# Advancing from Outsider to Insider: A Grounded Theory of Professional Identity Negotiation

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Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Engineering Education

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March 23rd, 2017
Blacksburg, VA

Keywords: identity, grounded theory, professional identity, identity formation, constructivism

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## ABSTRACT

Engineers' identification with their profession is crucial for persistence among engineering students and professionals; those individuals who do not maintain a sense of belonging, identify with engineering groups, or perceive themselves as engineers are more likely to leave the profession. However, little is known about the ways in which engineering students construct their personal and professional identities in tandem with disciplinary values, behaviors, and practices that are learned during the undergraduate education experience, particularly at the disciplinary level.

To deepen the understanding of professional identity formation within this context, a quasi-longitudinal grounded theory study was conducted to explore the experiences of 31 undergraduate students as they enrolled in and navigated through their civil engineering programs. Upon conducting an iterative process of data collection and analysis using a constant comparative approach, a grounded theory of professional identity negotiation emerged from the analyzed interview transcripts. This emergent theory titled *Negotiating Equilibrium: Advancing from Outsider to Insider* or the *AOI Model*, captures the identity negotiations performed by students as they iteratively define, adjust, and readjust definitions of self and profession to maintain a balance between their personal self and the learned disciplinary identity of the civil engineering profession. As participants gained this balance, they began to see themselves as professionals, advancing from an outsider (i.e., one not belonging to the civil engineering profession) to an insider (i.e., one belonging to the civil engineering profession).

The emergent grounded theory model of this work positions professional identity formation as a dynamic, process-oriented phenomenon that is continuously evolving as an individual learns the values, behaviors, norms, and discourse of the civil engineering profession. Ultimately, this study contributes a more nuanced understanding of professional identity formation that can be used to directly inform classroom interventions that bolster the formation of professional civil engineering identities to enhance retention in the field.

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GENERAL AUDIENCE ABSTRACT

As evidenced by a large body of research within the engineering education community, those individuals who do not maintain a sense of belonging, identify with engineering groups, or perceive themselves as engineers are more likely to leave the profession. However, little is known about the ways in which engineering students construct or develop their personal and professional identities as influenced by the disciplinary values, behaviors, and practices learned during the undergraduate education experience. In order to deepen the understanding of professional identity formation within the engineering disciplines, a grounded theory study was conducted to explore the experiences of 31 sophomore, junior, and senior level undergraduate students enrolled in a civil engineering program. Upon conducting an iterative process of data collection and analysis, a theory of professional identity negotiation emerged from interviews depicting participants' experiences. This theory titled *Negotiating Equilibrium: Advancing from Outsider to Insider* or the *AOI Model*, captures the identities negotiated by students as they iteratively define, adjust, and readjust definitions of self and profession to maintain a balance between their personal self and the learned disciplinary identity of the civil engineering profession. As participants gained this balance, they began to see themselves as professionals and advance from an outsider (i.e., one not belonging to the civil engineering profession) to an insider (i.e., one belonging to the civil engineering profession). The AOI Model provides a framework for researchers to further explore professional identity formation, promotes the development of identity-influencing coursework and instructor teaching approaches, and inspires future research trajectories in engineering and civil engineering education.

DEDICATION

To the participants of this study

# ACKNOWLEDGEMENTS

To my co-advisor, Dr. Lisa McNair: Thank you for all of your support and guidance through the labyrinth that is graduate school and life. You have helped me overcome so much with your kindness, patience, and wisdom.

To my co-advisor, Dr. Denise Simmons: Thank you for your encouragement and guidance throughout my dissertation journey – especially during the "duh" moments.

To Dr. Marie Paretti: Thank you for always being there to have the difficult conversations and for helping me become a stronger person. Your guidance, support, and wisdom have been invaluable, and I promise to never drive a tractor through your yard.

To Dr. Elizabeth Creamer: Thank you for introducing me to the wild world that is grounded theory and for encouraging my creative approaches to research. Your guidance and support have inspired me and given me the courage to push the methodological boundaries of our time.

To Dr. Jennifer Karlin: Thank you for introducing me to the field of Engineering Education and for your continued support throughout the years. You are a dear friend and colleague.

To Dr. Stephanie Cutler and Dr. Katie Nelson: Thank you for being the mentors a woman could ask for. Your friendship, guidance, and support have been invaluable.

To my family: Thank you for your unwavering love, support, and encouragement over the years and instilling in me the incredible work ethic it takes to get to where I am today. I love you guys!

To my Virginia friends and family: Thank you for helping me find a home away from home.

To the Department of Engineering Education at Virginia Tech: Thank you for just being awesome and supporting me through it all.

To John Thacker at Blacksburg Acupuncture: Thank you for reminding me to stop and take care of myself every once in a while and for keeping me physically capable of completing this work.

To Next Door Bake Shop: Thank you for the endless hours of hospitality and lavender milk tea lattés throughout these final phases of my graduate career.

And finally, to my amazing other half, Mac McCall: Thank you for your unwavering love and support throughout this process. You truly have been my rock and my constant in life, and for that, I am eternally grateful.

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# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

Credited as the second oldest engineering discipline behind military engineering (CSCE, 2015; Grigg, Criswell, Fontane, & Siller, 2001), civil engineering in ancient civilizations were individuals responsible for building shelter, water systems, and protection for their people during peacetime (CSCE, 2015). These emergent engineers did not receive a specialized education, and often relied on an apprentice-based, hands-on, tinkering model of training to ensure the survival and the welfare of their people. However, as society and technology have evolved, so too have the demands on the civil engineering discipline and the ways in which engineers are prepared for the workforce.

Today, civil engineering is a profession that requires its members to acquire a formal education that is deeply rooted in and influenced by the historical advancements of the discipline (Dryburgh, 1999; Klass, 1961; McGuirt, 2007; NAE, 2005; Seely, 1999; Straub, 1964; Tiedeman, 1990; Wankat, Felder, Smith, & Oreovicz, 2002). By incorporating activities into university curricula such as materials testing certifications, licensure exams, and the use of current design manuals as textbook supplements, the education of undergraduate civil engineering students is largely shaped by the professional societies governing the discipline. From this perspective, civil engineering education serves as the nexus that links students' transitions from "ordinary [members] of society" (Dryburgh, 1999, p. 666) into engineering professionals as they learn about the profession and "become" engineers (Capobianco, 2006; Dannels, 2000; Loui, 2005; Stevens, O'Connor, Garrison, Jocuns, & Amos, 2008). From this research perspective, learning is not considered to be a site for simply acquiring disciplinary knowledge and skills that are later applied in a professional workplace. Rather, learning serves as a site for professional identity development in which students subjectively merge the identity of the discipline to their own personal identities (Berger, 1966; Cerulo, 1997; Dryburgh, 1999; Loui, 2005; MacIntosh, 2003; Scanlon, 2011; Thornton & Nardi, 1975). This integration of self and professional identity is important for undergraduate civil engineering students as they become a member of the civil engineering discipline, a discipline that maintains direct, pervasive, and potentially life-altering influences on the culture and society in which these students live.

Engineering educators have begun to conceptualize and deepen the understanding of engineering education through lenses of identity (Allie et al., 2009; Besterfield-Sacre, Atman, & Shuman, 1997; Tonso, 2014), asking questions about what engineers *do* and who engineers *are.* Prior work in this area has established the importance of the topic of identity as related to the retention and quality of future engineers (Eliot & Turns, 2011; Jones, Ruff, & Paretti, 2013; Lichtenstein et al., 2009; Seymour & Hewitt, 1997; Tonso, 2014), the nature of engineering work and what "counts" as engineering (Dannels, 2000; Stevens, Johri, & O'Connor, 2014), and an individual's ability to maintain a sense of belonging to the field (Dryburgh, 1999; Foor, Walden, & Trytten, 2007; Jorgenson, 2002; Meyers, Ohland, Pawley, Silliman, & Smith, 2012; Stevens et al., 2008). Hence, the study of engineering identity holds significant implications for the engineering education community, particularly regarding what and how disciplinary content and practices are taught and who wants to learn them.

Significant research has been conducted on the various internal, intimate (e.g. gender, race, sexuality, and religion) and external, social perspectives of identity (e.g. discourse, nature of engineering work, and content knowledge). Still, little is known about the ways in which these identities interact and evolve to form a student's professional identity within a specific disciplinary context, particularly within the civil engineering discipline. Therefore, I frame this work to look at the ways in which students develop identities related to civil engineering as influenced by historical advancements of the profession (e.g., credentialing, ethics, and valued content knowledge and skills).

In this chapter, I define and focus the phenomenon examined by this study, elaborate on pertinent background information and study rationale, and identify and discuss relevant stakeholders. To conclude this chapter, I outline the research questions guiding this study and present a brief overview of the research methods, limitations, and researcher bias of this work. However, to more effectively guide the reader through the following sections, I first present key definitions relevant to the context, aim, and approaches of this study.

### 1.2 Definitions

In this section, I present the primary definitions underpinning this work to identify and explicate underlying assumptions of key terms. Included within this list of terms are those relevant to the

explored phenomenon in this study as well as the grounded theory approaches by which this study was conducted.

- *Identity* – "A concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations" (Holland, Lachiotte, Skinner, & Cain, 1998; Tonso, 2014).
- *Profession* – an occupational group that requires its members to possess a large amount of disciplinary knowledge, adhere to a regulatory code of ethics, and learn the valued behaviors and symbols of the profession (Dryburgh, 1999; McGuirt, 2007).
- *Professional Engineering Identity* – an identity that is constructed through formal and informal processes in which an individual learns, internalizes, and maintains the values, behaviors, and discourse of an engineering profession as a result of social interactions with its members and disciplinary practices (Downey & Lucena, 2004; Dryburgh, 1999; Tonso, 2014).
- *Professional Formation of Engineers* – the formal and informal processes and value systems by which individuals become engineers (NSF, 2015).
- *Critical Incident Technique* – a well-established qualitative research method that is useful in exploring significant positive or negative contributions to an activity or phenomenon in order to better understand resulting behavior (Flanagan, 1954; Grant & Trenor, 2010; Grove & Fisk, 1997).
- *Grounded Theory Methods* – methods consisting of "systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theory from the data themselves" (Charmaz, 2014, p. 1).

Identity is a complex, dynamic, and contextually-dependent phenomenon that hinges on individual and group positioning (Spears, 2011; Stevens et al., 2008). Therefore, it is important to define the ways in which individuals identify themselves and are identified by others as civil engineers. Using the terms presented above, I framed my inquiry to consider the process by which engineering students become civil engineers during the undergraduate civil engineering experience. To understand how these identities form and are negotiated in an unbounded manner, I utilized a grounded theory approach in conjunction with the critical incident technique to

identify broad impacts that contribute to the dynamic and ever-evolving nature of students' professional identities both within and outside of the engineering curriculum.

### 1.3 Statement of the Problem

As evidenced by a large body of research within the engineering education community, individuals who do not maintain a sense of belonging, identify with engineering groups, or perceive themselves as engineers are more likely to leave the profession (e.g., Jones, Osborne, Paretti, & Matusovich, 2014; Lichtenstein, Chen, Smith, & Maldonado, 2014). However, little is known about the ways in which students construct, negotiate, or develop professional identities in tandem with disciplinary values, behaviors, and practices that are learned during the undergraduate education experience, particularly within civil engineering. In order to deepen the understanding of engineering education, far more studies investigating identity construction within these contexts are needed (Tonso, 2014). To enhance the professional formation of civil engineering students, we must identify the activities, experiences, and relationships that influence the development of students' identities. As we gain an understanding of how these promote or inhibit identity formation, we can make necessary pedagogical, course, and curricular changes to increase students' identification with civil engineering, influence the ways in which they perceive themselves as civil engineers, and promote their retention and career advancement as students and as emerging professionals.

### 1.4 Purpose of the Study

The purpose of this grounded theory, qualitative study consisted of two primary research aims: 1) to identify student perceptions of the civil engineering discipline and understand the process by which their professional identities are negotiated as those perceptions change, and 2) to develop a grounded theory that captures the dynamic and complex nature of this process.

First, gaining an understanding of the ways in which students create and negotiate professional identities can reveal to educators and researchers the nuanced impacts of engineering education on our students as they prepare for their future careers. Professional identity formation is a particularly useful area of inquiry regarding educational impacts as it considers the ways in which students perceive, interpret, and internalize the values, behaviors, and knowledge of the civil engineering discipline during their undergraduate education. However, due to the intimate

and subjective nature in which individuals perceive and interpret the world around them (Charmaz, 2014; Guba & Lincoln, 1994; von Glasersfeld, 1995), the personal identity of the student outside of engineering-related environments must also be considered.

Secondly, a grounded theory depicting the professional identity formation of undergraduate civil engineering students has not yet been developed. Therefore, this work was conducted using a constant comparative approach to develop a grounded theory that broadly captures the complex and dynamic ways in which civil engineering students develop and negotiate professional identities as tailored to the unique and historically-influenced characteristics of the civil engineering discipline (e.g. licensing exams, materials testing certifications, and the use of manuals developed by the civil engineering professional societies). The influences of these characteristics on the civil engineering discipline are introduced in the next section and further discussed in Chapter 2. Upon identifying the various components of a grounded theory such as causal mechanisms, strategies, intervening conditions, and outcomes (Charmaz, 2014; defined in Chapter 3), we could determine who our students are; how they perceive, interpret, and integrate engineering-related activities with respect to their own lives; and how they negotiate those experiences as they are beginning to view themselves as civil engineers. Developing a grounded theory of undergraduate civil engineering professional identity formation also implied an unbounded investigation of the topic. This allowed for unanticipated findings to emerge and added to the significance of this study, as described in the next section.

### 1.5 Significance of the Study

This work yielded a variety of significant outcomes related to the context considered in this study and the ways in which it was conducted. The resulting grounded theory provides engineering educators and researchers with a qualitative understanding of the ways in which students perceive and interpret their undergraduate experiences as they form professional identities. In particular, this grounded theory model is significant due to three inherent research design considerations: 1) the exploration of identity formation as a dynamic process; 2) the consideration of historical impacts of the civil engineering discipline on current civil engineering education; and 3) the identification of key experiences that impact identity formation within the context of undergraduate civil engineering education.

As students learn disciplinary content, participate in engineering-related extracurricular activities, engage in disciplinary discourse, and take part in other institutional and disciplinary rituals, they embark on a dynamic process of professional identity formation (Allie et al., 2009; Atman et al., 2008; Dannels, 2000; McGuirt, 2007; Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). While prior work investigating professional engineering identity formation of undergraduate engineering students exists, these studies are often conducted via applied theories that scope or limit the study to exploring only a portion of identity-influencing factors such as race, gender, social or economic class, or sexual orientation (Abes & Jones, 2004; Dryburgh, 1999; Foor et al., 2007; Jorgenson, 2002; Tonso, 2007a). Further, these works primarily explore identity as a phenomenon rather than a dynamic, continuously-evolving process. By emphasizing the temporal dimension of identity formation as a process (Charmaz, 2014) that is influenced by multiple identity dimensions, this research explored the ways in which various personal and social identity-influencing factors interact with one another and contribute to the overall formation of an individual's professional identity.

The symbols, values, and rituals practiced by members of a profession create a disciplinary culture that is deeply rooted in the histories of that profession (Downey & Lucena, 2004; Dryburgh, 1999). Still, little is known about the existence of the variety of disciplinary cultures and their influences on engineering education, with recent work on this topic only occurring within the past few years (Murzi, Martin, McNair, & Paretti, 2014). However, through initiatives created by the professional societies such as the ABET EC2000 criteria and content guidelines established by the American Society of Civil Engineers (ASCE) Body of Knowledge (BOK) and Code of Ethics (COE), it is apparent that these societies and their inherent cultures maintain a direct influence on the content, knowledge, and practices that underpin civil engineering education. Because these societies were created for a variety of reasons that are historically-informed, we may then relate the history of civil engineering to current practices in civil engineering education. By focusing on undergraduate civil engineering as a site for learning and professional identity formation, this research highlights the link between the history of the civil engineering discipline, students' professional identities, and the future generations of civil engineers.

As further discussed in Chapter 2, instructors within civil engineering education are encouraged to incorporate civil engineering-specific experiences such as materials testing certifications, licensure exams, and ethics training into their courses (ASCE, 2007, 2008).While few studies have considered the interaction of these disciplinary cultures and factors influencing the formation of an engineering identity, e.g., Walther, Kellam, Sochacka, and Radcliffe (2011), many of these studies generalize identity formation to all engineering students, thus neglecting potential identity-influencing factors that are unique to a single engineering discipline's culture, making it difficult to operationalize, transfer, and implement findings in discipline-specific contexts. This research identifies discipline-specific experiences that impact students' professional identity formation and the ways in which engineering educators teach and interact with their students. Implications for the multiple stakeholders of this study are discussed in the following section.

### 1.6 Stakeholders

There are several stakeholders impacted by this research. These stakeholders include civil engineering educators and students, researchers in engineering education, industry, and the general public.

First, the primary set of stakeholders of this study includes engineering educators and instructors within the civil engineering disciplines. Prior work within professional identity formation suggests that the very experiences educators provide to students greatly impact their engagement and retention in engineering (Atman et al., 2008; Loui, 2005; Pierrakos et al., 2009). In this study, we gained a better understanding of the ways in which these experiences impact students' formation of professional identities. As a result, we also established implications for developing and implementing classroom and curricular activities that promote students' identifications with engineering during their undergraduate careers.

Second, students within undergraduate civil engineering programs serve as stakeholders of this study. While prior work has shown that engineers' identifications with their profession is crucial for persistence among students and professionals (Jones et al., 2013; Lichtenstein et al., 2009; Seymour & Hewitt, 1997; Tonso, 2014), this study affords us the opportunity to learn more about who our students are and how they experience their undergraduate careers. As we gain this

understanding, we can begin to make necessary changes enhancing students' identifications with their discipline and promote their academic and career retention, advancement, and emotional well-being.

Third, another group of stakeholders are the engineering education researchers and methodologists interested in studying professional identity formation and/or utilizing grounded theory methodology. While prior work primarily explores identity-influencing factors in a phenomenological sense, this research contributes a theoretical framework that can be used to further understand the dynamic nature of students' identity formation and negotiation as they experience it. The methodological strategies utilized within this study also advance the use of grounded theory methodology within engineering education research. As an emerging research method within the field of engineering education (Case & Light, 2011; Charmaz, 2008), the application and use of the methodology "shows promise" (p. 190) but is not well represented in engineering education research. While some researchers grapple with the flexible, yet systematic, framework of grounded theory methods (Charmaz, 2014), this study serves as a useful guide for qualitative researchers wishing to utilize similar methods in their work.

Fourth, engineering industry and governmental organizations, particularly those who hire entry-level civil engineers are stakeholders of this study. While the results of this study are not directly related to industry and governmental contexts, these stakeholders may experience these results at a broader level. Through this study, we gain a better understanding of the ways in which students professionally form as engineers during their undergraduate careers. Serving as a catalyst for academic change and improving students' learning experiences, this research allows us to gain a better understanding of our students to inform current educational practices. From these practices, engineering education will be able to better prepare these emerging engineers for the workplace as well as provide industry with competent, ethical individuals who are equipped with the necessary tools to be effective[1] civil engineers.

[1] In this context, the term "effective" is defined as obtaining the necessary skills, behaviors, values, and content knowledge to conduct work within civil engineering industry. Specifications of these characteristics are further defined by the *EC2000 Student Outcomes Criteria* (ABET, 2008) and the *Civil Engineering Body of Knowledge* (ASCE, 2008).

