first is that adapting the goal commitment items from Hollenbeck et al. (1989) to this new context produced items that still represented the same construct (as evidenced by loading on the same factor), and that construct is still reliably measurable, based on the internal consistency score. The second is that there may be specific relationships between individual types of mechanisms and some goal-related constructs. The factor loading seen in this study could be due to the orientation of the items toward the future (items about making plans and sticking to goals) versus other items that are oriented towards the past, such as those that ask about decisions that have been made (items 14 and 20). Future PGCG research could consider differences in the time frames of mechanisms when exploring relationships between PGCG content and mechanisms. Such research could consider the work that has been done with future-time perspective (Husman & Shell, 2008; Simons, Vansteenkiste, Lens, & Lacante, 2004), which provides a framework for exploring the effects of time-related orientation of goals. Future-time perspective research has shown that individuals who consider events in the future have a tendency to approach present tasks differently. For example, students

who consider their future careers with respect to coursework are more likely to connect that coursework to those careers, and to learn more deeply (Hilpert et al., 2014).

4.5.3 Connection: Wanted jobs and ambiguity

Factors 2 and 3 contained items related to job goal connection and ambiguity connection, respectively, and no items developed to measure other constructs. The internal consistency scores for these factors were within the acceptable range (above 0.7). This means that the instrument created in this study can be used to measure the *connection* of PGCG content and mechanism choice with an acceptable level of validity and reliability. The concept of connection can be measured separately from other goal related constructs like specificity and commitment, which directly addresses the overall research question of this study.

4.6 Conclusions and future work

Future work using PGES should focus on three areas. The first is further validity and reliability testing. The second is larger-scale implementations of PGES that can provide generalizable results about how students connect their PGCGs to their mechanism choices. Finally, researchers and educators should conduct future work on the potential use of PGES as an assessment tool for academic programs with outcomes related to student PGCGs.

4.6.1 Continued validity and reliability work

Researchers should conduct continued work to confirm the validity and reliability of PGES. A next step would be collecting a larger amount of data and performing a confirmatory factor analysis (Hoyle, 2000). Unlike exploratory factor analysis, confirmatory factor analysis begins with a set of factors, and focuses solidifying the validity of those factors. Future implementations of PGES can also be used to recalculate Cronbach's α to make additional reliability measurements.

4.6.2 Research directions

PGES can be used by researchers to conduct large-scale analyses of how students connect their wanted job goals and ambiguity in their job goals to their mechanism choices. Those researchers could investigate whether there are any differences in that connection between students of different demographics. One area to begin would be examining whether there are differences between male and female students in how often ambiguity is connected to mechanism choice. Brown (In preparation, B) found that female students connected ambiguity in job goal content more than male students. PGES could be used to see if there are any statistically significant differences between male and female students based on the PGES factors in a larger dataset. Though the implementation in this study did *not* show any significant differences, the comparison between male and female students within job goal content connection was close to the threshold of significance (0.07, threshold of 0.05). In future studies, larger samples can reduce the confidence interval of reported means, and thus make it easier to determine whether and differences in means are significant.

Researchers could also use PGES to compare PGCG-related constructs to other often-studied outcomes like persisting in a major. Researchers could set up future studies to examine whether any of the factors that PGES measures are correlated to, or causal in, persisting in a major. This could be used to see if the connection of mechanism choice and PGCG content measured by PGES relates to actual mechanism choice. Such a study could benefit from the longitudinal collection of both PGCG information with PGES and persistence data to investigate whether changes in PGCG-related constructs might also relate to whether students persist with their majors.

4.6.3 Assessment uses

PGES also has potential as an assessment tool for engineering programs. For example, if programs have outcomes related to connecting coursework to future careers, educators in those programs could use longitudinal implementations of PGES to track how students are connecting their goals to mechanism choices, which occur while they are in undergraduate programs.

Educators could see whether students generally connect the jobs they want or the ambiguity they have about their job goals to choices made within their engineering programs, and use that information to help them better meet any career-related outcomes.

4.7 Appendix B: The PGES survey

Table 4-10

Survey items before and after focus group

All items are 7 point Likert Scale between Strongly Agree and Strongly Disagree except where noted by *.

* - Short response answer.