The final stakeholder of this research is the general public. Civil engineers maintain a direct, persistent, and potentially life-altering influence on the culture and societies in which they work, as evidenced by the multiple definitions used to describe the civil engineering discipline. The American Society of Civil Engineers (ASCE) begins their definition of civil engineering by stating, "Civil engineers design, build, and maintain the foundation for our modern *society* [emphasis added]" (ASCE, 1996c). In the United Kingdom, the Institute for Civil Engineering (ICE) presents a similar definition: "Civil engineering is *all about people* [emphasis added]. It's the work that civil engineers do to develop and improve the service and facilities that we, the public, all use" (ICE, 2015). Further, the safety of people is also emphasized as the first canon in ASCE's Code of Ethics: "Engineers shall hold paramount the safety, health and welfare of the public…" (ASCE, 1996a). Due to these direct societal ties, the general public serves as a stakeholder that may benefit from a greater understanding of the ways in which civil engineering students learn and internalize the knowledge, skills, and values that maintain the safety and welfare of their everyday lives.

The aims of this study provide benefits to the stakeholders of this work and were achieved by designing and conducting a qualitative, grounded theory study in which constant comparative methods were used to further explore civil engineering students' professional identity formation. In the next section, I provide a brief overview of the research design and methods. An in-depth discussion of these topics is presented in Chapter 3.

### 1.7 Research Questions and Research Design

To understand and explore the processes by which civil engineering students form professional engineering identities, I asked the following overarching research question: How do undergraduate civil engineering students form identities as professional engineers? To further frame my investigation, I asked the following questions to guide my inquiry:

RQ1. What are students' initial perceptions of the civil engineering profession?

RQ2. How do students' perceptions of the civil engineering profession change as they enter college and navigate undergraduate experiences?

RQ3. What are the outcomes resulting from these changes in perception?

RQ4. How do these perceptions intersect with students' personal identities?

To answer these research questions and understand how students' undergraduate experiences impact their professional identity formation, I utilized the Constructivist Grounded Theory framework developed by Charmaz (2014). Using this framework, I designed a quasi-longitudinal study in which 32 interviews were conducted with student participants at a large research-focused university in the southeastern United States during the spring 2016 semester. Rather than inquiring about a phenomenon as a single concept or idea, grounded theory allows researchers to generate a general explanation of a process containing identifiable markers over a specific period of time (Charmaz, 2014; Creswell, 2013). This methodology is typically used when a theory is not available to understand or explain a process or to further refine an existing theory for application to a specific population (Creswell, 2013).

Unlike other research traditions, grounded theory utilizes inductive logic to drive the method once a research topic has been identified. Rather than deductively applying a theoretical framework to answer research questions, grounded theorists identify *sensitizing concepts* (i.e. initial or tentative ideas relating to a research topic) that are used to develop research questions and guide the initial research process (Bowen, 2006; Charmaz, 2014). The chosen sensitizing concepts for this work are Gee's (2001) four identity constructs: nature identity, institution identity, affinity identity, and discourse identity. These constructs enabled me to conduct an initial examination of the inherent interactions, interpretations, and communication practices within the multiple aspects of students' lives as they negotiate their professional civil engineering identities. For this reason, this sensitizing concept appropriately initiated my inquiry and enabled me to answer each research question within this study.

Grounded theory utilizes constant comparative methods in which data collection and analysis are simultaneously and iteratively conducted to inform one another and further theory development (Charmaz, 2014). Data is collected in the form of *intensive interviewing* (Charmaz, 2014) that consists of semi-structured interviews informed by prior, relevant literature and the research questions. Each interview was conducted using a combination of techniques including constructivist interviewing (Charmaz, 2014) and the Critical Incident Technique (Flanagan, 1954; Grant & Trenor, 2010; Gremler, 2004; Sattler, Turns, & Gygi, 2009; Simmons, 2012) to allow for emergent interactions with participants as well as to capture key incidents in which

students' professional civil engineering identities were negotiated as a result of their experiences. As each interview was conducted, it was immediately analyzed as a means to inform further questioning and discussion in subsequent interviews. Throughout the duration of the study, interview questions grew increasingly focused to advance theory development.

### 1.8 Scope of the Study

The primary goal of this study was to further understand *why* and *how* students negotiate various identity dimensions as they are exposed to perceived civil engineering-related activities both inside and outside the classroom. Because students experience multiple transitions throughout their undergraduate careers (Stevens et al., 2008), I conducted this study over a single semester with sophomore-, junior-, and senior-level students who were enrolled in a civil engineering department. This group of students was chosen to participate in this study for three reasons: 1) their first-hand experience of identity shifts as the exposure to their disciplinary work becomes increasingly more focused; 2) the transitional positions of these students within the curriculum (i.e., sophomore-level students are emerging as *civil engineering students* – as opposed to *general engineering students* in their first year – within the curriculum; junior-level students are emerging as *specialists* who are tailoring their education to a specific civil engineering track; and senior-level students are emerging as *early career professionals* as they transition into the engineering workforce); and 3) sophomore- and junior-level students are typically studied less than their freshman and senior counterparts in the field of engineering education research, even though these are challenging and critical phases of engineering education.

As a result of this study, I developed a grounded theory of professional identity formation for civil engineering undergraduate students that informs educational practices within the civil engineering curriculum. This theory provides educators and researchers with an abstract, overarching view of civil engineering students' professional identity negotiation and formation within a single engineering discipline. Focusing on a single discipline reveals the direct influences of the discipline on student education and their evolving perceptions of civil engineering. As we gain a better understanding of who our students are and the impacts of educational experiences on their identities, we can begin to make necessary and appropriate changes to enhance our students' professional identity negotiation and formation and aid in

promoting their academic as well as career successes (i.e., retention, advancement, and emotional well-being).

### 1.9 Limitations and Bias

Several limitations were identified for this study. Five primary limitations were: 1) the single university at which this study was conducted, 2) the time duration in which this study took place; and 3) the nature of the designed intervention. While I provide a summary of these limitations here, an in-depth discussion of each limitation is located in Section 3.10. The institutional structure of the university at which this study took place plays a significant role in the orientations by which students negotiate their identities. Students enrolled at universities with structures differing from the one explored in this study may not experience the same institutional, identity-informing experiences. The time duration in which this study was conducted serves as another limitation; while this study utilized a quasi-longitudinal design as implemented via the semi-structured interview protocol, participant interviews only took place during the course of a single semester. Therefore, much of the experiences discussed by student participants are retrospective. To more accurately capture the identity formation and personal development of these students throughout their academic careers, a longitudinal study designed to follow participants from their freshman through to their senior years would provide a more holistic view of this process. However, the retrospective nature of student interviews prompted participants to reflect, construct, and process their own narratives of identity formation before my eyes. This enabled me to observe participant reactions to their developing narratives, thus adding to the richness of the collected data. All participants within this study intended to remain in civil engineering during their future careers in some capacity (e.g., graduate student, design engineer, manager, etc.). However, future work would need to be conducted to examine professional identity negotiations of those individuals who have left or are thinking about leaving the civil engineering profession. The final limitation of this study is the inherent nature of the intervention (i.e., semi-structured interviews). The interviews during which students recount their past experiences and perceptions of civil engineering is an identity-altering activity in itself and prompted identity-based reflections that students may not have otherwise experienced. Further research would need to be conducted to specify the impacts of these interviews on students' professional identity formation.

Aligning with the Constructivist Grounded Theory methodology, I acknowledge my non-neutral perspective as a researcher (Charmaz, 2014). I have chosen this research topic based on personal interest and my own past experiences as a civil engineering student. Therefore, I share a similar background with my participants and was aware of my own biases and assumptions that may have influenced how I collected, analyzed, and interpreted data (Charmaz, 2014). Because the resulting grounded theory from this study is an interpretation that cannot stand outside of my own views or bias (Corbin & Strauss, 1990), I utilized multiple tools within the grounded theory methodology that allowed me to remain transparent about my bias and extensively reflect on my own experiences as a civil engineering student (Groen, Simmons, & McNair, forthcoming). *Sensitizing concepts* were useful for not only guiding research efforts, but also for providing an anchor to maintain my awareness of the research purpose and upholding my focus during the study (Charmaz, 2014; Groen & McNair, 2016; Groen et al., forthcoming). *Bracketing memos* were recorded prior to data analysis and were used to disclose my preconceived notions about the context and participants within the study (Charmaz, 2014; Tufford & Newman, 2012). By utilizing these tools, I was able to reveal my own biases as I conducted this research (Creswell, 2014; Groen et al., forthcoming).

### 1.10 Chapter Summary

The purpose of this qualitative, quasi-longitudinal grounded theory study was to explore the process by which civil engineering students negotiate their disciplinary perceptions to form professional identities during their undergraduate careers. To accomplish this, I developed a grounded theory titled, *Negotiating Equilibrium: Advancing from Outsider to Insider* (also referred to as the *AOI Model*) that captures the dynamic and complex nature of identity negotiation and formation. While we know that students' identifications with engineering are critical for the retention and persistence of engineering students, this study was significant due to its exploration of professional identity formation as a dynamic process of negotiation. This process is continuously shaped by self-identified significant experiences within the historically-influenced disciplinary culture of civil engineering education at a single university. By utilizing the Constructivist Grounded Theory Methodology, my model contributes to prior literature by providing engineering educators and researchers with a framework that illustrates why and how civil engineering students develop professional identities during their engineering education

careers. From this work, we can further understand the valuable impacts of engineering education on the identities of future civil engineers.

This document is divided into five chapters. In Chapter 2, I provide a brief background of the history of the civil engineering discipline and its impacts on civil engineering education, multiple identity frameworks, and ways in which identity is explored. My review of the literature provides evidence that little is known about the ways in which students' professional identities are negotiated and evolve during their undergraduate careers, particularly while considering identity formation as a process in which students combine and negotiate their intimate worlds with the social world of the discipline. This integration of self and professional identiies is important for undergraduate civil engineering students as they become a member of the civil engineering discipline, a discipline that maintains direct, pervasive, and potentially life-altering influences on the culture and society in which these students live.

In Chapter 3, I present an overview of the research design and provide a rationale for my chosen methodology to answer my research questions. I then elaborate on this discussion by providing a description of study participants, context, and data collection and analytical procedures. Lastly, I discuss the validity and reliability of my methods, limitations of this work, and my own researcher bias that I brought to this study.

In Chapter 4, I present my grounded theory model, *Achieving Equilibrium: A Grounded Theory of Professional Identity Negotiation.* Throughout this chapter, I describe, define, and demonstrate the emergence and operationalization of this theory as grounded within the data.

In Chapter 5, I revisit and answer the research questions governing my study, identify key research contributions, and further integrate the results of this study into existing and emerging identity literature. To conclude this chapter, I discuss research implications, propose areas for future work, and provide concluding remarks.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

Identity is a complex, dynamic, and contextually-dependent phenomenon that hinges on individual and group positioning (Spears, 2011; Stevens et al., 2008). Similarly, the study of identity is also complex and dependent on the contexts in and the theoretical lenses through which it is investigated. Throughout the years, researchers in the engineering education community have conducted multiple investigations exploring various aspects of identity, including perspectives drawn from both developmental and sociocultural psychology. Research in these areas theorizes identity through a variety of topics including examinations of the innate student characteristics (Abes & Jones, 2004; Cech, 2015; Chachra, Kilgore, Loshbaugh, McCain, & Chen, 2008), student attributes (Loui, 2005; Meyers et al., 2012; Pierrakos et al., 2009), engineering activities (Eliot & Turns, 2011), and the culture of engineering itself (Faulkner, 2007; Tonso, 2007b). However, few studies examine a dynamic process by which identity continuously evolves and simultaneously develops in tandem with engineering students as they experience their undergraduate careers. Further, little research explores these identity constructions and formations within a single engineering discipline, thus convoluting the transfer of research into everyday practice.

In this chapter, I articulate the motivations of this study by synthesizing multiple areas of identity research and their applications. First, I define *professional identity* as explored in prior engineering education research. Second, I draw from this definition to articulate the educational influences on student identity formation. In particular, I emphasize two underlying concepts to frame this discussion: 1) the learning process perceived as a means of identity development (Dryburgh, 1999; Loui, 2005; Tonso, 2014); and 2) the influences of the civil engineering profession on the environments in which this learning takes place. Third, I broaden this influence on education to individual students by examining literature in engineering education elucidating the sociocultural and developmental psychology perspectives of identity and their intersections as outlined by Gee's (2001) four identity constructs. I conclude this chapter by providing a brief overview of the present study that has been designed to address the observed gaps in this literature and introduce the theoretical foundations on which this work is based.

## 2.2 Examining Professional Identity

Engineers' identification with their profession is crucial for persistence among engineering students and professionals (Jones et al., 2013; Lichtenstein et al., 2009; Seymour & Hewitt, 1997; Tonso, 2014). As evidenced by a large body of work within the engineering education community, this statement establishes an important implication for the retention of engineering students and professionals. Those who do not maintain a sense of belonging to or identification with engineering groups or perceive themselves as engineers are more likely to leave the profession. Thus, the focus shifts from an issue of retention to one of identity, particularly regarding the ways in which students develop professional identity – an identity consisting of an alignment between students' attributes and characteristics with those of the engineering field.

Prior research has not yet established a holistic, agreed upon definition for the term *professional identity*. In her study exploring the ways in which women adapt to a professional engineering culture, Dryburgh (1999) discusses a professionalization process in which women learn, adjust to, and internalize the values, behavioral norms, and symbols of a profession to which an individual wishes to belong. Similarly, Loui (2005) rationalizes a process of learning the values upheld by a profession through the role acquisition model (Thornton & Nardi, 1975) as a means of professional identity development in undergraduate electrical and computer engineering students. While not explicitly defining the term *professional identity* in their study exploring professional identity and retention trends in freshman engineering students, Pierrakos et al. (2009) often refer to professional identity as engineering identity; however, they allude to the concept that a professional/engineering identity is one that a student develops as they experience their undergraduate engineering career.

Despite not establishing an explicit, agreed upon definition, the term *professional identity* is often used within a variety of contexts while implying or conveying the same meaning. To articulate this concept, I draw my definition of this term from the work of Dryburgh (1999), Downey and Lucena (2004), and Tonso (2014). I define *professional identity* as an identity that is constructed through a process in which an individual learns, internalizes, and maintains the values, behaviors, symbols, and discourse of a profession as a result of social interactions with its members and disciplinary practices. While Tonso (2014) defines *engineering identity* as the identity belonging to a person or group of people who practice engineering, I also refer to this

term synonymously as *professional identity* or, more specifically for this study, *professional civil engineering identity* within the context of this literature review.

### 2.3 Learning as a Site of Professional Identity Formation

Learning as a site for professional identity formation may be further explained through the work of Scanlon (2011). In her introductory book chapter titled, *Becoming a Professional*, Scanlon (2011) draws from the work of Berger (1966) and Cerulo (1997) to expand her description of "professional becoming" (p. 9). Rather than perceiving "becoming" as an acquisition of disciplinary knowledge and skills that are learned within a formal education environment to be enacted in a professional workplace (Scanlon, 2011, p. 9), she discusses becoming as a collective identity (Cerulo, 1997) in which an individual iteratively negotiates the objective identity of a group to be subjectively applied to one's personal identity (Berger, 1966). In other words, as individuals begin to experience and be socialized into a group, they begin to recognize their own identities through the socially-defined terms of that group to create another identity dimension. When considering an undergraduate civil engineering education context, students generally enter college as "ordinary [members] of society" (Dryburgh, 1999, p. 666) and generally have unclear expectations of professional engineering work (Stevens, Johri, & O'Connor, 2014); therefore, as students learn the values, knowledge, and skills inherent within undergraduate civil engineering education, they also begin to form a professional identity that results from the subjective application of the civil engineering disciplinary identity to their own personal identity.

Multiple studies on identity have been empirically conducted to determine the complex ways in which personal identities intersect within professional engineers as well as engineering students (Tonso, 2014). Much of this research has been conducted in work emphasizing the importance of identity regarding the retention and persistence of engineering students within academic as well as industrial contexts (Faulkner, 2007; Lichtenstein et al., 2009; Meyers, Ohland, Pawley, & Christopherson, 2010; Tonso, 2014). Within the context of engineering education, the "intimate or personal world[s]" of engineering students are combined with the "collective…cultural forms and social relations" of the engineering profession as students learn disciplinary content, participate in engineering-related extracurricular activities, engage in disciplinary discourse, and take part in other institutional and disciplinary rituals (Allie et al., 2009; Dannels, 2000; McGuirt, 2007; Pierrakos et al., 2009; Stevens et al., 2008). From this perspective, students are

enculturated into the engineering profession during their academic, undergraduate experiences and begin to develop their identities as or "become" engineers (Capobianco, 2006; Dannels, 2000; Loui, 2005; Stevens et al., 2008).

Researchers in engineering education have further explored specific contributors that promote this enculturation, including course activities and instructor roles. Course activities that promote identity formation have included multiple components such as engagement with professional activities and developing social networks; however, further research has begun to highlight sense-making in which students integrate personal and professional goals (Eliot & Turns, 2011; Ibarra, 2004). In a course for electrical and computer engineering students, Loui (2005) developed an essay assignment in which students identified and described the characteristics of ethical engineers. At the end of the assignment, students were also prompted to evaluate their own values and identify their readiness for the engineering responsibilities discussed in class. While he found that many students recognized professional responsibility and values as a liability for blame, they also positioned these characteristics as a "stewardship for society" (Loui, 2005, p. 383). From this assignment, students began to internalize the values and characteristics of ethically responsible engineering professionals. Eliot and Turns (2011) also developed a workshop module in which students created professional portfolios. The purpose of this activity was to promote sense-making, which included the writing and rewriting of personal narratives. From their analysis, they identified that participants utilized two "frames of reference" while constructing their personal portfolios. While external frames focused on understanding potential recruiters' and employers' expectations, the internal frame of reference placed emphasis on students' emerging realizations, values, and interests as professional engineers (Eliot & Turns, 2011). These activities move beyond traditional approaches relating to course content and professional networking to foster the integration of students' professional and personal selves throughout academic contexts.

Instructors also maintain significant roles in this enculturation and professional development. In their grounded theory study, Walther and colleagues (2011) explored the complex relationship between instructor teaching activities and influences from broader educational contexts as contributors to the professional development of students. While they identified multiple contributors to this growth including *perceptions of professional self* and *knowing self*, they also

revealed important implications for instructors. They noted that pedagogical approaches such as using gender-neutral examples to demonstrate engineering content, maintaining a strong commitment to engineering ethics, and developing inclusive learning environments serve as role models from which students glean their own conceptions of professional engineering. Similarly, in their study of pedagogical approaches used by engineering capstone instructors, Pembridge and colleagues (2011; 2010) identified that instructors influenced the development of students' identities through psychosocial dimensions of mentoring that include allowing students to complete meaningful and successful projects and encouraging students to take ownership of their own work and work independently. In this view, instructors are not only deliverers of content, but rather mentors and role models that promote the professional and personal growth of students (Lutz & Paretti, forthcoming; Pembridge, 2011; Pembridge & Paretti, 2010).

### 2.4 Considering Disciplinary Influences on Identity Formation

The culture of engineering simultaneously shapes and is shaped by the academic cultures in which it is introduced to students (Atman et al., 2008; Dannels, 2000; Faulkner, 2007; Stevens, Johri, & O'Connor, 2014; Stevens et al., 2008). While multiple studies have explored the plethora of factors that influence identity formation and the ways in which it is communicated and interpreted, more studies need to be conducted in this area (Tonso, 2014), especially at the disciplinary levels of engineering and engineering education. Few studies consider the interaction of disciplinary and experiential factors that influence the formation of an engineering identity, often generalizing the process of professional identity formation to all or multiple engineering majors (Allie et al., 2009; Capobianco, 2006; Dryburgh, 1999; McNair, Newswander, Boden, & Borrego, 2011; Meyers et al., 2010; Tonso, 2007a). While there are similarities among students' professional identity formation common across engineering disciplines such as those related to ABET student outcomes (Walther et al., 2011), few studies explore these common identity formation factors within the unique contexts of the engineering disciplines. However, emerging research has shown that differences exist within the cultures developed through and by individual engineering disciplines (Murzi et al., 2014), reinforcing the need for discipline-based identity research. In the following section, I introduce the history of the civil engineering discipline as a means to highlight the nuanced history inherent within engineering education and thus, the members belonging to the civil engineering profession.

### *2.4.1 The History of the Civil Engineering Discipline*

As students learn about the civil engineering discipline during their undergraduate experience, they begin to merge their intimate or personal world with that of the civil engineering discipline (Holland et al., 1998; Tonso, 2014). Throughout history, the field of engineering, as well as the discipline of civil engineering, has evolved into a profession (Dryburgh, 1999; McGuirt, 2007; Straub, 1964; Tiedeman, 1990). As a profession, civil engineering requires members to possess a significant amount of disciplinary knowledge and adhere to a regulatory code of ethics (Dryburgh, 1999; McGuirt, 2007). Hence, to gain membership into the profession, one must learn its valued behaviors and symbols and other disciplinary characteristics(Dryburgh, 1999). However, the practices, behaviors, symbols, and disciplinary knowledge that are valued by the profession in the present day were once abstract ideas that described engineering work for existing civil engineers rather than tenets that guided novice engineers' entry into the profession.

Credited as the second oldest engineering discipline behind military engineering (CSCE, 2015; Grigg et al., 2001), early civil engineers in ancient civilizations were responsible for building shelter, water systems, and protection for their people during peacetime (CSCE, 2015). As society evolved, the role of civil engineering has remained fairly consistent by adapting to government policies, technological advancements, and societal needs that shape the world in which we live. Today, civil engineers have maintained a close connection to the cultures and people for which they work as evidenced by the multiple definitions used to describe the civil engineering discipline. The American Society of Civil Engineers (ASCE) begins their definition of civil engineering by stating, "Civil engineers design, build, and maintain the foundation for our modern *society* [emphasis added]" (ASCE, 1996c). In the United Kingdom, the Institute for Civil Engineering (ICE) presents a similar definition: "Civil engineering is *all about people* [emphasis added]. It's the work that civil engineers do to develop and improve the service and facilities that we, the public, all use" (ICE, 2015).

However, the discipline of civil engineering has not always maintained a prestigious, socially-responsible role within society to which these definitions allude. The evolution of civil engineering from its "sticks and stones origins" (Kuo, 2012) endured growing pains as the nature of civil engineering work grew to be more complex and demanding. This growth influenced the establishment of the licensure exams (McGuirt, 2007) and professional societies (ASCE, 1996b;

NCEES, 2015b; NSPE, 2015) that established ethical and topical requirements necessary to pass the licensure exams yielding significant implications for engineering education. Thus, the shift from the apprenticeship, tinkering, and hands-on model of engineering to one requiring a more rigorous training within a formal educational setting was created (McGuirt, 2007; Straub, 1964). A historical timeline of the professionalization of the civil engineering discipline is presented in Figure 2.1and is discussed in the following sections.

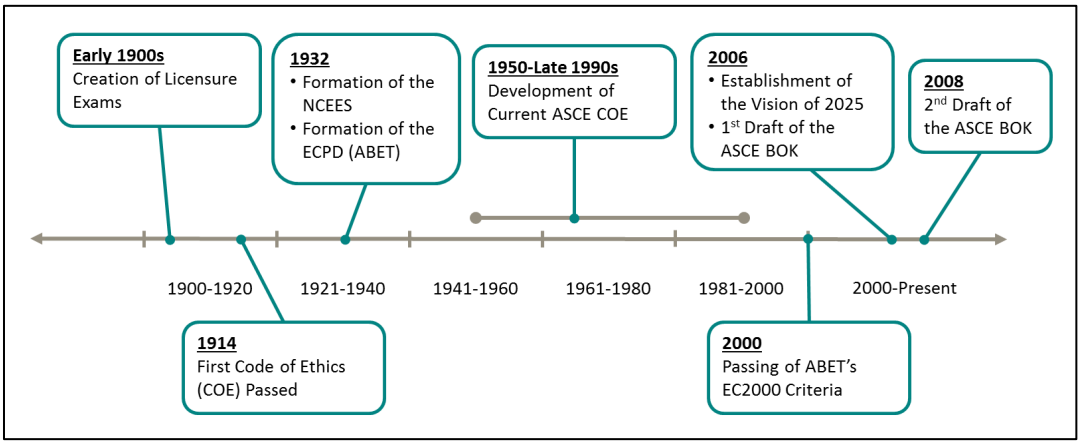



Figure 2.1: Major Events in Civil Engineering Professionalization

### *2.4.2 Influences of Disciplinary Professionalization on Civil Engineering Education*

The earliest universities were established to prepare students for the professions (Klass, 1961). As the civil engineering discipline grew as a profession, so did the means to educate future engineers. It is hoped that as students move throughout their undergraduate educational experience, they obtain the necessary competencies to enter into the engineering workforce. In this section, I connect the history of the civil engineering discipline to the present-day education of civil engineers. By drawing on the previously-presented disciplinary advancements, I provide a brief background of each and summarize their key influences on the current state of civil engineering curricula. I conclude this section with an overarching summary that illustrates how these advancements simultaneously influence civil engineering education.

#### *2.4.2.1 The NCEES and Licensure Exams*

One of the first advancements toward professionalization of the civil engineering discipline was the creation of licensure exams. Due to erroneous mapping and haphazard cataloging of water rights during the settlement of the American West in the late 1800s and early 1900s, states across

the US began to initiate laws requiring practicing engineers to train for and pass a licensure exam as proof of their practical competence (McGuirt, 2007). Today, this exam is known as the Professional Engineering Exam (PE) and is regulated by the National Council for the Examiners for Engineering and Surveying (NCEES) (NCEES, 2015d). Since its inception in 1932, the NCEES has strived to provide a uniform and regulated licensure process across the United States by establishing consistent laws, licensing standards, and ethics to "safeguard the health, safety, and welfare of the public" (NCEES, 2015b, 2015e). The NCEES is governed by a board of licensed engineers from across the US and provides normed examination processes for its members, establishes model laws and rules for member boards, promotes professional ethics among all engineers and surveyors, and globally coordinates the licensure process (NCEES, 2015e).

The NCEES currently offers two types of licensure exams for engineers: the Professional Engineering Exam (PE) and the Fundamentals of Engineering Exam (FE). The PE is designed to test an engineer's ability to practice competently within their chosen engineering discipline upon obtaining at least four years of post-college work experience (NCEES, 2015d). For recently- and nearly-graduated students, the FE is the first step in the licensure process and is designed to test students' knowledge of disciplinary content acquired throughout their undergraduate careers (NCEES, 2015a, 2015c). Additionally, the FE is designed to assess a uniform knowledge base as established through other professional societies (e.g. the ASCE Body of Knowledge) (ASCE, 2008; NCEES, 2015a). For this reason, the exam is promoted to universities as a robust program assessment tool (ASCE, 2008; NCEES, 2015a). Educators are also encouraged to promote the knowledge of licensure among students (ASCE, 2008). With the increased complexity and globalization of civil engineering work, licensure does not only solidify the future of the engineering profession, but it also promotes a students' success after he or she leaves the university and is exposed to higher levels of responsibility and liability within civil engineering practice. This examination practice created an avenue for civil engineers to "organize themselves as licensed professionals" (McGuirt, 2007, p. 27) and bolstered the growth of professional engineering societies such as the ASCE (founded in 1872) (ASCE, 1996b).

#### *2.4.2.2 ASCE's Code of Ethics*

Initially developed as a means of describing civil engineering work rather than guiding it, the first ASCE Code of Ethics was accepted by the society in 1914 to ensure the "crucial character of a civil engineer through judicious membership" (Pfatteicher, 2003); however, the passing of such a code was not without its struggles. Many civil engineers were reluctant to pass the code in fear that it would restrict their behavior and practice (Pfatteicher, 2003). Despite much debate throughout the years as the discipline became more professionalized, the code essentially remained the same with one primary message, "Do not do anything to harm the profession, its reputation, or your fellow engineers" (Pfatteicher, 2003, p. 29). However, the code experienced significant changes in the late twentieth century due to catastrophic engineering failures such as the Hyatt Regency Walkway Collapse and the Challenger Shuttle Explosion (Morin & Fischer, 2006; Tilley, 2003).

Today, the existence of the ASCE Code of Ethics takes a more altruistic tone that shifts the code's focus from upholding and maintaining the reputation of the discipline to upholding and maintaining the safety of the public. The current Code of Ethics is comprised of seven canons that outline desired behaviors and practices of civil engineers and are summarized using the following topics (ASCE, 1996a): Canon 1) hold paramount the safety of the public; Canon 2) perform services only in areas of competence; Canon 3) issue objective and truthful public statements; Canon 4) avoid conflicts of interest; Canon 5) build professional reputations based on the merit of work; Canon 6) act in honor, integrity, and dignity of the profession and maintain a zero tolerance for bribery, fraud, and corruption; and Canon 7) continue lifelong professional development.

These canons maintain a significant influence on civil engineering education because they describe to student and novice civil engineers the valued behavioral and practical expectations of their careers (Harris, Davis, Pritchard, & Rabins, 1996). Typically, students will take at least one course introducing them to the professional practices and values of the civil engineering discipline or are exposed to engineering ethics during other courses within their undergraduate experience (Russell & Stouffer, 2005; SDSMT, 2014; Stappenbelt, 2013; VT, 2015).

#### *2.4.2.3 ASCE's Vision of 2025 and the Body of Knowledge*

By establishing the Vision of 2025 which states that future civil engineers will be "[e]ntrusted by society to create a sustained world and enhance the global quality of life," ASCE and members of other professional societies demonstrate the highly visible nature of civil engineering work (ASCE, 2007). To aid in satisfying the outcomes of this vision, the ASCE Body of Knowledge (BOK) was created in alignment with the ASCE Code of Ethics and ABET Student Outcomes to meet the cultural, societal, and structural demands on the discipline; promote intentional change within civil engineering education; and define a standard knowledge base and skill-set required of civil engineers entering into the profession (ASCE, 2008). Resulting from the 2006 Summit on the Future of Civil Engineering, the BOK (found in Appendix A:) was drafted by members of ASCE and other national and international leaders as a means to create civil engineers who are expected to "serve [society] competently, collaboratively, and ethically" (ASCE, 2007).

The influence of the BOK consists of 24 outcomes that are clustered into three categories: foundational, technical, and professional. ASCE encourages civil engineering and other faculty to use the BOK as a resource when creating and improving courses, teaching and mentoring students, and designing curricula (ASCE, 2008). It is hoped by ASCE that, in the future, the ASCE BOK may be used to develop civil engineering education in lieu of the ABET Student Outcomes (ASCE, 2008).

According to ASCE's Vision of 2025 and the BOK, students must complete a bachelor's degree in civil engineering, complete a master's degree in civil engineering (or 30 credit-hours of equivalent upper-level or professional society coursework), and obtain appropriate experience (ASCE, 2007). While some individuals argue that the BOK and its mandate for continued higher education is outside the purview of ASCE (Huff, 1996), its present outcomes and emphasis on professional licensure have drastically influenced the culture of civil engineering education and the field of engineering education as a whole (ASCE, 2007, 2008; Grigg et al., 2001; Tiedeman, 1990).

#### *2.4.2.4 Influence of ABET's Student Outcomes*

While currently under review (ABET, 2015a), the initial ABET Student Outcomes criteria may be one of the most significant advancements in the professionalization of the entire engineering

field regarding educational practices. Initially, ABET was founded under the guise of the Engineering Council of Professional Development (ECPD) in 1932 by members of ASCE and other professional societies to "provide a joint program for upbringing engineering as a profession" (ABET, 2015b). Upon its establishment, the ECPD quickly evolved into an accreditation agency for evaluating engineering programs in the US and is now known as ABET (ABET, 2015b). Today, this organization has established, and continues to establish, the guidelines and standards for the high-quality education and professional development of future engineers.

In partial fulfillment of accreditation with ABET, an academic program must meet specific student outcomes that both align with and shape the ASCE BOK (ABET, 2008; ASCE, 2008). To address these outcomes, programs wishing to become or maintain accreditation must offer students specific activities that may be assessed to track a program's progress in satisfying specific criteria. However, these assessments may occur in a variety of ways and are not dictated by ABET; programs may conduct assessments by and at their convenience. It is through these offered activities and assessments that each engineering program may tailor the curriculum to meet the unique needs of their discipline and institution. A mapping of the ABET Student Outcomes, ASCE BOK, and curricular activities specific to the civil engineering discipline is shown in Table 2.1. A list containing a description of each design manual, experiment, and exam listed in this table may be found in Appendix B: and are denoted by the italicized text.

Table 2.1: Course Activities Mapped to ABET Student Outcomes and ASCE BOK Outcomes

| ABET EC2000 Outcomes | ASCE BOK Outcomes | Example Course Activities* |
|---|---|---|
| a) Apply knowledge of mathematics, science, and engineering | 1. Mathematics<br>2. Natural Sciences<br>5. Materials Sciences<br>6. Mechanics | • Requiring that students use loading values and guidelines from industry design manuals (e.g. *ASCE 7*) |
| b) Design and conduct experiments as well as analyze and interpret data | 7. Experiments | • Requiring that students conduct laboratory experiments according to civil engineering field tests (e.g. *Liquid Limit of Fine Grained Soil*) |
| c) Design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, political, social, ethical, and health | 9. Design<br>10. Standards<br>12. Risk/Uncertainty | • Requiring that students use loads and guidelines from industry design manuals and local, state, and federal specifications for design constraints (e.g. *ASCE 7, AISC Steel Construction Manual*) |

Table 2.1 (Continued)

| ABET EC2000 Outcomes | ASCE BOK Outcomes | Example Course Activities* |
|---|---|---|
| d) Function on multi-disciplinary teams | 13. Project Management<br>20. Leadership<br>21. Teamwork<br>22. Attitudes | • Dividing students into teams as they work on various projects |
| e) Identify, formulate, and solve engineering problems | 8. Problem Recognition and Solving | • Requiring that students identify an engineering problem present in their own, everyday lives |
| f) Understand professional and ethical responsibility | 24. Professional and Ethical Responsibility | • Requiring students research current civil engineering-related topics from other countries and how they vary based on global, economic, environmental, and social contexts<br>• Requiring that students investigate a catastrophic engineering failure and analyze the mechanics behind that failure to determine ethical responsibility |
| g) Communicate effectively | 16. Communication | • Hosting a seminar in which students explain engineering concepts to younger students |
| h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | 3. Humanities<br>4. Social Sciences<br>11. Contemporary Issues and Historical Perspectives<br>17. Public Policy<br>18. Business and Public Administration | • For an assignment, requiring students research current civil engineering-related topics from other countries and how they vary based on global, economic, environmental, and social contexts |
| i) Recognition of the need for, and the ability to engage in lifelong learning | 23. Lifelong Learning | • Hosting a speaker for students to learn about current, ongoing projects in their area |
| j) Knowledge of contemporary issues | 11. Contemporary Issues and Historical Perspectives<br>19. Globalization | • Requiring students research current civil engineering-related topics from other countries |
| k) Use techniques, skills, and tools necessary for modern engineering practice | 8. Problem Recognition and Solving<br>14. Breadth in Civil Engineering Areas<br>15. Technical Specialization | • Holding study sessions to prepare students for the FE Exam<br>• Using certification exams (e.g. *PCI Concrete Testing Exam*) as course assessments |

*Not an extensive list of course activities; activities overlap to simultaneously satisfy multiple criteria.

As shown in Table 2.1, a variety of activities may be used to satisfy both the ASCE BOK and the ABET Student Outcomes. For sake of time, money, and effort, many universities choose activities and assessments that satisfy multiple requirements simultaneously. For example, some

universities may offer certification by the American Concrete Institute (ACI) in entry-level concrete courses as an opportunity for students to demonstrate and apply engineering knowledge about concrete materials (ABET Outcome a); ASCE BOK Outcomes 5,6) and use techniques, skills, and tools necessary to test concrete out in the field (ABET Outcome k); ASCE BOK Outcomes 14, 15). Another example would be having students investigate, analyze, and present their findings of an ethical case study. In this activity, students can apply mathematics, science, and engineering principles to determine why a structure failed (ABET Outcome a); ASCE BOK Outcomes 1,2,5,6); further understand professional and ethical responsibility and global impacts of engineering work (ABET Outcomes f), h); ASCE BOK Outcomes 3,4,11,17,24); and gain knowledge of contemporary issues (ABET Outcome j); ASCE BOK Outcomes 11, 19).

One primary contribution of the ABET Engineering Criteria 2000 (ABET EC2000) was the inclusion of professional competencies never before seen as a necessary outcome for accreditation (Lattuca, Terenzini, & Volkwein, 2006). While maintaining traditional accreditation standards that emphasized the development of students' mathematical, scientific, and technical knowledge, EC2000 also stressed the importance of professional and ethical competencies. The addition of these outcomes bolstered programmatic efforts within civil engineering, as well as other disciplines, to promote activities related to professional development such as licensure, materials testing certifications, and participation within the professional societies such as ASCE.

### *2.4.3 Summary of Professionalization Impacts on Civil Engineering Education*

To ensure the competent and ethical practice of civil engineering and the education of future civil engineers, the advancements implemented by the various professional societies have created a civil engineering culture that is shaped by the discipline's values. By establishing professional and technical requirements necessary to pass licensure exams, acquire certifications, and earn a Bachelor's of Science degree in civil engineering, these societies have greatly shaped the culture that underpins civil engineering education and the experiences that students may encounter as they navigate the early stages of their careers. I summarize the influences of these societies and advancements on the education of civil engineers in Figure 2.2.

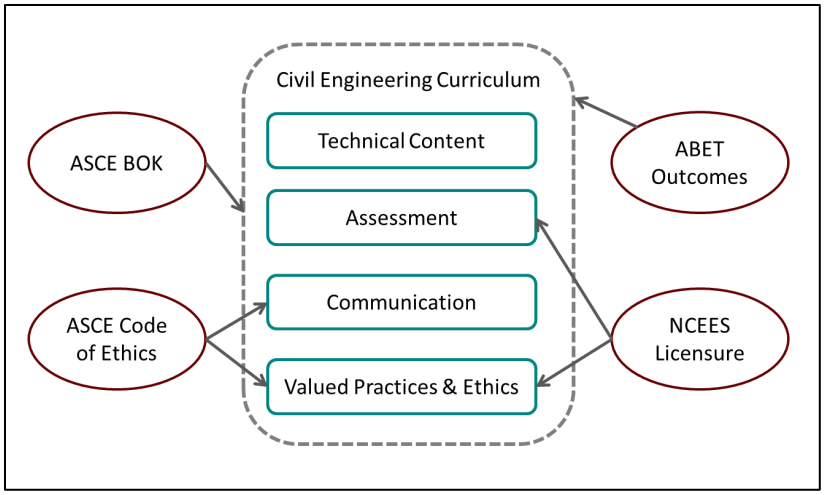



Figure 2.2: Summary of Professional Advancements on Undergraduate Curriculum

As students are subjected to the multiple behaviors, practices, symbols, and discourse valued by the civil engineering profession throughout their undergraduate career, they also begin to learn about the disciplinary identity of the civil engineering profession; it is through this experience that students are told what civil engineers *do* and who civil engineers *are* (Pierrakos et al., 2009). Through this learning process, students begin to internalize and merge their personal identities with those of the profession, thus creating a professional identity for that student.