** - Reverse coded.

Initial	Post Focus Group	#
Job Goal Content		
Please think of the job or type of job you want after graduating from college. Please describe it in the space below. The multiple choice questions following this prompt are in reference to this response.	Please think of the career choice you want to make immediately after you finish your undergraduate program. This can include graduate school, joining the military, getting a job, or any other activity you consider to be part of your professional career. Please describe it in the space below. The multiple choice questions following this prompt are in reference to your response.	SR*
Specificity		
I know the specific job that I want after I graduate.	I know the specific career choice that I want to make after I graduate.	1
I know the kind of work I want to do in my post-graduation job.	I know the kind of work I want to do in my post-graduation career choice.	2
Commitment		
I don't take the goals I have for my post-graduation job seriously.	I don't take the goals I have for my post-graduation career choice seriously.	3**
It's unrealistic for me to expect to reach the goals I have for my post-graduation job.	It's unrealistic for me to expect to reach the goals I have for my post-graduation career choice.	4**
It's quite likely that the goals I have for my post-graduation job will change.	It's quite likely that the goals I have for my post-graduation career choice will change.	5**
I don't care if I achieve the goals I have for my post-graduation job.	I don't care if I achieve the goals I have for my post-graduation career choice.	6**
I am strongly committed to pursuing my goals for my post-graduation job.	I am strongly committed to pursuing my goals for my post-graduation career choice.	7
It is very possible that I will abandon my goals for my post-graduation job.	It is possible that I will abandon my goals for my post-graduation career choice.	8**
The goals I have for my post-graduation job are good to work towards.	The goals I have for my post-graduation career choice are good to work towards.	9
Ambiguity		
I am considering multiple types of jobs after graduation.	I am considering multiple career choices after graduation.	10
I am sure of the details of what I want to do in my post-graduation job.	I am sure of the details of what I want to do in my post-graduation career choice.	11**
I may change my mind about what I want in my post-graduation job.	I may change my mind about the post-graduation career choice I want to make.	12
I don't know what I want to do for my post-graduation job.	I don't know what my post-graduation career choice will be.	13
Job Goal Connection		
The job that I want after graduation was important, or will be important, in selecting my academic major.	My desired post-graduation career choice was important, or will be important, in selecting my undergraduate academic major.	14

I am pursuing my degree because I think it will get me the job I want after graduation.	I am pursuing my undergraduate degree because I think it will lead me towards the post-graduation career choice I want to make.	15
I make academic decision based on the job I want after graduation.	I make academic decisions based on my desired post-graduation career choice.	16
I make internship-related decisions based on the job I want after graduation.	I make or will make internship-related decisions based on my desired post-graduation career choice.	17
I have a plan that will allow me to get the job I want after graduation.	I have a plan that will allow me to make my desired post-graduation career choice.	18
I am aware of the decisions I should make to get the job I want after graduation.	I am aware of the things I should do that will lead me to my desired post-graduation career choice.	19
Ambiguity Connection		
I make decisions that will keep my job options as open on possible.	I chose, or will choose, an undergraduate academic major that will keep my career choice options as open as possible.	20
	I am pursuing my undergraduate degree because it will give me many options for my post-graduation career choice.	21
I avoid making academic decisions that narrow my job options.	I avoid making academic decisions that narrow my career choice options.	22
I have committed to academic decisions even though they narrow my overall job possibilities.	I have committed to academic decisions even though they narrow my post-graduation career choice options.	23**

5. Dissertation conclusions and implications for stakeholders

My dissertation was guided by the overarching research question: “What is post-graduation career goal (PGCG) content, and how do undergraduate engineering students use it to choose mechanisms?” To answer this question, I identified three sub-questions and conducted three studies, one for each sub-questions. In Chapters 2-4, I provided answers to each sub-question. In this final chapter, I focus on answering the overarching research question and describing the implications of my study outcomes for each group of stakeholders (Students, Engineering Educators and Researchers). Finally, I identify potential avenues for future work stemming from my study.

5.1 Main outcomes

There were four main outcomes from my dissertation. Three outcomes directly resulted from answering the research questions from each manuscript, including 1) a theoretically grounded exploration of PGCG content in undergraduate engineering students 2) a longitudinal exploration of how students connect PGCG content to their mechanism choices, and 3) a tool that supports future research on PGCG content. The fourth outcome stemmed from patterns that were observed across studies, in which female students described lack of job goal content and connected ambiguity in job goal content to mechanism choices more often than male students.

5.1.1 Characteristics undergraduate engineering students described in post-graduation career goal content

My research provides a theoretically grounded way of describing different kinds of PGCG content that did not previously exist in the literature. In answering my first research question, I found that PGCG content was made up of two types: job goal content, descriptions of specific jobs and types of jobs that students wanted and attribute goal content, the more general attributes that students wanted from their careers that were independent of job or job type.

Within job goal content, some students discussed ambiguity in job goal content. Ambiguity in job goal content included having a lack of content (i.e. not knowing what one wants to do) and fluidity in content (e.g. changing their mind, having multiple jobs they might want, not knowing certain details about what they want in their job).

5.1.2 Undergraduate engineering students consider different kinds of post-graduation career goal content when choosing mechanisms

From answering my second research question, we now have an understanding for how students connect different kinds of PGCG content to their mechanism choices. We now know that both identified types of content are potentially connected to students' mechanism choices. This connection existed across a range of mechanism choices, such as choosing a major, persisting with or withdrawing from a major, choosing internships, and strategizing and planning for future actions they would have to take. Students were not uniform in the types of content that they favored when connecting to these choices, so we cannot point to a specific type of PGCG content and say it is more important in determining student choices: each type is important and used by some students.

5.1.3 Measuring the connection between post-graduation career goal content and mechanism choices

Building on the outcomes from Study 1 and Study 2, I have also created a tool for future exploration of how students use PGCG content to choose mechanisms. The survey instrument I created can reliably measure a factor that I call connection: that is, connection between PGCG content and mechanism choice. In developing this instrument, I quantitatively operationalized the constructs from my first two outcomes in a way that paves the way for new avenues of research on PGCGs.

5.1.4 Patterns by gender

Throughout this dissertation, I found some differences between how male and female students describe their PGCG content. In my first manuscript, I found that female participants described a lack of job goal content (a kind of ambiguity) as compared to male students. In my second manuscript, I found that female students connected ambiguity in their job goal content to their mechanism choices more often than did males. Differences by gender, while not hypothesized at the beginning of this study, are nonetheless an important outcome. I was not able to confirm these trends in quantitative pilot data from my third study due to an insufficient number of responses. Consequently, my dissertation provides another piece of understanding related to how women, an underrepresented group in engineering, experience engineering programs. This can add to our ability to aid women who are pursuing or interested in pursuing engineering disciplines. Future research could use my survey instrument to either confirm that these trends exist more generally, or suggest that this trend is more localized to the population of students who were interviewed.

5.1.5 Overarching research question

The answer to my overarching research question has two components. The first is that PGCG content is comprised of both job goal content and attribute goal content. The second is that both job goal content and attribute goal content are considered by students when choosing mechanisms. In this dissertation, I have described the specific details behind each of these components, as well as efforts I have made to set up future research directions on PGCG content.

5.2 Implications for stakeholders

In the opening chapter of my dissertation, I identified three stakeholders for the outcomes of my dissertation including students, engineering educators and researchers. Table 5-1 provides

a summary of the implications for those three stakeholders. Students gain a new perspective on how they can think about, and use, their own goals. Engineering educators gain new ways of understanding and assessing the career goals of their students. Finally, researchers have a new theoretical understanding PGCGS, along with new methodological tools for analyzing PGCGs.

Table 5-1

<i>Implications for stakeholders</i>		
Stakeholder	Why they care about PGCG content	Implications from dissertation
Students	Goal content helps guide students in choosing mechanisms	This dissertation provides the insight for students to build upon their intrapersonal foundation and self-authorship by being aware of how PGCG content factors into their choices (mechanisms).
Engineering Educators	Use careers in their program outcomes and in the advertisement of their programs	<p>The ways that engineering programs present potential careers to students could specifically address job goal content, attribute goal content and ambiguity in job goal content that students might have.</p> <p>Within the classroom, educators could connect material to relevant future careers.</p> <p>My survey instrument could be used to assess PGCG related outcomes that programs have.</p> <p>Educators could consider the meaning and implications of our students being ambiguous about their careers.</p>

Researchers	Goals are related to often-researched outcomes like learning, persisting with a major and major choice	<p>The emergent concept of ambiguity in job goal content is related to the existing GST construct of specificity.</p> <p>An example of how content can be expanded for distal goals in future research.</p> <p>A new perspective on how individuals make choices about careers with respect to other career decision making research.</p> <p>A new potential research direction for the gender and gender studies in engineering programs.</p>
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5.2.1 Students

A potential implication of my study for students is a new way for students to think about their goals and the ways that they tie their goals to the choices they make. It might be helpful for students to consider that there are different kinds of PGCGs: job goals and attribute goals. When one considers their future career, the job or jobs they might have could be the first thing to come to mind. For students who do not know the exact job they want, this might make their future career, and how it ties to their current choices, seem like more of an unknown commodity. However, attribute goal content and ambiguity in job goal content present some new perspectives. Perhaps a student knows that they want a job that is beneficial to society, or jobs that serve the underprivileged, but does not know which job will fulfill that requirement. This student still has a post-graduation career goal, and if it is important to the student, they could consider how they can work towards accomplishing it. The student could consider whether the academic major they have chosen, or internships they are considering, might help them find a career path that lets them accomplish their attribute goal content.