### 2.5 Exploring Identity Dimensions in Engineering Education

In her prominent study of student pathways through engineering education, Sheppard and colleagues' (2010) found that broader impacts outside of academia influence students' identity formation in engineering and the discredit of the pipeline metaphor (Atman et al., 2008; Foor & Walden, 2009). Aligning with this work, multiple researchers have drawn from frameworks in sociology, social psychology, and educational psychology to identify multiple factors that impact identity development in tandem with academic contexts. These factors include but are not limited to institutional structure (Stevens et al., 2008), the nature of engineering work (Dannels, 2000; Faulkner, 2007), the use of discourse and communication practices (Dannels, 2003; Douglas, Koro-Ljungberg, Therriault, Lee, & McNeill, 2012; Paretti & McNair, 2012), knowledge of the field (i.e. what engineering *is* and what engineers *do*) (Stevens, Johri, & O'Connor, 2014), and exposure to engineering-related experiences.

This body of literature incorporates multiple perspectives on identity, including identity as a phenomenon to be studied and as a psychological act or discursive enactment. As a phenomenon to be studied, identity may be considered as an individual's perceived sense of belonging (Tonso, 2006) through comparisons of the self to a group (Abrams, 2015; Spears, 2011; Tonso, 2014) or comparisons among groups (Spears, 2011). Drawing from the constructionist (Berger & Luckmann, 1967) and constructivist (von Glasersfeld, 1995) paradigms, the ways in which these comparisons are interpreted and enacted may change. As a psychological or performative act, identity may be created through processes of identification (Abrams & Hogg, 1990; Jones et al., 2014; Osborne & Jones, 2011) and performed through discursive practices ("The Americans with Disabilities Act," 1990; Bamberg, 2012; Bamberg, De Fina, & Schiffrin, 2011; Douglas et al., 2012; Gee, 2011; Jorgenson, 2002).

To capture these varied factors that influence identity and the way it is constructed and enacted, I outline the following literature review using Gee's *Four Ways to View Identity* (2001). While I use his framework to structure the literature review, I acknowledge that not all of these research studies were informed nor conducted according to his work. Rather, this structure frames the discussion of the vast array of identity research in engineering education. An outline of this discussion as framed by Gee (2001) is shown in Table 2.2, below.

Table 2.2: Application of Gee's Identity Framework to Professional Identity Formation Literature

| Construct | Definition | Topic in Identity Research |
|---|---|---|
| Nature Identity (a state) | Identity developed from forces of nature | • Gender and Sexuality<br>• Race and Ethnicity |
| Institution Identity (a position) | Identity authorized by authorities within an institution | • Institutional Navigation |
| Discourse Identity (an individual trait) | Identity recognized in discourse of/with "rational" individuals | • Discourse<br>• Use of Communication Practices |
| Affinity Identity (experiences) | Identity shared in the practice of an "affinity group" | • Nature of Engineering Work<br>• Interdisciplinary Work |

As shown in Table 2.2, Gee's four views of identity are: 1) nature identity, 2) institutional identity, 3) discourse identity, and 4) affinity identity (Gee, 2001). Nature identity, also referred to as "N-Identities" (Gee, 2001), are identities that are determined due to a state developed by a

force outside of an individual's control. From this perspective, there are some aspects of an individual's identity such as race, gender, sexual orientation, or disability that are determined in nature through forces such as genetics that influence specific characteristics of an individual. However, this is not to say that all biologically- or genetically-determined characteristics of an individual are considered as N-identities; the distinguishing attribute of N-identities is that they must be recognized by an individual in order to be a meaningful constituent of his or her identity. The second identity perspective presented by (Gee, 2001) is the institutional identities or I-identities. Institution identities are authorized by certain authorities through laws, principles, rules, and traditions within a given context. Once an individual obtains an authority, they maintain the rights and responsibilities that accompany the position of which the authority entails. Examples of this type of identity are easily identified within academic settings as students enter into an engineering discipline. As described by Stevens and colleagues (2008), for an engineering student to become institutionally identified as an engineer, they must be "'admitted' to college, 'pass' a series of courses, and 'complete' certain sets of requirements to 'graduate'" (p. 357). Hence, the student must pass a series of "obligatory passage points" (Stevens et al., 2008, p. 357) as established by the university in order to be authorized as possessing a professional engineering identity as granted by the institution. The third perspective of identity presented by Gee (2001) is discourse identity, or D-identity, which draws its power from dialogue occurring between "rational individuals" (Gee, 2001, p. 103). From this perspective, identity is not only a characteristic or trait that is to be had by an individual, but can be constructed by speaking subjects in which identity is created, managed, and negotiated through everyday discursive activities (Bamberg et al., 2011; Gee, 2001). However, this is not to say that an individual maintains complete control over this identity. While identity is enacted through language, it must also be engaged in and recognized by other individuals (Gee, 2001). Therefore, unlike N- and I-identities, D-identities allow individuals some sense of agency in maintaining an identity while still relying on the perception of others. Affinity identity, or A-identity, is the final identity perspective presented by Gee (2001). Similar to social identity theory (Tajfel, 1974), affinity identities draw their power from distinctive practices and experiences of which members of that group share. However, affinity identity deviates from social identity theory based on the level of experiences and the meanings that are shared by members of each group. Members of an affinity group primarily focus their allegiances to a set

of common practices and experiences and place a secondary focus on a shared culture or traits (Gee, 2001). Individuals that socially identify with a group, however, bring these cultural influences to the fore through shared knowledge, values, behaviors, and symbols (Abrams, 2015; Tajfel, 1974).

### *2.5.1 Research Associated with Nature Identities*

Multiple identity researchers have conducted work that is related to nature identities (Abes & Jones, 2004; Capobianco, 2006; Cech & Waidzunas, 2011; Faulkner, 2007; Foor & Walden, 2009; Jorgenson, 2002; Walker, 2001). As shown in Table 2.2, nature identity is defined as an identity that is developed from forces of nature such as gender, race, and sexual orientation (Gee, 2001). However, in order for a force of nature to be considered as a meaningful constituent of one's identity, it must be recognized by the individual as relevant within a specific context.

One of the most prevalent forms of nature identity research in engineering are those studies that investigate the relationship between gender and engineering identity, particularly regarding experiences of women. Capobianco (2006) investigated such an identity perspective in her longitudinal case study examining how young women in an engineering program begin to construct professional identities as they become engineers. In particular, she uncovered *gendered identities* in which she considered how students' beliefs of who they are as women were mediated within their engineering programs. From this perspective of identity, students identified both advantages and disadvantages that they attributed to being a minority in a male-dominated field (Capobianco, 2006). However, not all women in her study recognized a gender imbalance; for these students, their academic identities became more dominant. Walker (2001) yielded similar results from her work at a Scottish university. As women attempted to shift their identities to be more masculine, they acknowledged their roles as women and the impacts that their gendered identities may have on their careers. One woman discussed being asked in an interview about how her boyfriend would feel about her moving to a job, stating that "none of the boys having the interview were asked if they had a girlfriend" (Walker, 2001, p. 86). However, despite these recognized gender differences within these contexts, these women still reinscribed traditional gender narratives in engineering along with their male counterparts. She found that while women attempted to degender their identities in relation to engineering, or disassociate from gender, by assuming aspects of masculine identities, men typically did not

reciprocate. As women spoke of gendered perceptions such as the woman being asked about her boyfriend during an interview, they also reinforce traditional gender identities by perceiving roles such as "career breaks and child care as the responsibility of women" (Walker, 2001, p. 87). Hence, in this study, Walker revealed the complex role of gender within engineering contexts.

Similar to Walker (2001), Faulkner (2000) also made an interesting and significant contribution that further investigates the relationship between engineering and gender. She explicated the presence of multiple dualisms within the engineering field, observing that the social/technical dualism maps onto a feminine/masculine dualism. In this sense, technical content is typically discussed in a masculine way while professional skills are gendered as feminine. Faulkner (2000) discusses that because the values of the engineering field (e.g. the acquisition and demonstration of technical content knowledge) are typically considered to be masculine in nature, men are also considered to maintain a higher power dynamic within the engineering culture.

Drawing from Faulkner's (2000) work, Cech and Waidzunas (2011) recently conducted emerging research on the engineering identities of lesbian, gay, and bisexual students (LGB) in engineering disciplines. They found that students face a heteronormative climate that shapes the engineering culture and is fostered by general expressions of sexual prejudice while simultaneously silencing the concerns of the LGB students. In particular, students discussed a variety of disadvantages experienced within their engineering education and the ways in which students "pass" or "cover" (Cech & Waidzunas, 2011, p. 5) to cope with them. These disadvantages often arose from the power dynamics resulting in a hetero-dominant environment. Drawing from Faulkner's (2000) study, gay men are often perceived to be "feminine" and their technical abilities undermined. Lesbian women, on the other hand, were perceived as "masculine;" however, this classification did not afford them any advantages. Bisexual students must cope with a heterosexual/homosexual dichotomy. In essence, this nature identity impacts the ability for these students to develop a professional identity as they expend large amounts of academic and emotional energy to navigate their undergraduate engineering experiences.

Another distinguishing form of research on nature identities explores the role of race in identity construction. McGee and Martin (2011) studied race and stereotype management in engineering and mathematics undergraduate courses. They discovered that many black students were

perceived as lacking the innate ability to successfully perform at a high level in mathematics. As a result, these students were subjected to stereotype threat, which is defined as a confirmation bias in which an individual fears the threat of being viewed through the lens of a negative stereotype or inadvertently doing something to confirm that stereotype (McGee & Martin, 2011, p. 1348). A study by Osborne (1997) showed that African American boys "disidentify" with domains at higher rates than White students and African American women due to stereotype threat. Steele (2011) echoed this sentiment in his study in which framing verbal reasoning exams impacted student stereotype threat. When the exam was presented as a test of ability, African American men performed much poorer than when the test was presented as a learning exercise. The tests of ability threatened these students with the stereotype regarding their group's intelligence; therefore, these students were cognitively overloaded during the exam not by the exam itself, but from the worry and pressures of stereotype threat. Aligning with Cross and Paretti (2012), these studies provide significant implications to researchers exploring engineering identity, showing that despite students' technical knowledge or capabilities, nature identities maintain a strong influence on who an engineer is and what an engineer "looks like".

Upon reviewing multiple studies that inherently or explicitly address nature identities, one common thread reinforces Gee's (2001) definition of these identities and links the findings of each of these studies together: nature identity is often recognized due to an identity conflict that the individual experiences with the dominant group. In these instances, the individual cannot easily change or negotiate these identities because they exist outside of one's control. For this reason, nature identities are particularly useful constructs for exploring the variety of ways in which individuals' perspectives and self-perceptions are developed in contexts where their nature identities do not align with the traditional identities belonging to a particular group. These conflicts reveal nuances that positively or negatively influence other aspects of an individual's identity and further challenge what it means to be a certain "kind of person" (Gee, 2001, p. 100) within a given context, e.g. being a lesbian woman in an engineering discipline, which is typically prescribed through notions of heteronormativity and masculinity (Cech & Waidzunas, 2011; Foor & Walden, 2009).

### *2.5.2 Research Associated with Discourse Identity*

Prior work involving discourse identity within the engineering education community has often explored the ways in which engineering students discursively enact, manage, and maintain a specific identity, particularly with respect to professional identities. Through the use of language within various contexts, researchers can attempt to understand how these individuals present themselves and are perceived by others as engineers through intentional and unintentional pre-existing language choices (Bamberg et al., 2011; Dannels, 2000; Douglas et al., 2012; Gee, 2011; Goffman, 1959).

In her ethnographic case study of mechanical engineers in a senior design course, Dannels (2000) observed the influence of classroom activities (e.g. design presentations and reports) on students' discursive practices. She observed that, despite the instructor's attempts to model an industrial workplace, students often grappled with managing their student and engineering selves. In instances in which students encountered a combination of workplace and classroom contexts (e.g. students were required to present a design model out of a textbook while also presenting design decisions to a client), they reverted to familiar academic discourse and practices, acknowledging that their design project "…is school…[it] isn't real" (Dannels, 2000, p. 6). Similar to findings by Paretti (2008), students realized that they were not being perceived as engineers; they were perceived as students working for a grade that would lead them to graduate from the program and utilized discourse to maintain that identity. Douglas et al. (2012) found similar results in a senior Materials Engineering and Science capstone course. Upon analyzing the interviews of eight students, Douglas and colleagues determined that students discursively positioned themselves as students while completing problem solving processes and did not connect their experiences with school to discourses existing within the engineering profession.

As these studies demonstrate, discourse identity is a powerful tool that provides researchers with the ability to dynamically capture identity enactment as individuals interact and engage with one another in a variety of contexts (Bamberg, 2012; Bamberg et al., 2011; Gee, 2011). Because identity is enacted, rejected, or maintained through the use of conscious and unconscious linguistic choices and discursive positioning, researchers may begin to see underlying nuances embedded within one's identity. In addition, they may also reveal the negotiation of that identity

as the participant moves from one language act to next as they talk about various experiences and contexts. For these reasons, many identity studies including Jorgenson (2002), Walker (2001), Capobianco (2006), Faulkner (2007), Paretti and McNair (2012), and Foor et al. (2007), often explore discourse identity in conjunction with other forms of identity presented within Gee's (2001) framework. In the studies presented above, researchers were able to identify shifts, conflicts, and gaps in students' professional identity formation as revealed through their discourse. However, due to its dependence on context and participants, discourse identity brings the importance of other identity dimensions to the fore. Rather than perceiving this identity construct as a separate phenomenon, discourse identity serves as a vehicle for individuals to enact and communicate identity with the world.

### *2.5.3 Research Associated with Affinity Identity*

Affinity identities draw their power from distinctive practices and experiences of which members of that group share (Gee, 2001). Members of an affinity group primarily focus their allegiances to a set of common practices and experiences and place a secondary focus on a shared culture or trait (Gee, 2001). For instance, members within an engineering community may share an affinity for mathematically-oriented work (Faulkner, 2007) or participate in a course because they are interested in learning about interdisciplinary collaborations (McNair et al., 2011).

Also acknowledging a combination of identity perspectives, in Faulkner's (2007) study of women in a professional work place, she explores the meaning of 'real' engineering work. In particular, she discusses a meeting with Karen, an engineer in mechanical services. Karen perceives "engineering work" to be heavily math-oriented which kept her "tied to [her] desk" (p. 342). Thus, when she left her design job to pursue a career in project management, a career she perceived to better fit her talents, she considered herself to be leaving engineering altogether. Therefore, the practices such as spending long hours "doing math" are perceived as practices that are directly tied to engineering identity and determines who may and may not be considered an engineer. This body of work fuels Stevens and colleagues' (2008) suggestion at the end of their article to broaden students' perception of "real" engineering work early in their careers so that more students may identify with engineering through a range of activities and practices that include both social and technical components.

Similar work on this topic was conducted while studying engineering students participating in self-managed interdisciplinary teams. In their study, McNair et al. (2011) argue that affinity identities may serve as a tool for students to value other types of work outside of their own discipline, particularly as the nature of engineering work moves toward interdisciplinary contexts. As engineering students interact with individuals from other fields with which they share an affinity, they may also begin to value other work that is inherent within engineering but not stereotypically expected. Stevens, Johri, and O'Connor (2014) state that, "…what is obscured for students are the identity elements of … practice that engineering students typically do not see or learn to value as central –those related to communication, coordination, organizing, and persuasion amidst people *and* technical practices and objects" (p. 128). Therefore, despite beliefs about the engineering profession (Faulkner, 2007), the technical competencies of engineers are not the only skills required of engineering students as they enter into the profession (ABET, 2008; ASCE, 2008).

This body of work suggests that affinity identities may serve an important role in exploring students' professional identity formation in two ways: 1) affinity identity has shown promise as a means to identify initial or shifting phases of students' professional identity formation; and 2) affinity identity may serve as a valuable lens when considering students' disciplinary identity formation (McNair et al., 2011; Pierrakos et al., 2009). As students begin to associate with others and are subjected to new interests through affinity groups, they may begin to assign value to those activities, hence potentially shifting the valued activity and practice from an affinity identity to a professional one. Affinity identity may also reinforce the influence of a disciplinary identity on students' professional identity formation. As students initially enter into an engineering discipline based purely on topical interest, they may begin to internalize the values and practices of that discipline. Therefore, affinity identities may be useful in exploring the initiation and development of students' professional identities.

### *2.5.4 Research Associated with Institutional Identity*

While this process may seem straightforward, gaining an institutional identity within an undergraduate engineering context may be a complex endeavor and may establish itself in multiple ways such as entry into and navigation through a desired engineering program, graduation from an engineering department, and passing licensure exams. In their study

consisting of a smaller data subset of the Academic Pathways Study (APS) by Sheppard et al. (2010), Stevens et al. (2008) presented a framework of "becoming an engineer" that consists of three "sensitizing concepts" (Stevens et al., 2008, p. 366; Charmaz, 2014): accountable disciplinary knowledge (ADK), identity, and navigation. Stevens and colleagues (2008) identify that as students experience important transitions throughout their undergraduate careers and move from one passage point to the next, they must demonstrate predetermined levels of *accountable disciplinary knowledge* (ADK), which is defined as any type of knowledge that, when performed, counts as engineering-related work (Stevens et al., 2008, p. 357). They observed that demonstrating ADK is one primary key to obtaining an institutional identity (Stevens et al., 2008) and is often an indicator of valued engineering work (Dannels, 2000; Faulkner, 2007). Students who do not perform well in their courses may experience stifled formation of a professional engineering identity as restricted by university engineering curricula. There are instances where this is not the case, however. Jill, a student who could not easily maintain a high grade-point average due to other social and cultural factors was unable to be admitted to the engineering program of her choice despite her interest and strong work ethic (Stevens et al., 2008). Simon, another student within the APS, maintained similar grades to Jill; however, he navigated the institution much differently and was admitted to his chosen engineering program. While Jill held a part-time job as a lifeguard to support herself during her first two years of college, Simon had a friend whose father was an engineer. From this connection, Simon was hired into an engineering firm during the summer and for part-time work during the school year. Hence, while Simon was applying to programs, he could strengthen his grade-point average through the practical experience that he had gained through a social connection (Stevens et al., 2008). From this work, Stevens and colleagues highlights that, while disciplinary knowledge within a university is a primary means of achieving an institutional identity, the structure of the university itself and how it is enforced can also shape how students achieve an I-identity.

Investigation of these two forms of institutional navigation within these cases highlighted some potential institutional structures that may hinder or promote engineering identity. In some universities such as Large Public University, students who are unable to declare a chosen engineering discipline to study in college during their freshman or sophomore years may also feel less identified as an engineer due to institutional regulations that prohibit them from self-

categorizing as and establishing a belonging to a specific engineering discipline (Stevens et al., 2008). In other institutional structures, students are required to sit for and/or pass the Fundamentals of Engineering Exam (FE) as a requirement for graduation (NCEES, 2015a). However, only individuals wishing to become *professional* engineers are required to formally pass the exam and, in turn, be bestowed the responsibility of developing, submitting, and constructing plans and supervise those engineers working beneath them (McGuirt, 2007). Engineers who do not pass the exam or do not wish to maintain such a high level of social responsibility are able to work in other capacities as directed by a professional engineer.