Understanding one's career goals, and how they factor into the decision one makes, relates to the idea of self-authorship, as presented by Magolda and King (2004). In their book, Magolda and King define self-authorship as the "Capacity to internally define a coherent belief system and identity that coordinates mutual relations with others." They argue that developing self-authorship is an integral part to an undergraduate education. One of the main components of self-authorship is intrapersonal foundation: the ability to choose one's own values and identity that helps one regulate their own choices. It is here that understanding one's own career goals comes into play. Students who are aware of their goals, and how they factor into the choices they make, will help themselves develop this intrapersonal foundation. This will aid them in interacting with the educational system, currently, and in their future professional life. Being aware of the connection between one's choices and one's goals can lead to a better match between the two.

Whether students have goals about the jobs they want, attributes of their desired career, or self-knowledge that they have some ambiguity in job goal content, the acknowledgement and consideration of those goals in the process of making choices about their current situation is part of maintaining an intrapersonal foundation. Taking action to move towards those goals through mechanism choices fits into attaining and maintaining self-authorship.

5.2.2 Engineering educators

Engineering educators can also benefit from the outcomes of my dissertation. In discussing the need for my research, I noted that engineering educators at multiple levels, from those who work in individual engineering programs, to those who work at the national policy level, have recognized the importance of preparing students for careers. I argue that the outcomes of this dissertation suggests that educators who place an emphasis on preparing students for

careers could consider the PGCGs that students have, and their potential to affect the choices students make. I have also created a survey instrument that could aid in the assessment of some career-related outcomes that programs may have. Finally, I have described how ambiguity could play an important role in the way students perceive engineering programs.

5.2.2.1 Informing programs with an understanding of post-graduation career goals

I have laid the groundwork for understanding student post-graduation career goals. Engineering educators could use this groundwork in a variety of ways to meet their own needs. Programs with career-related outcomes can use my expanded understanding of PGCG content to better understand what their students are striving to do with their careers. This, in turn, could help those programs better match their outcomes to student needs. Programs with career-related outcomes could be interested in knowing that students do consider their PGCG content when making academic choices: that is, students are connecting their future careers to what they are doing in their academic life when it comes to big choices like academic major, persisting with a major, and internships. They could also be interested in the variety of ways that students think about their careers. While it may not be surprising that some students are driven to make choices based on the jobs they want, the fact that job-independent career attributes and ambiguity surrounding desired careers also factor in could help programs expand the ways in which they discuss careers with students.

Programs could try to inform students about aspects of career possibilities that relate to job-independent career attributes. A description of financial benefits, work-life balance, at-work environment, and the societal benefits of jobs could be appended to efforts that programs already make to introduce students to members of industry and their careers. This could have an additional benefit for students who lack job goal content, as it could help them connect their job-

independent attribute content to potential future careers. Benefits could extend beyond helping students set, and connect their programs to, career goals. Previous research has shown that students consider future jobs, monetary benefits and how they could benefit society (monetary benefits and helping others are types of attribute goal content) as reasons for pursuing engineering degrees (Sheppard et al., 2010). Connecting engineering programs to career possibilities and their job-independent attributes could help programs retain more students.

5.2.2.2 Connecting to goals in the classroom

In the classroom, educators could tie course content to potential careers in which students would use that content. In addition to introducing students to more career possibilities, previous research has suggested that students who connect what they are currently doing to their future careers experience more connection to material, deeper perceived utility of material and more new knowledge of material (Hilpert et al., 2014). This presents the possibility of academic benefit to integrating future careers into classroom environments.

5.2.2.3 An assessment tool

Engineering educators who are interested in measuring PGCG related constructs could consider using the survey instrument I developed for their assessment needs. The instrument is capable of qualitatively surveying students for information about what they plan to do after college. Additionally, it is capable of quantitatively measuring ambiguity in job goal content and specificity about their job goal content, their commitment to their job goals and to what extent they connect the jobs they want and ambiguity in their job goal content to the choices they make. If, for example, a program wants to help students make more connections between their academic choices and career goals, this survey could be used to take before and after measurements of those connections.

5.2.2.4 *What does ambiguity mean for your program?*

Finally, educators should consider the idea that students are ambiguous about their job goal content, and consider what ramifications that idea might have for how students experience engineering programs. Engineering programs face some unique challenges when it comes to understanding why students choose to persist with or withdraw from enrollment. Degree requirements are more stringent, and sometimes require taking extra courses. Because of this, students in engineering generally have to declare a major choice sooner. Even though persistence rates are higher in engineering than in other fields of study, fewer students switch into engineering from elsewhere in part due to these rigorous coursework requirements and minimal overlap with coursework in other fields (Ohland et al., 2008). This raises the question: are we discouraging other students from entering engineering for similar reasons, and is ambiguity the root cause?

In the data used in this dissertation, most students were ambiguous about *something* related to their job goal content, meaning they either had a lack of job goal content, or acknowledged fluidity of that content in that it might change or that there was more than one career they might want. Some students also connect that ambiguity to mechanism choices they make, like deciding on a major or persisting with their degree. First, to be clear, I believe that ambiguity is *not* a bad thing. It is just reality. Post-graduation careers are large components of students' post-graduation *lives*. It only seems natural for students to not know or not be sure of some things that will happen in the future; the future is not set in stone. However, particularly in students who lack job goal content altogether, ambiguity over what one will do after one graduates might clash with the need to decide what degree one will graduate with a relatively short time after matriculation. Perhaps we are driving some students away from engineering, or

certain engineering majors, with that early choice. Perhaps we are driving other students to make choices of which they are uncertain, or with which they might feel stuck. I think I saw some examples of the latter in this study. Sadie did not know what she wanted to do for her career, but felt constrained to persisting in her major because she had invested so much time and effort into it. Valerie admitted that she really only began to understand what her major, Industrial Systems Engineering, was about in her third year of study, nearly two years after she chose the major. There are not examples of the former, as they never would have enrolled in engineering.

Could these rigorous requirements drive students with ambiguous career goals away from enrolling in engineering programs in the first place? If so, can we, as educators, do anything to make engineering more attractive to students who shy away from it for these reasons? One answer could be connecting career possibilities from engineering programs to attribute goal content that perspective students might have. Most students have attribute goals: perhaps they could be a gateway to helping students set job goals that they connect with their engineering major. Another answer could be putting more focus on introducing students to more engineering career possibilities in their first year of study, while there is still time to decide on an engineering major. Finally, we should conduct continued research to better understand the role that ambiguity plays on the choices students make in engineering programs.

5.2.3 Researchers

The outcomes of my dissertation have four implications for researchers. My results add two new concepts to goal setting theory. The first is the idea of ambiguity, and its relationship to the pre-existing construct of specificity. The second is an example of how the construct of goal content can be expanded into different types of content in different contexts. My exploration of PGCG content also has implications for the study of goals within other theories. The results of

my dissertation provide a new perspective on how students approach career decisions, with respect to other career decision making research. Finally, my dissertation provides new finding and research direction for the study of gender and gender in engineering programs.

5.2.3.1 Relating specificity and ambiguity

From the results of this dissertation, I suggest that specificity and ambiguity are not necessarily the same, but are closely related, and perhaps part of a broader, more encompassing construct. When I began the process of exploring PGCG content, I started with only the initial idea of what that content represented. As I broke it into types, and then those types into different ideas they contained, I noted the similarities between the existing construct of specificity and the emerging construct of ambiguity in job goal content. Conceptually they are similar, but not the same. For example, a lack of content (one kind of ambiguity) is the absence of any content. This is not the same thing as a lack of specificity in content. Specificity requires some content to be in reference to: something that is, or is not, specific. Similarly, the ideas that make up fluidity in content (another kind of ambiguity) are not mutually exclusive from content having specificity. One can describe multiple, specific jobs that they might want in the future, or describe a very specific career goal that they then acknowledge might change. Only the idea of being unsure of certain details about a job seems to match up, conceptually, with being the reverse of specificity. Results shown in Chapters 3 and 4 support the suggestion that ambiguity and specificity are different components of a broader construct. In Chapter 3, students who connected their choices to ambiguity in their job goal content also tended to describe their job goal content with lower specificity, although not in every case. In Chapter 4, items designed to measure specificity and ambiguity were represented by a single factor in exploratory factor analysis. I believe that this shows they are, in practice, part of the same overarching construct.

For future GST research, the implication is that one might want to consider not just specificity of content, but ambiguity and specificity of content together when trying to measure and describe different properties that goal content can have. This is especially true for future PGCG research, as that context is where the relationship between ambiguity and specificity has been developed.