As evidenced from the studies presented above, an inherent power dynamic underpinning institutional identities has been established. Depending on the context, an individual may be granted or authorized an institutional identity by demonstrating specific levels of agency. While acknowledging that the individual must *always* be granted an institutional identity from someone else, I have identified these levels of agency as high, medium, and low. High levels of agency include instances such as obtaining an institutional identity of an Engineer-in-Training (EIT), the first step in the licensure process. To be granted this identity, one must pass the FE exam; however, the amount of time used to prepare for and the amount of energy exerted on the exam is determined by the individual. From this perspective, that individual can control how well he or she performs on the examination. Medium levels of agency include instances in which students must navigate an institutional structure. Revisiting the cases of Simon and Jill (Stevens et al., 2008), we begin to see how institutional identity may be achieved in two different ways. While Jill sought an institutional identity by attempting to achieve high grades, Simon gained institutional identity through personal networks that he had created for himself. Hence, in these situations, these students were able to retain some level of agency while still being guided by the structure of the engineering university and departmental requirements. Low levels of agency include strict, institutional structures that have established policies and regulations that restrict an individuals' ability to navigate the context. As stated in the work by Stevens and colleagues (2008), some institutions are simply structured in such a way that keep students from declaring an engineering major until their second or third year of enrollment, potentially hindering that student's ability to form a professional identity. This body of work has demonstrates that we may begin to see influences of the power of institutional structure on the ways in which individuals form their professional identities. This yields major implications for identity work, particularly

within academic contexts. However, institutional identity is also interesting in that it does not necessarily dictate the formation of a professional identity. Other studies have shown that being institutionally identified as an engineer does not guarantee a student's identification with and retention in the engineering field (Lichtenstein et al., 2009). In essence, just because one earns an engineering degree does not necessarily mean that they will become an engineer, thus highlighting the impacts of other dimensions on an individual's professional identity.

### *2.5.5 The Intersections and Interactions of Identity*

As evidenced by this vast body of literature, there are multiple contributors to a student's professional identity formation that include both professional and personal characteristics inside and outside academic settings (Atman et al., 2008; Stevens et al., 2008; Walther et al., 2011). As shown in Figure 2.3, these identity contributors have been explored within the literature in a variety of ways. While Figure 2.3 is not a comprehensive illustration of the research examining identity intersections, it does demonstrate the complex nature by which they interact. In this section, I further explicate the approaches by which researchers within the engineering education community explore these dynamic interactions.

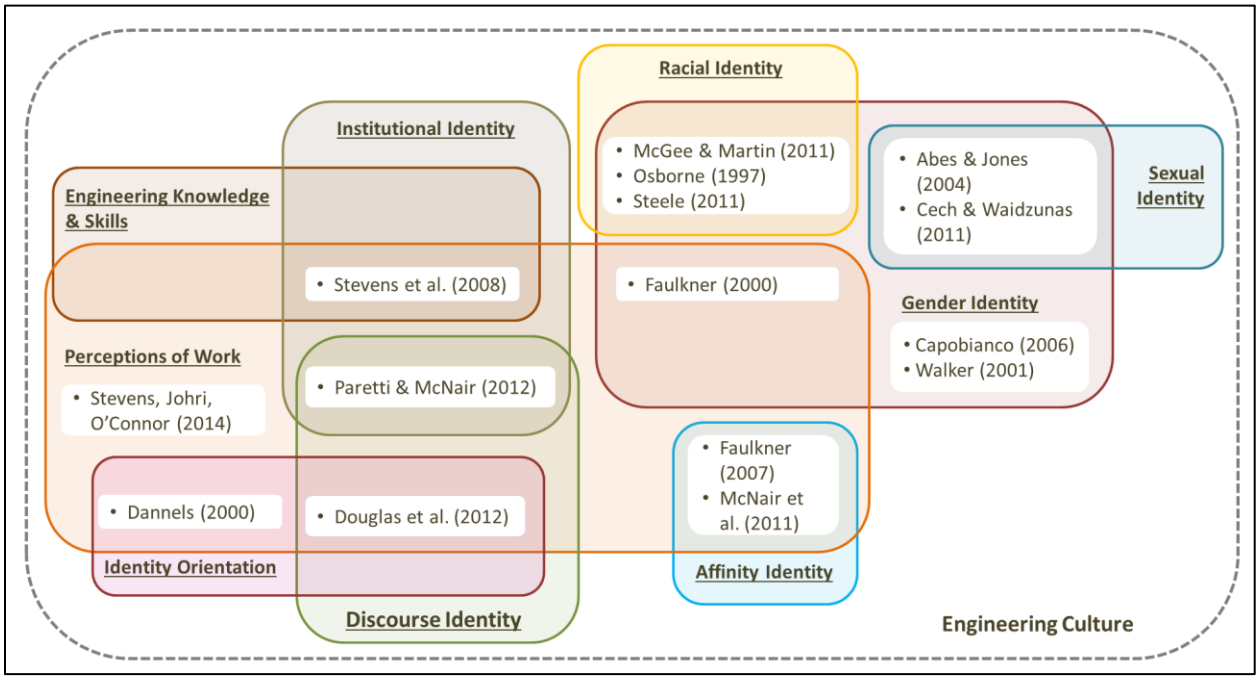



Figure 2.3: Venn Diagram of a Sample of Intersections of Identity Research

To further understand identity formation, it is imperative to understand the multiple aspects of one's identity and how they synergistically work together as an individual experiences, interprets, compares, constructs, and communicates their experiences. This approach to identity research is most widely known from the work of Abes, Jones, and McEwen (2007) in which they present their *Reconceptualized Model of Multiple Dimensions of Identity*. This framework builds on an initial model by Jones and McEwen (2000) and presents the idea of a core personal identity or sense of self that, while remaining unchanged, is influenced by multiple dimensions of identity. Through this framework, the authors suggest that these multiple dimensions of identity become more salient through various contexts and social interactions as the individual interprets and makes meaning of them. From their perspective, identity saliency considers the importance of an identity dimension relative to an individual's core personal identity within a given context. For example, for a woman engineer, her identity as a woman may become more salient while she is interacting with a group of male engineers. In contrast, her identity as an engineer may become more salient in a room full of women. Identity salience varies greatly depending on context (Abes et al., 2007; Jones & McEwen, 2000).

Paretti and McNair (2012) further explored the influence of context on identity enactment at the intersection of perceptions of work, discourse identity, and institutional identity. In their study examining two workplace contexts (i.e., an international corporation and an interdisciplinary senior design course), Paretti and McNair (2012) found that each institutional structure afforded participants specific identity discourse enactments and conceptions of work. In the senior design course, students were encouraged to interact across disciplines, thus broadening engineering students' discourse identities and subverting stereotypical work roles. The corporation employees, however, were confined to stereotypical work and discursive roles and experienced minimal interaction with non-engineers. From this examination, Paretti and McNair (2012) demonstrate the ways in which identity intersections within local contexts can either reinforce or weaken broader definitions of who engineers are, what they do, and how they communicate with others.

Similar to Abes and colleagues' (2007) concept of *identity saliency*, Settles (2004) quantitatively examined *identity centrality* and interference at the intersection of professional and gender identity of women in science fields. In particular, she examines these intersections by

considering an individual's ability to exit specific dimensions upon experiencing identity interference. She identified a complex interactions among ascribed (i.e., nature) identities (e.g., gender), non-ascribed (i.e., affinity or institutional) identities (e.g., scientist), and identity interference. She found that both gender and science centrality can serve as a buffer or expose a vulnerability based on an experienced interference. These experiences can then lead to various outcomes regarding personal well-being and science performance. From her work, Settles (2004) emphasizes the importance of considering multiple dimensions of identity and acknowledges the complexity of contributors to one's identification with a field or professional identity formation.

As demonstrated by this body of work, a single individual's identity is comprised of and enacted through multiple identity dimensions that intersect in complex relationships as influenced by external contexts such as local and global institutions. In particular, this work further reinforces the need to examine identity formation from a holistic perspective. While the majority of studies presented in this literature review provide interesting perspectives on holistic identity formation, they examine multiple identity dimensions as a phenomenon to be studied, rather than a dynamic process that considers the personal evolution of individuals over time. Therefore, in addition to understanding how these multiple identity dimensions intersect and influence one another, further research is needed to examine how these dimensions may slowly be integrated into and change an individual's sense of self or "core identity" (Jones & McEwen, 2000, p. 408).

### 2.6 Synthesis of Identity Research and Areas for Future Work

Multiple societal, economic, and technological factors influence what engineers *do* and who engineers *are* (Sheppard et al., 2010; Stevens, Johri, & O'Connor, 2014; Stevens et al., 2008), as reflected in research on topics such as the development of professional and ethical competencies (Barry & Herkert, 2014; Nersessian & Newstetter, 2014; Paretti, McNair, & Leydens, 2014) and identity development, in particular (Capobianco, 2006; Stevens, Johri, & O'Connor, 2014; Tonso, 2014). Upon reviewing the literature of professional identity formation in engineering, I have identified multiple trends that link these studies together and provide insight into areas of future professional identity formation research.

While studies investigating the process of professional identity formation have been conducted within fields such as nursing (Cook, Gilmer, & Bess, 2003; MacIntosh, 2003; Price, 2009) and

counseling education (Gibson, Dollarhide, & Moss, 2010), few studies explore this process within engineering education. Many of the studies that seek to understand students' professional identity formation in engineering typically explore this formation as a single incident in which a temporal component is not considered (Charmaz, 2014; Grotevant, 1987). Capobianco (2006) begins to conceptualize identity formation as a process as she tracks women's professional identity formation over time; however, she does not present this formation as a process. Rather, she focuses her analysis to describe the multiple ways in which the women in her study interpreted their identities within specific contexts. Striving to "bring to the forefront the ways in which engineering has played a role in [women's] thinking about who they are and what kind of person they want to be," (p. 114), Capobianco (2006) presents an identity framework that is similar to Gee (2001) in the sense that it provides four perspectives of identity formation that are not connected through a time dimension. Similar results have been yielded by other studies (e.g. Stevens et al., 2008; Faulkner, 2000) that begin to identify ways in which students' professional identities are formed, but not necessarily the process in which formation occurs. However, one study within the engineering education community explores identity formation as a process in addition to the factors that influence it. In their study, Walther et al. (2011), utilized an approach informed by grounded theory to explore how students' achievement of the ABET Student Outcomes (ABET, 2008) influenced their professional identity formation. With their process identified as *Accidental Competency formation*, Walther and colleagues compared the learning outcomes as defined through ABET with those of students' perceptions as they navigated their undergraduate careers. Their results revealed the potential for engineering educators to enhance connections between learning outcomes and student life, particularly as students develop into engineering professionals.

The paucity of professional identity formation research increases in tandem with disciplinary scope; few studies focus on formation within just one engineering discipline. Studies on civil engineering students are few and far between. In their recent book titled *Becoming a Civil Engineer*, Mau and Maalouf (2015) begin to connect the history and primary advances of the civil engineering discipline, as previously discussed in this chapter, but they do not connect this history to student identity formation. Rather, this book reads more as a "how-to" guide for becoming an engineer in a literal, systematic sense. Researchers investigating engineering identity formation have primarily utilized mechanical (Dannels, 2000; Tonso, 2007a), materials

science (Douglas et al., 2012), electrical and computer (Du, 2006; Loui, 2005; Walker, 2001) engineering students as participants. In some studies, civil engineering students may be included within the study, but are not specified (Foor et al., 2007; Tonso, 2006) or are combined with other engineering majors in other studies (Meyers et al., 2012). Focusing on a single engineering discipline, particularly civil engineering, allows engineering education researchers to see the direct influences of the discipline on student education and potentially apply results directly to relevant courses and contexts.

Another gap within engineering education research in identify formation is the academic level of the students who are participating within the study. Studying freshman engineering students allows identity researchers to understand students' initial perceptions of the engineering field and their intent to stay within engineering (Lichtenstein et al., 2009; Meyers et al., 2012; Pierrakos et al., 2009) while studying senior engineering students provides researchers insight to the culmination of the engineering curriculum and student transitions from school to work (Dannels, 2000; Douglas et al., 2012; Tonso, 2007a). However, students within the junior and sophomore levels of undergraduate engineering may also provide an interesting perspective on identity formation that is not typically discussed. After completing general education requirements throughout their first year, sophomore engineering students are typically introduced to the engineering field and their chosen discipline through courses that inform students about engineering work and what engineers in their chosen majors do (e.g. Intro to Civil and Environmental Engineering); expose students to tools used by civil engineering professionals in industry (e.g. computer-aided design courses); and teach students the foundations of engineering design through application of mathematical modeling and computation for solving physical systems (e.g. statics, dynamics). Upon entering their junior year, civil engineering students begin to take courses that are focused specifically on their discipline. For example, at Virginia Tech, four out of six courses that a typical first-semester junior will take begin with the prefix "CEE". Each of these courses, chosen by the student, are technical courses that teach students the fundamentals of civil engineering within sub-disciplines such as construction, environmental, structural, transportation, and water resources (VT, 2015). Thus, these courses provide interesting transition points in which students are introduced to the engineering field as well as their discipline and provide key experiences to students as they continue their undergraduate education.

Although not an empirical study, Downey and Lucena (2004) discuss the implications of historical impacts at a national level as a way to impact engineers' identities and preparation. In their article, they discuss how engineers *code-switch.* They describe code-switching as a process through which "engineers build legitimacy for themselves and their knowledge simultaneously in professional and popular terms" (p. 396) as nations shift priorities. While Downey and Lucena (2004) do not present an empirical study with civil engineering students, they exhibit the same message that underpins and informs my proposed research: historical events impact the way professional identities are constructed by engineers. A similar message is embedded within the work of Pierrakos et al. (2009) who state that, "exposure to meaningful engineering-related experiences and engineers are critical in developing an engineering identity" (p. 1).

These experiences are perceived, interpreted, and internalized differently by different groups of students as their nature, institutional, discourse, and affinity identities (Gee, 2001; Meyers et al., 2012) change throughout their academic careers. Men and women may identify with different sets of values or activities within engineering (Chachra et al., 2008); institutional identity, identity knowledge, and affinity identity (i.e. being recognized as an engineer) influence students' identification with engineering (Stevens et al., 2008); and discourse, affinity, and career trajectory are all important factors to consider with regard to students' identification with engineering (Meyers et al., 2012). Ultimately, this body of work shows that students' identity formation is influenced by broader impacts that many studies do not acknowledge simultaneously (Atman et al., 2008). While these studies are valuable for advancing identity research, more work is needed to further understand the dynamic ways in which students construct their professional identities and how we, as engineering educators may help them.

## 2.7 Toward a Framework of Professional Identity Formation in Undergraduate Civil Engineering Students

Prior research has clearly established that engineering identity construction is complex and relies not only on the accumulation of disciplinary engineering knowledge, but also other personal and professional characteristics (Atman et al., 2008; Capobianco, 2006; Foor et al., 2007; Stevens et al., 2008). Still, calls from the engineering education community encourage further research on identity construction, stating that "existing empirical work is suggestive, but incomplete about how identity formation processes in engineering student culture . . .shape transitions into

engineering workplaces" (Stevens et al., 2014, p. 127), and ". . . far more of these studies are needed to broaden the scope of what is known about [these] important processes . . . to deepen understandings" and advance the field of engineering education, research, and practice (Rover, 2008; Tonso, 2014).

To contribute to the body of work presented in this chapter and explore professional identity formation as a process, I have designed a grounded theory study (discussed in further detail in Chapter 3) that answers the following research question: How do undergraduate civil engineering students form identities as professional engineers? To further frame my investigation, I ask the following questions:

RQ1. What are students' initial perceptions of the civil engineering profession?

RQ2. How do students' perceptions of the civil engineering profession change as they enter college and navigate undergraduate experiences?

RQ3. What are the outcomes resulting from these changes in perception?

RQ4. How do these perceptions intersect with students' personal identities?

Typically, grounded theory is used when a theory is not available to understand or explain a process (Creswell, 2013). In the event that a model applicable to the process under study does exist within prior literature, a researcher typically utilizes grounded theory in an attempt to further develop that theory for a particular sample population that possesses potentially valuable variables and characteristics of interest (Creswell, 2013).

Presented in the literature review herein, theories of identity formation have been well-established and applied to multiple professions such as nursing and engineering; however, these theories typically do not consider identity formation as a holistic process that merges the personal world of the student to that of the engineering discipline, particularly within civil engineering. In many of the studies reviewed above, most of these researchers assist in bringing these identities to the fore as they construct their research designs. In some instances, students may not necessarily talk about specific identities that researchers aim to study.

For these reasons, I chose to develop a grounded theory of undergraduate civil engineering professional identity formation that considers the nuanced disciplinary practices, values, and beliefs that constitute the civil engineering profession in addition to students' personal and academic-related relationships, interactions, and activities. Using Gee's (2001) framework as sensitizing concepts (Bowen, 2006; Charmaz, 2014), I explored the civil engineering students' professional identity formation while simultaneously considering multiple factors as they interacted with one another and capture the dynamic nature of these individuals' professional identities.

### *2.7.1 Sensitizing Concepts*

For the purpose of this work, I am adopting the general definition of identity presented in Tonso (2014) and posed by Holland, Lachicotte, Skinner, and Cain: "Identity is a concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations" (1998, p. 4).This definition places emphasis on the ways in which an individual forms an identity as he or she interprets, is influenced, and internalizes the experiences, incidents, and relationships of the world in which they live. In this section, I introduce two primary theoretical frameworks to support this study: Social identity theory (Abrams & Hogg, 1990; Hogg, Abrams, Otten, & Hinkle, 2004; Hogg & Terry, 2000; Spears, 2011; Tajfel, 1974; Tajfel & Turner, 1979) as supplemented by Gee's (2001) *Four Ways to View Identity*.

To explore the ways in which participants develop a professional identity, I situate the integration of an individual's intimate and social worlds as they participate as a professional-in-training (i.e. an undergraduate engineering student) within a specific discipline (i.e. civil engineering). By applying the definition of identity in this way, I am able to explore the ways in which individuals align their personal values, beliefs, and behaviors with those established by the culture of the civil engineering discipline and vice versa; the disciplinary identity and culture of civil engineering shapes and is shaped by the members within that particular group.

Social identity theory (SIT) was the first theoretical framework within identity research to acknowledge identity development at the group (e.g. disciplinary) level and is sometimes generically referred to as *group identity* (Abrams, 2015; Spears, 2011). In general, this theory

implies that membership in a group is framed through comparisons of values and behaviors that members make between each other and individuals belonging to other groups (Abrams, 2015; Spears, 2011; Tajfel, 1974). These comparisons allow members to partially define who they are based on the valued meanings and regulatory influences that the group provides for them (Abrams, 2015; Tonso, 2014). For example, as civil engineering students move through a civil engineering curriculum, they may be constantly reminded of the federal, state, and local governing bodies that regulate their work either through their design or analysis coursework. Therefore, as civil engineering students compare their coursework with their colleagues' from other engineering disciplines, they may begin to value professional design manuals (e.g. the Precast Concrete Design Handbook, the American Instituteof Steel Construction Design Manual, and the National Design Specifications for Wood Construction) more so than their peers and perceive these as necessary tools for completing civil engineering-related work (Dannels, 2000; Faulkner, 2007). Through these comparisons, civil engineering students may partially define who they are as a civil engineer based on the value placed on national design manuals within their civil engineering courses. In contrast, civil engineering students who do not conduct work according to these manuals may begin to view this type of work as unrelated or irrelevant to civil engineering.

While the SIT perspective focuses on the social influence that a group maintains on its members and on other groups, it also upholds that members possess a personal identity in addition to social identities (Tajfel, 1974; Tonso, 2014). To consider both group and individual forms of identity, SIT has been further delineated as a meta-theory that includes two primary sub-theories: the SIT of intergroup relations and SIT of the group, also known as self-categorization theory (Abrams, 2015; Hogg & Terry, 2000; Spears, 2011).