5.2.3.2 Exploring different types of content

Goal setting theory (GST), as defined by Locke and Latham (Locke & Latham, 1990, 2002, 2013) and used in numerous experimental, academic and workplace related studies (Locke & Latham, 2013; Morisano et al., 2010; Wood, Mento, & Locke, 1987) was developed and used as a theory for understanding the role that goals have on task performance and achievement. In this use, the content of a goal was given when experiments or workplace tasks were assigned. Goals in these settings had a certain amount of specificity as assigned by those conducting studies. Importantly, both content and specificity were in practice, things that were assigned.

In my dissertation, I used GST in a different context. With PGCGs, content could not be assigned to students. It was something that they already had, developed over years of their own experiences and through potentially disparate means. As such, in any study on career goals in students, one needs a way of understanding and describing the different content that students might have. This became the focus of the first study of my dissertation, and the resulting description of types and subtypes of PGCG content can be used in future research on post-graduation career goals.

5.2.3.3 Goal and career research

There are also implications for those who conduct goal research, in a more general sense. Goals have been researched in different contexts, from achievement in academics (Ames &

Archer, 1988; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Senko et al., 2011), to persisting with majors (Lent & Brown, 2006; Lent et al., 1994; Lent, Brown, Nota, et al., 2003; Lent et al., 2005), to achievement of physical goals like weight loss (Cullen, Baranowski, & Smith, 2001). In many of those contexts, the content of goals is either not described, as in achievement goal research that focuses on a concept called goal orientation, or assumed as a static, as in some studies on goals about persisting, where students either set or do not set a goal to persist in their major. However, in some contexts, especially those involving distal goals like PGCGs, understanding varieties in content can be important to investigating avenues of research and developing new understanding. In this context, the methods used in my dissertation serve as an example for how another goal-related study could similarly explore different varieties of another kind of distal goal.

The results of my dissertation also have implications for those who do research on how students approach careers. The large body of career decision making research includes studies that investigate different factors that go into how students make career decisions, including personality traits (N. Betz, 1988), indecisiveness (Osipow & Gati, 1998), and comprehensive taxonomies of different factors (Gati et al., 1996; Gati et al., 2010; Gati et al., 2000). These studies are often very broad in the types of careers they discuss, instead focusing on general trends in how individuals approach careers. My dissertation is more specific in context, looking at how undergraduate students in engineering use their career goals when making choices. The result is a more specific set of constructs describing not personal predispositions for decision-making, but the content of goals and how that content is used to make decisions. This represents a different way of viewing careers and career related choices, and could add a different perspective to career decision-making research.

5.2.3.4 *Research on gender*

Finally, the outcomes of my dissertation have implications for researchers studying the role of gender in engineering programs. As mentioned in the previous section, the finding that female engineering students express more of one kind of ambiguity in job goal content (lack of content) than male students, and connect ambiguity in job goal content to their choices more often. These findings add new perspective to how female students might have different experiences in engineering programs, or in the process of deciding on a career in engineering. Researchers may want to consider whether this finding is related to factors like stereotype threat (Bell et al., 2003; Inzlicht & Schmader, 2011; Spencer et al., 1999) and lack of gender representation in STEM fields (Hill et al., 2010) that are already related to why fewer women enroll in engineering programs. Diversity is an important consideration for engineering educators and engineering education researchers. We are consistently looking for new ways to enable and encourage more individuals from underrepresented groups to be part of the engineering community (Du & Kolmos, 2009; Foor, Walden, & Trytten, 2007; Lam, Doverspike, & Mawasha, 1997; Maton, Pollard, McDougall Weise, & Hrabowski, 2012), and developing a better understanding for why groups remain underrepresented (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Lee et al., 2014). The fact that my findings have implications for our understanding of women in engineering programs is of significance to myself, and other engineering educators who work to make the engineering community more diverse and inclusive.

5.3 Conclusions and future research directions

Future research stemming from my dissertation can be divided up into two areas. The first is the continued development of PGCG content and its subtypes as constructs. The second is

follow-up studies that use the survey instrument developed in Chapter 4 to support some of the outcomes and implications identified in my dissertation, and create more generalizable research results that will be acknowledged and responded to by a wider audience of researchers and educators.

One interesting question for future research is whether there are missing components to goal content that were not evident in my dissertation. A reality of research is that not every line of questioning can be asked, whether I had control of the interview protocol. As such, I had no opportunity to ask students about aspects of goal content that one might expect to exist.

For example, previous research by Winters (Winters, 2012) shows that early career engineers frequently discuss interest in their jobs as an important factor in their careers and their choices of employment. Further, entire theories have been built around the idea of interest, and how it can motivate individuals (Hidi & Renninger, 2006). Yet there were few examples of interview participants in my study who tied interest in certain topics to the job goal content they had. Within the interviews I analyzed (outside of things that I coded for), many my study's participants discussed interest in certain topics, and how that interest related to their choice to enroll in engineering programs or particular engineering majors. The idea of interest did not come up in the coding process. This is an extension of a limitation in the coding process I used for this dissertation. In Study 1, students' statements of interest in engineering, or topics related to engineering, were not discussed in conjunction with jobs, so interest never became a part of PGCG content codes. Only after analysis for Study 2 was complete, and I began revisiting quotations for other reasons, did I begin to realize that many of those statements of interest were in reference to mechanism choices like deciding to enroll in engineering or deciding on an engineering major, and might have some relationship to PGCG content as well.

When considering PGCG content and its subtypes, future research could also focus on the relationship between job goal content and attribute goal content. One possibility is that different subtypes of attribute goal content share a connection to how students select job goal content, in a hierarchical sense (see Figure 5-1). Recall that in Chapter 3, I describe how other attributes seemed to influence the job goal content students have. Cathy from U2 wanted a job that allowed her to work outside. She then used this to narrow her job goals content to jobs within civil engineering related to transportation and construction. There may be other attribute content to be described, and that attribute content may fill in gaps in understanding about how students set certain job goals. To investigate this, I would like to conduct new qualitative research that focuses on exploring more types of attribute goals content.

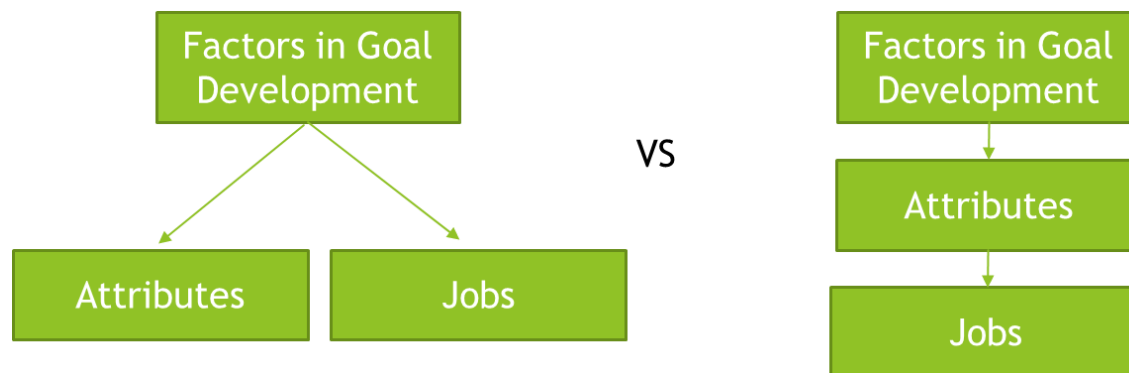


Figure 5-1: Visual representation of two potential relationships between job goal content and attribute goal content.

Future research could also continue to investigate outcomes from my dissertation. The differences in how male and female students described ambiguity of job goal content in Chapters 2 and 3 could be investigated via the survey instrument in Chapter 4. This could go towards either confirming that this is a wide phenomenon, or an observation limited to the small population of students who participated in interviews.

Similarly, the nature of the connection between PGCG content and mechanism choices could be further explored utilizing the survey instrument. The resulting instrument from Chapter 4 reliably measures two factors that contain questions related to connection with wanted jobs and ambiguity in job goal content respectively. However, connection between two concepts is usually measured via a correlation or regression analysis of two separately measured variables. Due to the nature of job goal content and mechanism choice, it was not possible to create items to measure each of those concepts quantitatively. So, what is the meaning of the items that measure connection? Future mixed methods research could use the survey instrument along with interviews or focus groups that ask students about the connections between their mechanism choices and job goal content, and determine whether the ways students describe their connection relates to the quantitative measurements provided by the survey instrument.

5.4 Uses of the PGES survey

This section contains some general guidelines and ideas for using PGES for research and assessment purposes. Researchers and educators can use PGES to qualitatively poll students about the post-graduation career decision they plan to make, and collect quantitative data about the specificity and ambiguity of those plans, how committed they are to those plans, and how those plans connect to the choices they have made in undergraduate engineering programs. In other words, it measures one construct qualitatively, wanted job goal content, and four constructs quantitatively: 1) job goal commitment, 2) connection of mechanism choices to wanted job goal content, 3) connection of mechanism choices to ambiguity in job goal content, and 4) specificity/ambiguity of job goal content.