Initially expanded by Tajfel (1974), the SIT of intergroup relations acknowledges the comparisons, conflicts, and struggles between groups found within a larger social structure known as "intergroup dynamics" (Abrams, 2015, p. 204). It is important to note that while SIT partially allows individuals to determine who they are through group interactions, SIT may also indicate to individuals who they are not (Spears, 2011). For example, some civil engineering students may find themselves struggling to either perceive themselves or be perceived by others as an engineer based on the perception of other factors that do not traditionally align with

engineering such as gender, sex, race, and even economic status (Dryburgh, 1999; Foor et al., 2007; Jorgenson, 2002). The individual is unable to be identified with a group due to external constructions that are defined and accepted by society, not defined by the individual. This concept introduces the *double-sided perspective* of identity in which individuals position themselves and are positioned by others through socially-influenced constructs (Stevens et al., 2008); however, it also brings the individual perspective of identity development to the fore. At this point, this first sub-theory of SIT begins to intersect with another sub-theory of SIT through self-categorization, which maintains the presence of an individual's identity within that of a social group (Spears, 2011; Tajfel, 1974).

To further expand SIT, Tajfel (1974) integrated an individual component called self-categorization theory (SCT), or SIT of the group (Abrams, 2015; Spears, 2011). This framework relies on a core concept of *social categorization* that considers a social system as a defining framework from which an individual's place in society is determined (Tajfel, 1974). Social categorization leads to categorizations of groups to which an individual may self-categorize (Abrams & Hogg, 1990). Hence, this sub-theory of SIT creates and explicitly acknowledges the psychological link between the self and the group, articulating the influential relationship between individual interpretations and categorizations about a social context or environment (Abrams, 2015). It places primary focus on the positive values that an individual may derive as being a member of a group.

As individuals interact with multiple groups and interpret social contexts in a variety of ways, they maintain positive values from some groups and distance themselves from those with whom they maintain negative values. From these experiences, individuals are able to create, or *construct*, an identity from chosen, positive values exhibited by particular groups. These constructions may vary depending on the individual's surroundings and contexts, presenting the concept of multiple identities (Abes & Jones, 2004; Abes et al., 2007). An individual may enact multiple identities as certain aspects of their identity become more prominent within specific situations (Abes et al., 2007).

While individuals may possess multiple identities, they are not distinct from one another; therefore, it is important to consider multiple identity factors within a single context (Abes et al., 2007; Gee, 2001). Acknowledging that a single person's identity may take on many forms and

laying the foundational research structure for other researchers studying identity (Capobianco, 2006; Eliot & Turns, 2011; Paretti & McNair, 2012; Sfard & Prusak, 2005), Gee (2001) developed a framework consisting of four views of identity that encourage researchers to understand how a "certain 'kind of person,' . . . [is recognized] in a given context" (p. 99). The collection of these four views of identity, presented in Table 2.2 on page 29, provides an analytic tool for studying the myriad identity dimensions possessed by or granted to a single individual as he or she encounters, negotiates, and performs within a variety of contexts. In this framework Gee (2001) reinforces the complex and double-sided perspective of identity (Stevens et al., 2008) by acknowledging the interrelated processes, power shifts, and varied levels of agency by which individuals construct an identity. Throughout the rest of this section I explicate each construct by providing its definition and describing its process and inherent power relations.

Gee's (2001) identity framework is particularly useful when studying civil engineering students' professional identity formation for two primary reasons: 1) he does not bound the identity perspectives to specific contexts or relationships; and 2) he acknowledges that these identity perspectives may exist simultaneously and in important, complex ways. By combining this framework with social identity theory, I am able to scope my study to focus on the various ways in which civil engineering students form professional identities as impacted by the inherent culture and identity of the civil engineering discipline within multiple contexts throughout the civil engineering undergraduate experience.

By combining the definitions of identity (Holland et al., 1998; Tonso, 2014); social identity theory (Abrams, 2015; Spears, 2011; Tajfel, 1974); professional identity informed by Dryburgh (1999), Downey and Lucena (2004), and Tonso (2014); and Gee's (2001) four identity perspectives, I can explore the ways in which students internalize the valued behaviors, practices, and symbols to construct a professional identity.

### 2.8 Chapter Summary

In this chapter, I reviewed multiple areas of literature exploring identity in engineering education and their intersections. In particular, I discussed the nuance of disciplinary context of professional identity formation while emphasizing two underlying concepts: 1) the learning process perceived as a means of identity development; and 2) the influences of the civil

engineering profession on the environments in which this learning takes place. By recounting the history of the civil engineering profession, its impacts on civil engineering education, and influences on the professional identity formation of future civil engineers, I further articulate the need for discipline-based identity research in engineering education.

As the discipline of civil engineering has evolved into the profession that we know today, measures have been taken by the members of the civil engineering profession as well as engineering educators to ensure that students possess the necessary skills to be successful in their careers upon graduation. To accomplish this, many of the experiences that students encounter during their undergraduate careers have been directly impacted by the civil engineering profession. As students learn the values, knowledge, and skills inherent within undergraduate civil engineering education, they begin to merge their intimate, personal self with that of the civil engineering discipline.

However, prior work in identity has not yet considered these disciplinary characteristics that inform engineering education nor do they consider the broad interactions of identity-influencing characteristics that influence students as professional civil engineers. In the following chapter, I will introduce the methods to further explore gaps identified within the literature.

# CHAPTER 3: RESEARCH METHODS

## 3.1 Introduction

In this chapter, I present the overall research design and methods used to conduct this study. To further understand and explore the processes by which civil engineering students negotiate disciplinary perceptions to form professional identities, the purpose of my study, I asked the following overarching research question: How do undergraduate civil engineering students negotiate disciplinary perceptions to form identities as professional engineers? More specifically, I asked the following questions to further frame and guide my inquiry:

RQ1. What are students' initial perceptions of the civil engineering profession?

RQ2. How do students' perceptions of the civil engineering profession change as they enter college and navigate their undergraduate experiences?

RQ3. What are the outcomes resulting in these changes in perception?

RQ4. How do these perceptions intersect with their personal identities?

To answer these questions, I utilized the Constructivist Grounded Theory methodology (Charmaz, 2014). Using this framework, a theory of professional identity formation in undergraduate civil engineering students emerged from interview and survey data collected from sophomore, junior, and senior civil engineering students. Aligning with the Constructivist Grounded Theory approach, I utilized *sensitizing concepts* to serve as initial points of inquiry and loosely guide my analytical procedures (Bowen, 2006; Charmaz, 2014). For the purpose of this work, I employed Gee's (2001) four identity constructs and social identity theory (Spears, 2011; Tajfel, 1974) as my sensitizing concepts in order to gain an initial understanding of the *strategies* and *causal and intervening conditions* by which sophomore-, junior-, and senior-level civil engineering students acquire, negotiate, and internalize the valued knowledge, behaviors, and practices of the civil engineering profession.

There are two primary versions of grounded theory that are used throughout the research field: classic grounded theory (Glaser & Strauss, 1967) and constructivist grounded theory (Charmaz, 2014). While these approaches share a number of defining methodological characteristics, each version is separated by paradigmatic nuances reflective of its originators. The classis approach

to grounded theory by Glaser and Strauss primarily reflects the objectivist/positivist worldview of Glaser merged with the pragmatist worldview of Strauss (Bryant & Charmaz, 2007; Charmaz, 2008, 2014). Classically trained as a quantitative researcher, Glaser heavily influenced the objective, systematic processes embedded within grounded theory research. Glaser's primary aim was to identify key strategies or "codify" (p.9) the methods to demystify and conduct rigorous qualitative research (Charmaz, 2014). Glaser's research partner, Strauss, impacted the development of GT by bringing a symbolic interactionist perspective to the methodology. Symbolic interactionism assumes that reality is constructed through language, symbols, and social interactions that are utilized by individuals to construct, make, and enact meaning and action (Blumer, 1969; Charmaz, 2014). It was Strauss's perspective that gave grounded theory its qualitative-based approach of utilizing individual stories and accounts for the purpose of studying and understanding social processes (Charmaz, 2014). The constructivist approach to grounded theory presented by Charmaz (Charmaz, 2014) reflects her constructivist/relativist worldview. Trained as a student under Strauss, Charmaz was influenced by his symbolic interactionist perspective and iterative research approaches. Hence, she developed another form of grounded theory that maintained the basic components of Glaser and Strauss's "emergent, comparative, inductive, open-ended" (p. 12) approach and was distinct from social constructionism (Charmaz, 2014). The social constructionist perspective views individuals as products of society; *who we are* is based on socially and culturally-generated categorizations and ideologies (Berger & Luckmann, 1967). Constructivism, however, acknowledges individual agency in making meaning and maintains the interpretivist, relativist view of both the researcher and participants.

Grounded theory is typically used when a theory is not available to understand or explain a process (Charmaz, 2014; Creswell, 2013); however, in the event that a model applicable to the process under study does exist within prior literature, a researcher will utilize grounded theory in an attempt to further develop the theory for a particular sample population that possesses potentially valuable variables and characteristics of interest. As discussed in Chapter 2, multiple studies have identified a variety of identity dimensions belonging to a single individual and theories of identity formation have been introduced in a number of professions such as nursing and engineering. However, this body of work does not explore identity dimensions as dynamic interactions that influence one another as individuals change over time. For this reason, I chose

to utilize the Grounded Theory Methodology as a means to explore, in an unbounded manner, the process by which undergraduate civil engineering students develop professional identities as they enter and advance through their undergraduate experiences. In particular, grounded theory enabled me to simultaneously consider nuanced disciplinary practices as it is negotiated with relationships, interactions, and activities experienced inside and outside the classroom.

I begin this chapter by discussing my philosophical worldview as a qualitative researcher and my rationale for choosing Constructivist Grounded Theory as the framework for this study. Next, I provide an overview of this methodology and the methodological aims I achieved as a result of this inquiry. Then, I introduce my research design as an integration of data collection and analysis and identify the methodological tools used to carry out this work. To guide the reader through the iterative nature of this process of theory development, I explicate each sampling and analysis iteration as I advance from initial analyses through theory abstraction. Lastly, I discuss the validity and reliability of my methods, researcher bias, and the measures taken to minimize that bias.

### 3.2 My Philosophical Worldview and Constructivist Grounded Theory

A philosophical worldview is a basic belief system that a researcher holds to describe his or her ontological (i.e. the nature of reality and what can be known about it), epistemological (i.e. the nature of learning and what can be known), and methodological (i.e. the methods employed to inquire about what is to be known) assumptions (Creswell, 2014; Guba & Lincoln, 1994). As a researcher, it is imperative to understand these assumptions as they inform my own research decisions and analytical approaches during this study (Creswell, 2013; Guba & Lincoln, 1994). Therefore, in this section, I reflect on my own ontological, epistemological, and axiological beliefs that influence my research design decisions and inherent assumptions in my work.

As a civil engineer, I maintain a constructivist worldview with a relativist ontology and an interpretivist epistemology (Charmaz, 2014; Creswell, 2013, 2014; Guba & Lincoln, 1994). Individuals with this perspective seek to understand and make meaning of their surrounding world through subjective experiences as interpreted by the individual (Charmaz, 2014; Creswell, 2013). From this perspective, what is to be known as reality is highly dependent on the way in which it is come to be known by the individual experiencing it (Guba & Lincoln, 1994). This

constructivist/interpretivist worldview has greatly influenced my research interests, particularly regarding the formation of civil engineering students' professional identities. The professional identities of civil engineering students are influenced through a variety of experiences that may contradict and sharply contrast one another; however, all of these identities and experiences are relevant to further addressing the purpose of this study because they are *perceived* as being relevant by the participant. Due to this potential conflict of identity-influencing experiences among civil engineering students, I was particularly interested in understanding how students determine the importance of these experiences and their influences on one another.

My constructivist worldview not only informed my decision regarding a dissertation topic, but it also influenced the methodological approaches by which I investigated this topic. Due to my axiological perspective (i.e. the role of values and beliefs) (Guba & Lincoln, 1994) aligning with the constructivist worldview, I chose a specific form of the Grounded Theory Methodology to guide my work. As I reviewed both types of grounded theory research and their paradigmatic underpinnings, introduced above, I realized that I most closely aligned with the ontological, epistemological, and axiological views inherent within the Constructivist Grounded Theory approach (Charmaz, 2014). Constructivist grounded theory emphasizes the consideration of "diverse local worlds, multiple realities, and the complexities of particular worlds, views, and actions" (Creswell, 2013, p. 87). That is, the values, prior knowledge, and role of the researcher are maintained throughout multiple phases of the constructivist grounded theory design. Using this methodological framework allowed me to confidently research a topic of my own interest using a means with which my personal values closely aligned.

## 3.3 The Constructivist Grounded Theory Framework and Methodological Aims

To answer my research questions, I adopted a Constructivist Grounded Theory approach (Charmaz, 2014), henceforth referred to as *grounded theory* for simplicity. In this section, I briefly introduce the grounded theory framework and provide a discussion of my own methodological aims while conducting this study.

### *3.3.1 Overview of the Grounded Theory Framework*

Initially, the grounded theory research methodology was developed to merge the quantitative and qualitative traditions by providing a flexible research process that includes systematic, inductive,

and comparative approaches for the construction of a theory grounded in data (Bryant & Charmaz, 2007; Charmaz, 2014). Rather than inquiring about a phenomenon as a single concept or idea, grounded theory allows researchers to generate a general explanation of a process containing identifiable markers over a specific period of time (Charmaz, 2014; Creswell, 2013). From this perspective, grounded theory researchers seek to reveal potential explanations and underlying mechanisms that influence the occurrence and development of a phenomenon. For the purpose of my work, I sought to understand *why* and *how* students form their professional engineering identities as they are exposed to perceived engineering-related activities both inside and outside of the classroom throughout their lives. An overview of the grounded theory methodology is presented in Figure 3.1.

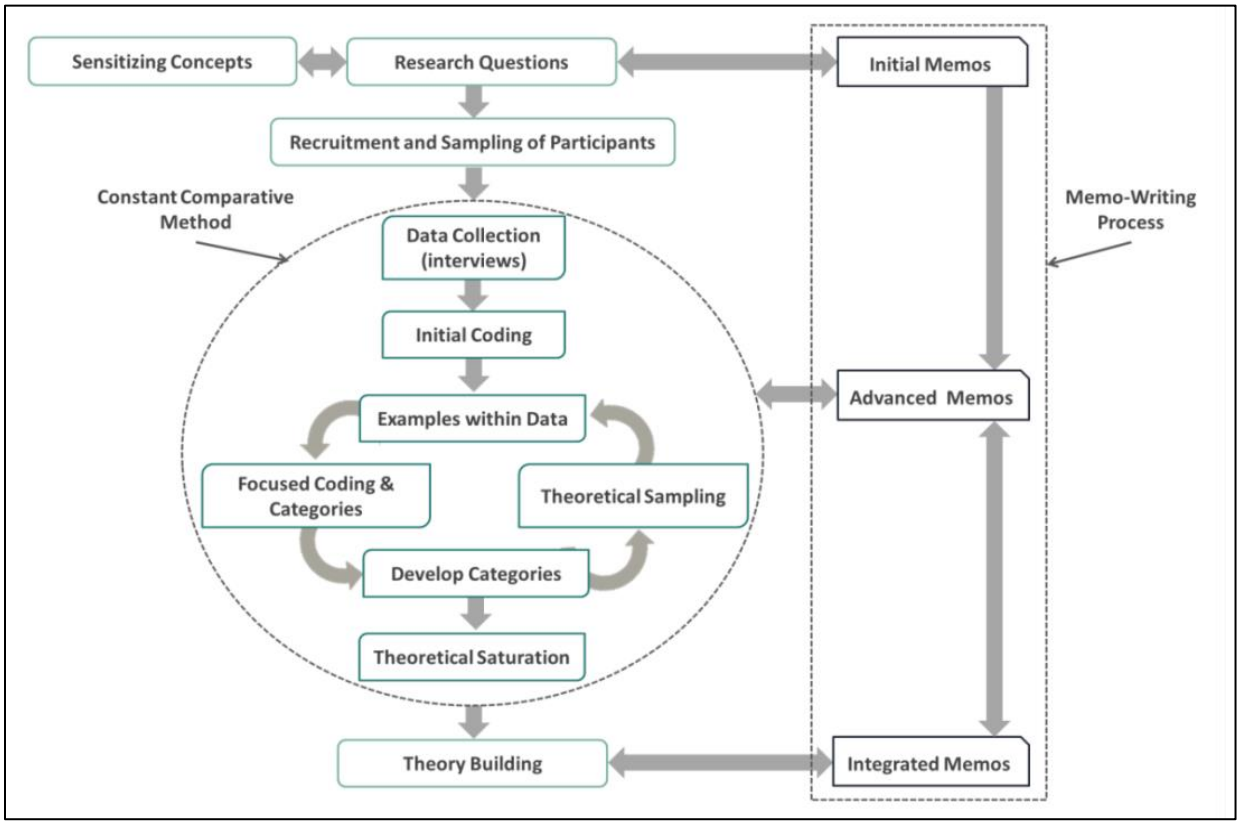



Figure 3.1: Overview of the Grounded Theory Framework (Adapted from Charmaz, 2014)

Unlike other research traditions, grounded theory relies on inductive logic to drive the method once a research topic has been identified. Rather than deductively applying a theoretical framework to answer research questions, grounded theorists identify sensitizing concepts (i.e. initial or tentative ideas relating to a research topic) (Bowen, 2006; Charmaz, 2014); these

concepts are used to develop research questions and guide the research process. Initially introduced in Chapter 2, the sensitizing concepts that I chose for my work were Gee's (2000) four identity constructs: nature identity, institution identity, affinity identity, and discourse identity and Social Identity Theory (SIT) (Abrams, 2015; Hogg & Terry, 2000; Spears, 2011; Tajfel, 1974). These constructs allowed me to conduct an initial examination of multiple aspects of students' lives and how they interact, interpret, and communicate them as they form professional civil engineering identities. Notably, these sensitizing concepts did not dictate my data collection and analysis; rather, they provided me with a way to initiate both of these research phases. In Section 3.6, I provide in-depth descriptions of the ways in which each component of the grounded theory methodology was operationalized and implemented in this study.

### *3.3.2 Methodological Aims*

While I have provided an overview of the grounded theory research process and the rationale for its selection, I conclude this section with a discussion of my own methodological aims for this study. My four *methodological aims* were goals that I developed to serve as a methodological guideline as I conducted this study. The guiding methodological aims of this study were: 1) understand the ways in which students in undergraduate civil engineering construct their narratives of identity formation; 2) conduct my analysis continuously throughout the data collection process; 3) explore this process in an inductive and unbound manner; and 4) probe for and abstract a richer meaning out of students' perceived identity-influencing experiences. These aims were imperative for answering my research questions and further reinforced my decision to utilize the grounded theory approach. To ensure that my research decisions aligned with my research questions and the investigation of each, I mapped the study purpose, research questions, and methodological aims to the signifying characteristics of grounded theory in Figure 3.2 on page 57. The signifying characteristics of grounded theory are: 1) inquire about a process-oriented phenomenon; 2) utilize inductive logic at the start of the inquiry; 3) conduct rigorous, comparative analyses with the data; and 4) continuously develop an increasingly theoretical analysis (Charmaz, 2014; Hood, 2007). These signifying characteristics, particularly the initial use of inductive logic, allow for the emergence of nuanced information that may otherwise be left unexamined using traditional frameworks, thus establishing grounded theory as a useful

methodology for this study. As shown by the complex relationships illustrated in Figure 3.2, the alignment of the research questions, methodological aims, and signifying characteristics situate grounded theory as a particularly useful methodology for studies of identity formation (Charmaz, 2014) and significantly influenced the overall quality of my research and findings.

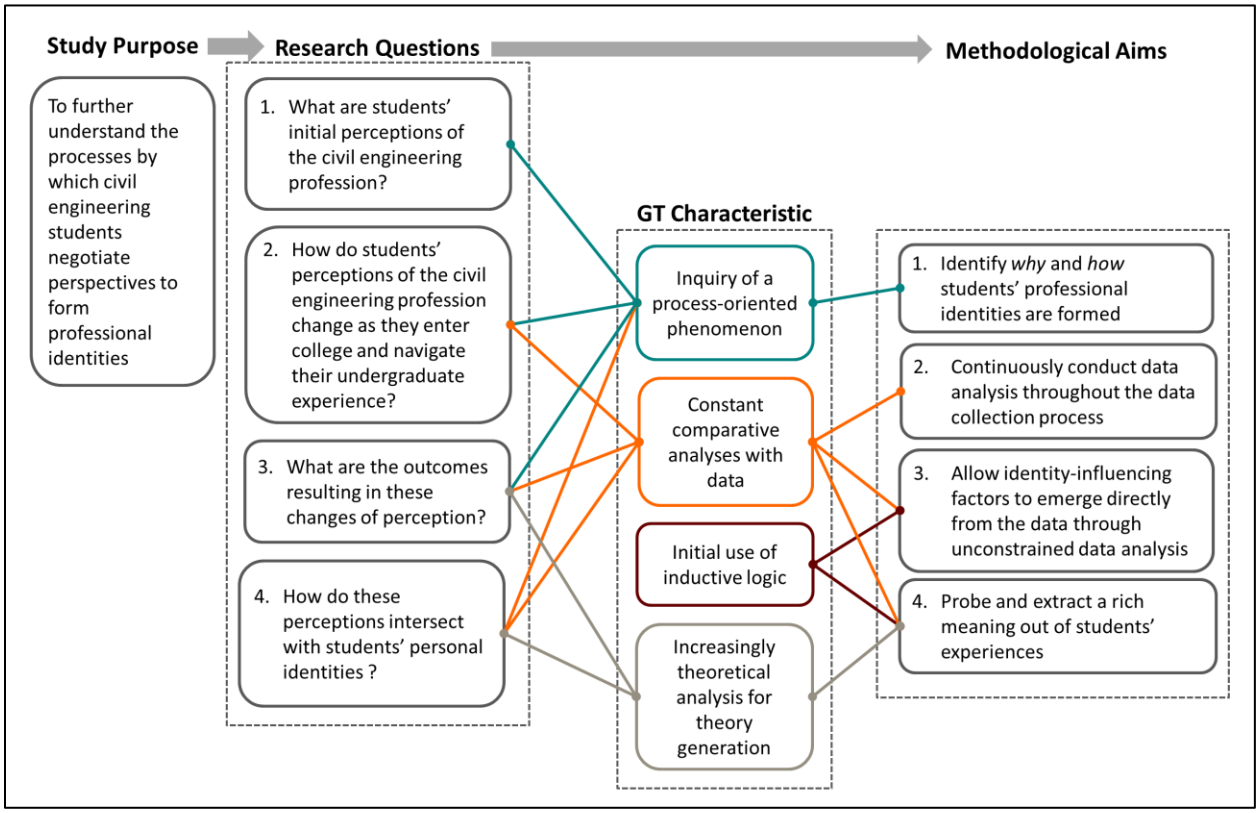



Figure 3.2: Relationships between Research Questions, Grounded Theory Characteristics, and Methodological Aims

### 3.4 Embarking on an Emergent Research Process

Grounded theory provides researchers with a systematic yet flexible research approach that is driven by the research purpose and underpinned by constant comparative methods and abductive reasoning (Charmaz, 2014). *Constant comparative methods* describe methodological iterations in which the researcher maintains continuous interaction with data during simultaneously-executed data collection and analysis (Bowen, 2006; Charmaz, 2014; Creswell, 2013). This approach is supplemented by *abductive reasoning*, an analytical technique that allows for researchers to account for anomalies in data by provoking the researcher to develop plausible explanations and explore all possible interpretations (Charmaz, 2008, 2014). Analysis began immediately upon

completion of the first interview and was iteratively conducted until a theory could be abstracted, as shown in Figure 3.3.

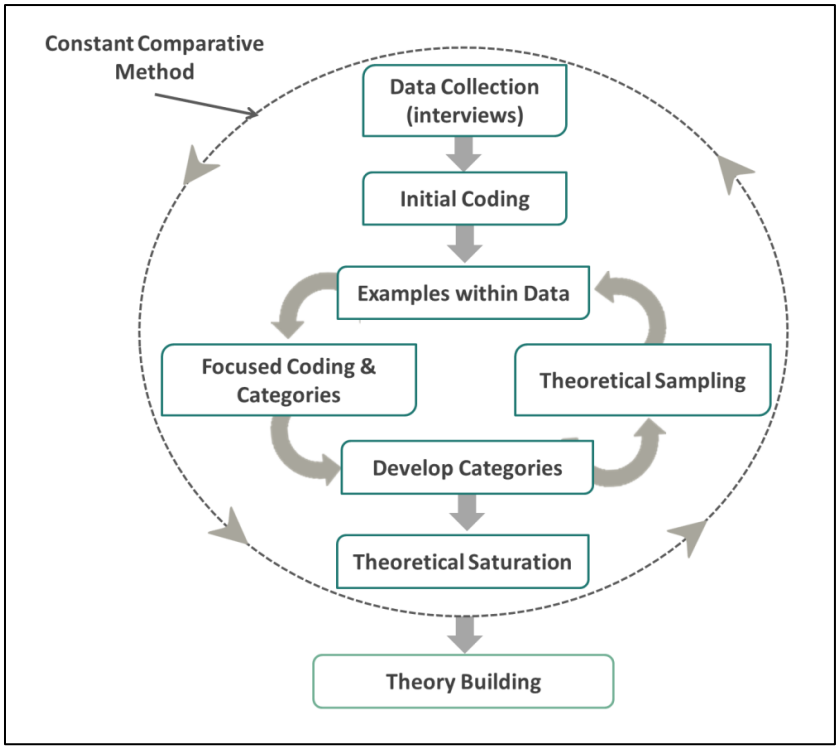



Figure 3.3: Constant Comparative Methods

This research approach has also influenced the ways in which I discuss my methods. Due to the iterative and emergent nature of the grounded theory research process, I deviate from traditional presentations of qualitative methods. Rather than discussing data collection and analysis as isolated methodological components, they are presented as an inextricable progression of inquiry that is iteratively abstracted throughout the duration of this study. However, to guide the reader through the varying levels of theory development and abstraction, I divide this discussion into two sections: descriptive research elements and emergent research elements. *Descriptive research elements* provide the reader with relevant background information and describe the necessary tools utilized to conduct this research (e.g., context, participants, and the initial interview protocol). *Emergent research elements* are methodological strategies that emerge as a result of continued research efforts (e.g., constant comparative methods, advancement through coding phases, and theory abstraction). In Table 3.1, I provide an outline of these sections and the order in which various topics will be discussed.

Table 3.1: Descriptive Outline of Methods Discussion

| Methodological Element | Description and Section No. | Section No. |
|---|---|---|
| Descriptive Research Elements | Context | Section 3.5.1 |
| | Recruitment and Participants | Section 3.5.2 |
| | Initial Protocol Development | Section 3.5.3 |
| | Interviewing Techniques | Section 3.5.4 |
| | Minute Interview Follow-Up Reflection Surveys | Section 3.5.5 |
| | Unit of Analysis | Section 3.5.6 |
| | Coding Strategies | Section 3.5.7 |
| | Sampling Techniques | Section 3.5.8 |
| | Memo-Writing | Section 3.5.9 |
| | Summary of Descriptive Elements | Section 3.5.10 |
| Emergent Research Elements | Iteration 1: Exploring Participant Experience | Section 3.6.1 |
| | Iteration 2: Identifying Negotiations of Identity | Section 3.6.2 |
| | Iteration 3: Moving Toward a Grounded Theory | Section 3.6.3 |
| | Iteration 4: Abstract Meaning to Enhance Cohesion | Section 3.6.4 |
| | Iteration 5: Identifying Theoretical Categories | Section 3.6.5 |
| | Iteration 6: Articulating a Theory | Section 3.6.6 |
| | Iteration 7: Achieving Theoretical Saturation | Section 3.6.7 |
| | Negotiating Equilibrium: Advancing from Outsider to Insider | Section 3.6.9 |

## 3.5 Descriptive Research Elements: Introducing Context and Research Tools

While the grounded theory methodology provides a systematic guideline for data collection and analysis, it also allows for methodological eclecticism in which researchers can pragmatically employ research tools most appropriate for achieving the research purpose (Charmaz, 2014). In this section, I introduce the reader to these tools as well as provide an overall description of the context in which this research took place. These research components are then used to conduct the emergent and constant comparative methods presented in Section 3.6.

### *3.5.1 Context*

Within the grounded theory tradition, the research context in which a study takes place provides a frame of inquiry that enables grounded theorists to discover, understand, and interpret emerging phenomena (Bowen, 2006). Participants in my study were undergraduate civil engineering students at a large land-grant university in the southeastern United States (LLG). This institution enrolls approximately 26,000 undergraduate students with 30% of those students

majoring in some form of engineering. A student wishing to major in the civil engineering program applies to LLG and is most commonly admitted into one of two academic tracks based upon the university's engineering application process. These students enter the university as either a general engineering (GE) or university studies (US) major. While both majors are allowed to enroll in general engineering courses during their first year at LLG, application into the civil engineering discipline is typically not permitted until the student completes their first-year courses. To apply to an engineering major, students receive an online application via email and are asked to declare their top three engineering program choices for enrollment. Entrance into a chosen discipline is primarily based on the students' grade point average (GPA) during their first year of college. Students achieving a 3.0 or higher are permitted into their top choice for engineering; those with a GPA below a 3.0 are then admitted to their ranked choices based on a variety of institutional factors such as the number of openings remaining in a chosen department and other GPA criteria. Upon being admitted into a specific engineering major, students are free to take the courses associated with that degree program. Those students who are not admitted into their top engineering choice will either take other classes to strengthen their GPA and reapply to the major or will decide to enroll in their second or third option.

The civil engineering department at LLG is relatively large with approximately 600 undergraduate students enrolled in the program. During their second year at LLG, civil engineering students are required to take an introductory course that provides an overview of the university's eight civil engineering sub-disciplines: land development, structural engineering, geotechnical engineering, water resources engineering, transportation engineering, construction management, building construction, and environmental engineering. The curriculum is designed in such a way that students are allowed to specialize in different sub-disciplines based on their interests. This specialization occurs as students take introductory courses early in their careers and supplement that instruction with electives throughout the remainder of their undergraduate experience. Introductory courses belonging to other sub-disciplines that are of less interest to a student are typically taken later on during the student's senior year. As a result, any junior-level course could potentially include students ranging from sophomore- to senior-level.

While the curricular structure of the civil engineering department at LLG was varied, this research site was particularly beneficial for my study due to this variation and rigorous

application process. Since I had not previously experienced this type of curriculum as a student or instructor, this lack of knowledge provoked me to ask students about their varied experiences in this environment. These conversations often led students to reveal new and unexpected information relevant to my study and informed my research questions in unanticipated ways. A further discussion of context-dependent impacts on the outcomes of this study is presented in Chapter 4.

### *3.5.2 Recruitment and Participants*

Aligning with traditional qualitative methods, the participants chosen for my study were purposely selected to best answer my research questions as informed by the sensitizing concepts guiding my work (Bowen, 2006; Creswell, 2013, 2014; Leedy & Ormrod, 2005). While civil engineering students at any academic level possesses the information and experience that will shed light on the professional identity formation of civil engineering students, I intentionally chose three groups of students, in particular to participate in this study. As discussed in detail in Chapter 2, I have chosen sophomore-, junior-, and senior-level students who have already enrolled in the civil engineering program. In summary of that discussion, this group of students was chosen to participate in this study for three reasons: 1) their first-hand experience of identity shifts as the exposure to their disciplinary work becomes increasingly more focused; 2) the transitional positions of these students within the curriculum (i.e., sophomore-level students are emerging as *civil engineering students* – as opposed to *general engineering students* in their first year – within the curriculum; junior-level students are emerging as *specialists* who are tailoring their education to a specific civil engineering track; and senior-level students are emerging as *early career professionals* as they transition into the engineering workforce); and 3) sophomore- and junior-level students are typically studied less that their freshman and senior counterparts in the field of engineering education research.

For the purpose of my study, I chose to recruit students from a variety of courses aimed at introducing students to technical content and professional development (e.g., licensure processes) that are fundamental to the entire engineering field and the discipline of civil engineering. In particular, I was interested in recruiting participants from courses that required students to learn industry-based skills and knowledge such as materials standards and other codes that are governed by federal, state, and local agencies. The topics covered in these courses

provided an interesting dimension to students' identity formation due to the incorporation of professional engineering tools within the engineering classroom, hence making these courses particularly relevant for this study.

To gain access to classrooms for recruitment purposes, course visit inquiries were sent via email to 11 total instructors, 9 of whom granted access to 10 sections within 7 courses. A summary of my course recruitment is shown in Table 3.2. Upon gaining course access, I visited with each class for approximately 5-10 minutes. During this in-person recruitment period, I described the nature of the research study, expectations, time commitment, and incentives. In addition to providing students with information regarding the research study, I also presented my role as a researcher and as a past civil engineering student as a means to build rapport with students (Charmaz, 2014; Creswell, 2014). Students were then asked to fill out a brief recruitment questionnaire (shown in Appendix C:). Those who anonymously volunteered to participate in the study were asked to provide their information and were contacted via email to schedule an interview.

Table 3.2: Summary of in-person recruitment courses and outcomes

| *Course Information* | | *Recruitment* | | *Class Level Breakdown* | | |
|---|---|---|---|---|---|---|
| **Name** | **Sections** | **P/R** | **%P** | **Soph.** | **Junior** | **Senior** |
| Statics | 1 | 0 / 2 | 0% | 0 / 0% | 0 / 0% | 0 / 0% |
| Measurements in Civil Engineering | 1 | 12 / 28 | 43% | 11 / 92% | 1 / 8% | 0 / 0% |
| Introduction to Environmental Engineering | 1 | 1 / 3 | 33% | 1 / 100% | 0 / 0% | 0 / 0% |
| Structural Theory | 2 | 7 / 21 | 33% | 0 / 0% | 4 / 57% | 3 / 43% |
| Reinforced Concrete Structures | 2 | 1 / 4 | 25% | 0 / 0% | 1 / 100% | 0 / 0% |
| Design of Steel Structures | 1 | 2 / 2 | 100% | 0 / 0% | 2 / 100% | 0 / 0% |
| Materials in Civil Engineering | 2 | 8 / 13 | 75% | 0 / 0% | 6 / 75% | 2 / 25% |
| Word-of-Mouth | --- | 1 / 2 | 50% | 0 / 0% | 1 / 100% | 0 / 0% |
| TOTALS | 10 | 32 / 75 | 47% | 12 / 38% | 15 / 47% | 5 / 15% |

P = participated in study, R = number of participants recruited

As shown in Table 3.2, out of the 75 individuals recruited, 32 participant interviews were conducted. Participant selection was primarily based on access (Creswell, 2014); all students who volunteered for the study and responded to interview scheduling requests were included in the data set. Because the number of volunteers did not drastically exceed the desired number of interviews appropriate for grounded theory research (Charmaz, 2014; Creswell, 2014; Leedy & Ormrod, 2005; Stern, 2007), further participant selection techniques such as maximum variation

sampling (Maxwell, 2013) were not necessary. Study participants consisted of a combination of sophomore-, junior-, and senior-level students in the civil engineering program at LLG. A list of these participants is presented Table 3.3.

Table 3.3: List of Participants

| ID No. | Pseudonym | Gender | Course Level |
|---|---|---|---|
| 007 | Anthony | M | Senior |
| 009 | Yvonne | F | Senior |
| 016 | Chad | M | Senior |
| 025 | Jimmy | M | Senior |
| 006 | Dave | M | Junior |
| 008 | Sid | M | Junior |
| 010 | Brandon | M | Junior |
| 011 | Cecilia | F | Junior |
| 012 | Meg | F | Junior |
| 013 | Jack | M | Junior |
| 014 | Corey | M | Junior |
| 027 | Charlie | M | Junior |
| 028 | Cameryn | F | Junior |
| 031 | Craig | M | Junior |
| 034 | Linda | F | Junior |
| 039 | Maggie | F | Junior |

| ID No. | Pseudonym | Gender | Course Level |
|---|---|---|---|
| 040 | Zane | M | Junior |
| 044 | Anders | M | Junior |
| 050 | Jared | M | Junior |
| 069 | Eleanor | F | Sophomore |
| 043 | Layla | F | Sophomore |
| 057 | Madison | F | Sophomore |
| 058 | Stevie | F | Sophomore |
| 064 | Macy | F | Sophomore |
| 065 | Lizzy | F | Sophomore |
| 066 | Shawn | M | Sophomore |
| 068 | Travis | M | Sophomore |
| 072 | James | M | Sophomore |
| 073 | Neil | M | Sophomore |
| 075 | Matthew | M | Sophomore |
| 076 | Amy | F | Sophomore |
| 077 | Maynard | M | Sophomore |

To align with prior research and acknowledge demographic impacts on identity formation (Capobianco, 2006; Faulkner, 2000; Walker, 2001), recruited students were asked to self-report demographic information in the minute reflection survey (further discussed in Section 3.5.5). While participants were not analyzed according these demographic characteristics, this information was used to provide context for student experience and further inform analytical procedures for developing a more encompassing theory. For this reason, participant demographics were collected and are noted, but do not serve as a basis for cross-demographic comparisons in this study. A demographic breakdown of participants is shown in Figure 3.4.

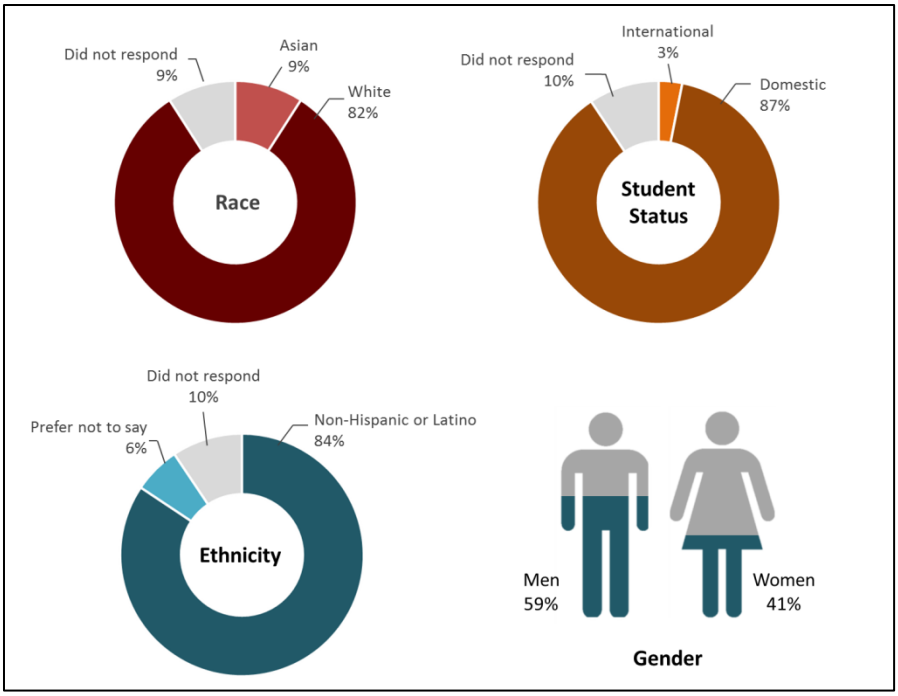



Figure 3.4: Participant Demographics

### *3.5.3 Initial Protocol Development*

The interview protocol for this study was intentionally designed to encourage discussion regarding identity formation without directly asking students about this topic. Additionally, by using this protocol, I sought to provide a safe space for students to talk about difficult or sensitive topics in an honest way. To accomplish this, interviews were conducted using a semi-structured interview protocol consisting of two components: a participant worksheet and the question protocol. The participant worksheet was used to frame the overall interview progression and provided students with a space to record their evolving definitions of civil engineering during three periods of their lives: prior to college, during college, and after graduation. Informed by my research questions, the question protocol was designed to include a temporal component (Charmaz, 2014) as well as gather detailed feedback about the evolving definitions on the worksheet. As students wrote down definitions and future plans based on different stages of their lives, they were asked about those definitions as guided by the question protocol. Specifically, students were asked questions regarding key experiences, people, and places that they felt contributed to those perceptions and how they have changed over time. The sensitizing concepts chosen for this study also served as a means to inform further questioning and

encourage rich, detailed accounts of student experiences relevant to the study. Both the participation question protocol and participant worksheet are included in Appendix D: and Appendix E:, respectively.