5.4.1 Uses for researchers

I envision researchers using PGES for two different purposes. The first is for demographic analysis of the constructs that PGES measures within populations of undergraduate engineering students. The second is to compare the quantitative constructs that PGES measures to other factors and constructs.

The purpose of a demographic analysis using PGES would be to determine if there are differences in various populations of engineering students in the ways that they view their post-graduation career goal content. A demographic analysis could focus on one or two sub-populations of engineering students, or aim to collect a large, representative sample of all engineering students. As one example, a researcher might be interested in studying whether there are any differences between students at historically black colleges and universities (HBCUs) and other institutes of higher education in terms of how they view and make choices related to their PGCG content. Such a study would want to sample students at HBCUs with engineering programs and students at other institutions. When choosing non-HBCU institutions, researchers might want to take care to sample from institutions that have a larger population of underrepresented students so they could have three strata of students to compare: underrepresented students at HBCUs, underrepresented students at non-HBCUs, and other groups of students. Analysis of data collected in this way would consist of statistical methods to determine whether there is a difference between two groups (ANOVA or non-parametric alternatives).

Researchers might also be interested in whether the constructs measured in PGES relate to other constructs. As an example, researchers could investigate whether the constructs of PGES relate to or predict persistence in engineering programs. Note, by persistence, I mean actual

persistence data, not self-reported persistence or intent to persist. Because students described a connection between their PGCG content in Brown (In preparation, B), this is a logical area for future research. PGES could be distributed to students in a longitudinal study every semester or every year, while their enrollment status in engineering is also being tracked. Analyses can then be performed both on changes in how students view their PGCG content over time, and on any differences in the ways that students who persist or leave engineering view their PGCG content. For every semester of data, a comparison can be made between the students who leave engineering, and those who do not. If this research found, for instance, that students who connect their PGCG content to their mechanism choices (factors 2 and 3 above) are more likely to persist, it could have implications for both future research on career goals and persistence, and how educators approach student career goals and the outcomes set around them.

5.4.2 Assessment uses

How PGES would fit into a course or program's assessment needs would depend on the outcomes educators set around student career goals. One type of course within which I see PGES as immediately useful is a seminar-style course designed to introduce students to engineering careers. While I was teaching in Virginia Tech's first-year engineering program, for example, students were required to attend a certain number of seminars given by individual engineering departments. The purpose of this was two-fold: to introduce students to the different engineering majors, and to introduce them to career possibilities within those majors. I think that a reasonable outcome for such a course would be to help students connect their major choice to the career they want to pursue. Educators could implement PGES before students start attending seminars, and then again, after they complete their seminar requirements. The qualitative responses from the short-response questions could give educators an idea of the careers their students were

considering before and after attending seminars. The quantitative responses could be compared in a pre-post analysis. If it shows significant changes in, for instance, the third factor from PGES, it could mean that the seminar sequence helped students connect their mechanism choices, like major choice, to their career goals. A caveat to this setup, however, would be students might have other experiences that also produce this result. To determine whether this is a case, educators may want to set up a control group of students who do not attend seminar and use the same pre-post survey implementation and analysis to compare the groups.

5.5 Reflections of the researcher

The experience of conducting research for this dissertation has helped me grow as a researcher and an educator. When I began planning this study, I wanted to frame it in terms of intervention development. I felt that many engineering students did not have a good understanding of why they were enrolled in their major programs, which caused them to make choices that kept their future options as “open” as possible. My understanding of those phenomena were completely anecdotal, however, and as I began to look for a starting point for research, I kept running into walls. How undergraduate engineering students view their future careers was not well defined through research, and there was not an easy way of stating my intuition through theory.

I was at an impasse. In order to do what I really wanted, create an intervention for students that helped them set career goals and match them to their academic choices, I needed to lay the groundwork first. Ultimately, this meant that my dissertation could not include an intervention. There was simply too much work to be done before that was possible.

This research has brought me back to where I started. I still want to make that intervention. The difference, now, is that I have the justification for that intervention. I have a

way of discussing student careers that is grounded in theory. I have some evidence that the goals that students have (or do not have) for their careers influence academic choices. And I have a tool for continued investigation of how career goals influence choices. My next step as a researcher is to continue to build towards ways of putting the knowledge I have developed in this dissertation to practice. This means building towards a way of helping students with their career-related decisions. I saw evidence of the benefits of thinking about how career goals connect to choices to while collecting focus group data for survey development. At different times in the focus group, students remarked that it was helpful to think about career goals with respect to their current academic situation. They also noted that they, and other students, might benefit from thinking about it. I think they are right: now it is my job to show that they are right.

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