While the interviews were framed using this protocol guide, the content of these interviews were flexible and highly dependent on emergent trends observed in previously-conducted interviews and participant responses. This interview approach allows researchers to follow-up on unanticipated hints, areas of inquiry, and implicit actions while streamlining data collection as the study progresses (Charmaz, 2014). This constant comparative protocol development is further explained in Section 3.5.3.

### *3.5.4 Interviewing Procedures: Intensive Interviewing and the Critical Incident Technique*

Within the grounded theory tradition, data is typically collected in the form of 20-30 interviews (Creswell, 2013; Leedy & Ormrod, 2005; Stern, 2007), although other forms of data may be considered (Charmaz, 2014; Creswell, 2013). In this study, 32 semi-structured interviews were conducted, which yielded a total of 728 pages of transcript data. Each interview lasted approximately 60-90 minutes and was conducted using intensive interviewing (Charmaz, 2014) as framed by constructive interviewing (Charmaz, 2014) using the critical incident technique (e.g., Simmons, 2012; Sattler, Turns, & Gygi, 2009). *Intensive interviewing* is a directed qualitative interviewing technique utilized in grounded theory research (Charmaz, 2006, 2014). While similar to semi-structured interviews, intensive interviewing focuses the researcher on participant responses, often using their words to develop follow-up questions to further explore participant perspectives (Charmaz, 2006). *Constructivist interviewing* is an "approach that views interviewing as emergent interactions during which social bonds may develop" (Charmaz, 2014, p. 91). Aligning with the flexible nature of data collection within the grounded theory tradition, these interviewing techniques enabled me to tailor the interviews to specific experiences and to maintain participant voices throughout the duration of the study (Charmaz, 2014). By relying on detailed participant responses to open-ended questions, the aim of these interviews was to achieve an in-depth exploration of individuals' experiences and situations with an emphasis on participant perspectives, meaning, and experiences. From these interviews, I was able to create the social bonds with my participants necessary for building rapport and promoting a safe space for them to discuss sensitive, identity-altering experiences in an honest and open way.

To capture these stories as told by students, I utilized a well-established qualitative method known as the critical incident technique. The *critical incident technique* consists of a flexible set of principles useful for exploring accounts of significant experiences as a means to further understand resulting behavior (Flanagan, 1954; Grant & Trenor, 2010; Gremler, 2004; Simmons, 2012). Aligning with grounded theory research and the goals of this study, the focus of this data collection method is always upon the detailed accounts of participants' experiences that influence their perceptions of a phenomenon (Grove & Fisk, 1997). A critical incident is defined as an activity that makes a significant contribution, whether positively or negatively, to a phenomenon (Bitner, Booms, & Tetreault, 1990; Gremler, 2004; Grove & Fisk, 1997; Simmons, 2012). For the purpose of my study, a critical incident was defined as any incident, relationship, activity, event, or experience that a student perceived as influencing, either positively or negatively, their professional identity formation. All interviews were transcribed and field notes were taken to preserve the context and subtle implications of topics discussed by participants. Interview field notes were also used to supplement memo-writing and analysis in later phases of the study.

### *3.5.5 Minute Interview Follow-Up Reflection Surveys*

Approximately two days after the completion of an interview, participants were sent an online follow-up *minute reflection survey* via email. These surveys were designed so that students were able to complete them within five minutes and consisted of four multiple choice and one short answer question. The minute reflection survey is shown in Appendix F:. These surveys were implemented for four reasons. First, they enabled students to express any concerns or topics that they forgot or were too uncomfortable to discuss during the interview. Second, they provided students with the opportunity to give me interviewer feedback to inform subsequent interviews. Third, they allowed me to stay in contact with participants while interviews were not being conducted. Finally, these surveys also collected participants' demographic information as a means to streamline interviews and reduce impacts of stereotype threat (Steele, 2011). While these surveys proved useful for gathering participant feedback about their interview experience, they did not disclose extra information that would further theory development. Therefore, these survey responses were solely used to collect demographic data and were not included in the analytical phases of the study.

### *3.5.6 Unit of Analysis*

Corbin and Strauss (1990) established that the primary source of information for grounded theory research does not lie within the data itself; rather, data are translated into concepts that are combined and interpreted to develop an overall theory surrounding the phenomenon. Charmaz (2014) echoes this sentiment but also encourages researchers to consider context and language presented by participants to preserve participant meaning. Therefore, the *unit of analysis* for my study was defined as any single concept occurring within an interview, meaning that each interview could result in multiple concepts (Corbin & Strauss, 1990). Due to this form of data collection, it is imperative that grounded theorists record memos (discussed in Section 3.5.9) to capture their logic as data collection and analysis progresses.

While the 32 interviews served as the primary data source for my study, an interview in itself was not considered as the unit of analysis for this work. Rather, the emphasis of analysis resided within participants' conceptualizations of incidents, events, and happenings that are perceived as indicators of the phenomenon (Corbin & Strauss, 1990). That is, while many students did not recognize their experiences as identity-influencing, these descriptions were conceptualized into emergent actions according to the context and meaning as communicated by the student. These actions were then analyzed using the techniques as described in the following sections.

### *3.5.7 Coding Strategies*

A variety of coding strategies were utilized to move throughout the constant comparative process. These coding techniques, as outlined by Charmaz (2014), engage and involve the reader with participants' conceptualizations (i.e., the unit of analysis) during the initial coding phase at the beginning of analysis. This is to encourage researchers to "set up a relationship with your data and with your [participants]" (Charmaz, 2014; Star, 2007, p. 80). This coding process employs both emergent and *a priori* techniques, as shown in Figure 3.5, that grow increasingly abstract throughout the research process due to abductive reasoning (Charmaz, 2014). Emergent coding schemes include the initial and focused coding phases in which coding may be conducted in a variety of ways such as word-by-word, line-by-line, or incident-by-incident (Charmaz, 2014). *A priori* coding schemes can be iteratively implemented as a researcher develops a codebook to understand the phenomenon (i.e., axial coding) and organizes large amounts of data

(e.g., theoretical coding) (Charmaz, 2014). For example, Charmaz (2014) suggests utilizing the components of a grounded theory (e.g., strategies, causal conditions, etc.) to assist researchers in sorting data after the initial and focused coding phases to scope and streamline analysis toward theory development. Acknowledging that I shared a similar background with my participants, I utilized a combination of line-by-line and incident-by-incident coding techniques to separate myself from participants' views during early phases of the study and encourage my review of the data in a careful way (Charmaz, 2014).

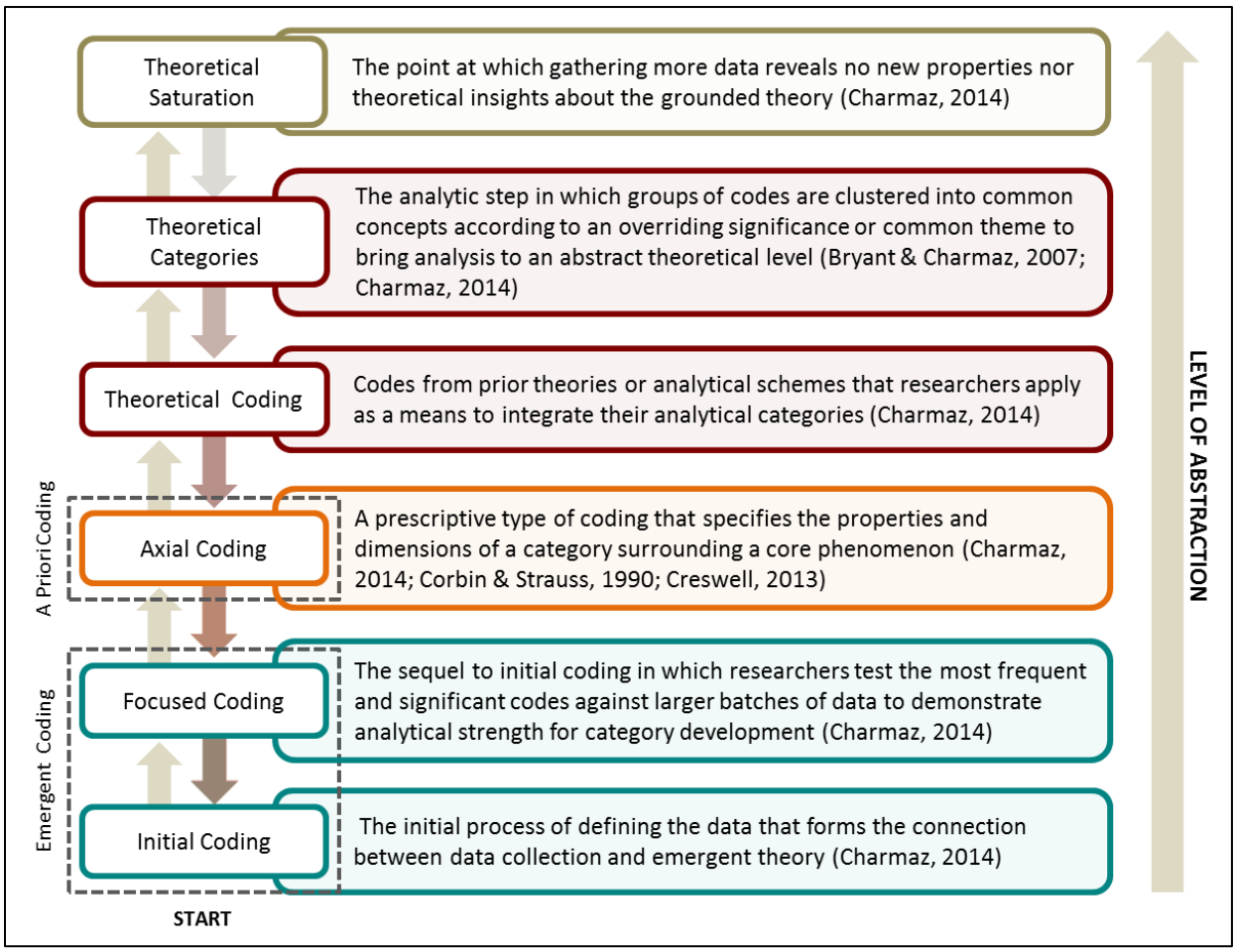



Figure 3.5: Description of Coding Phases

As demonstrated in Figure 3.5, each coding phase encompasses previous coding iterations (Charmaz, 2014). That is, focused codes are applied to newly-sampled data and those sampled in the initial coding phase; axial codes are also applied to newly-sampled data and those sampled in the focused and initial coding phases. Coding ends at the point at which theoretical saturation has

been achieved and no new findings emerge from the data. While Charmaz (2014) states that only two coding phases are necessary for grounded theory (i.e., initial and focused coding), I utilized all phases of coding throughout this study, as further described in Section 3.6.

### *3.5.8 Sampling Techniques*

As a researcher moves through each level of coding and analysis, they build on previously-collected data or sample from existing data to enhance theory development (Charmaz, 2014; Glaser & Strauss, 1967). In this particular study, I utilized a combination of data collection and sampling techniques that varied based on the level of analysis and the type of coding employed.

As shown in Table 3.4, the first sampling strategy was operationalized in the form of data collection that occurred during the first two analytical iterations (initial and focused coding techniques). All participant interviews were included in this first sample and enabled me to begin identifying gaps in the data and establish areas for further inquiry as I spoke with my participants. Based on these first iterations, study aims, and my prior knowledge of identity formation, I compiled interviews into three strata: 1) Stratum 1: contained obvious or significant changes in definitions of self or civil engineering, 2) Stratum 2: contained minor changes in definition of self or civil engineering, and 3) Stratum 3: contained a seemingly unchanged definition of self or civil engineering. For each of the remaining constant comparative iterations, I sampled data from different strata using an iterative, constant comparative approach (shown in Table 3.4). That is, the sample for each analytical phase included newly-selected interviews from the data set as well as the sample from prior iterations. For example, the sample size in Iteration 3 was 6 interviews; however, this iteration was also applied to the 11 interviews as analyzed during Iteration 2, and so on.

In Iteration 2, I sampled all 11 participant interviews from Stratum 1 to gain a broad sense and understanding of the types of identity shifts experienced by students (shown in Table 3.4). During this process, it was determined that one participant's experience was drastically different than her peers. In particular, this participant was an international exchange student who had only spent eight months in the United States education system at LLG as compared to her peers' minimal timeline of two years. While I do not aim to minimize her prior experiences, the drastic differences in her professional identity formation as compared to her peers prompted me to

remove her interview from further analysis at this time. I sampled 12 interviews from Stratum 2 for Iterations 3 and 4 (i.e., 6 interviews were sampled for each iteration) to deepen my questioning of the data using seemingly less-obvious identity shifts. In Iteration 5, I sampled from interviews in Stratum 3 as a means to identify negative cases and understand developing codes and categories from differing theoretical perspectives (i.e., identity saliency and discursive acts). For Iteration 6, I sampled all previously-analyzed interviews to check my analytical progress and compare the developing model across interviews. In Iteration 7, I analyzed the remaining 4 interviews sampled from Stratum 2 and 3 to test the model and tweak components of the theory. To further test my model, I reviewed all interviews one final time until I reached theoretical saturation. A summary of these sampling strategies is shown in Table 3.4. The purpose for each sampling strategy is further discussed in tandem with corresponding coding techniques in Section 3.6.

Table 3.4: Summary of Sampling Techniques

| Iteration # | Sample Size | Sample Characteristics | Stratum |
|---|---|---|---|
| 1 | 32 (all) | All interviews conducted with participants | All Strata |
| 2 | 11* | Interview contains obvious or significant identity shifts | 1 |
| 3 | 6 | Interview contains some identity shifts | 2 |
| 4 | 6 | Interview contains some identity shifts | 2 |
| 5 | 5 | Interview seemingly contains no identity shifts | 3 |
| 6 | 28 | All analyzed interviews to-date | All Strata |
| 7 | 4 + 28 (all) | Remaining interviews (one interview with some identity shifts, three interviews with seemingly no identity shifts) + all analyzed interviews to-date | (2, 3) +All Strata |

**One interview omitted from analysis = 31 total interviews analyzed*

### *3.5.9 Memo-Writing*

Throughout the duration of the entire data collection and analytical processes, I recorded notes in the form of *memos*. Memos serve as an informal place for grounded theorists to make comparisons among data, codes, and categories as well as provide an interactive space for a researcher to engage in conversation with themselves (Charmaz, 2014; Lempert, 2007). Within grounded theory, memos exist in three primary forms: 1) *initial memos* that capture the exploration and development of qualitative codes and provide direction for future data collection; 2) *advanced memos* that identify, trace, and describe the supporting assumptions, emerging

changes, and practical applications of categories throughout analysis; and 3) *integrated memos* in which the researcher begins to integrate codes, categories, and prior memos to enhance theory development (Charmaz, 2014).

In this study, I considered memos as both an analytical tool and as a strategy for enhancing research quality. Using the three types of memos identified by Charmaz (2014) as guide, I approached memo-writing from multiple perspectives. Initial memos were used to capture my thoughts and ideas as I explored participant perspectives, noting similarities and differences. One initial memo-writing technique that I developed, in particular, was the participant summary sheets. These summary sheets were completed during initial phases of coding as a means to summarize participants' key experiences and identity shifts. These sheets were designed to align with my research questions and prompted me to ask questions of the data and make comparisons across participants. Another initial memo-writing technique was in the form of hand-written field notes that were recorded before, during, and after participant interviews. I used these memos to capture my own feelings as a researcher, topics discussed during the interview and ideas for probing questions, and my thoughts after the interview was completed. Advanced memos were recorded in a large electronic document. This document provided me with a space to freely write reflective thoughts, ask and answer questions, and identify gaps in my data (Charmaz, 2014; Lempert, 2007). This form of memo was similar to an audit trail in qualitative research and was used to track evolving codes and categories and record research decisions and activities (Creswell & Miller, 2000). An example of an advanced memo is shown in Appendix G:. Integrated memos were hand-written on loose sheets of printer paper to allow me to draw, highlight, and sketch portions of an emergent theory. These were created for each participant and were kept with the hard copy of that participant's interview transcript. An example of this type of memo can be found in Appendix H:. Additionally, I used audio recordings of myself to capture my integrated memos. During theory abstraction, I found it was easier to talk about the ways in which multiple theory components were interacting with one another; therefore, I would record my thoughts on an audio recorder as a way to process information. These spoken memos were transcribed and stored with other memos. I stored my memos in two forms: 1) an electronic "memo bank" (Clarke, 2005 *as cited in* Charmaz, 2014) that included electronic files and multiple revisions of each memo, and 2) a research notebook that contained hand-written memos from interviews and spontaneous ideas.

### *3.5.10 Summary of Descriptive Elements*

Aligning with traditional forms of grounded theory, I conducted 32 semi-structured interviews with undergraduate civil engineering students enrolled at LLG; however, only 31 were considered for analysis. This number complies with the suggested number of 25-30 interviews within grounded theory literature (Creswell, 2013; Leedy & Ormrod, 2005; Stern, 2007). Participants were recruited in-person from chosen undergraduate civil engineering courses. Semi-structured interviews lasted between 60-90 minutes and consisted of two components: a participant worksheet and question protocol. The interview protocol was initially developed to foster discussion, promote emergence of unanticipated findings, and provide students with a safe space to discuss sensitive topics. To achieve this, techniques such as *intensive interviewing* (Charmaz, 2014), *critical incident* (Flanagan, 1954; Grant & Trenor, 2010; Simmons, 2012), and *constructivist interviewing* (Charmaz, 2014) were utilized to enhance the flexibility of the interview protocol. Participant worksheets also provided another form of data (Charmaz, 2014; Creswell, 2013) to supplement iterative analyses throughout the study. Completed interviews were sampled and analyzed using the coding strategies as outlined by Charmaz (2014) and supplemented by memo-writing. The unit of analysis was defined as participants' conceptualizations of incidents and events that were identified as indicators of the phenomenon. An in-depth description of the ways in which these research components were used to conduct the iterative, constant comparative methods is presented in the next section.

## 3.6 Emergent Research Elements: Employing Constant Comparative Methods

While grounded theory methods are operationalized through constant comparative methods and abductive reasoning, the use of and progression through these analytical techniques are based on the *theoretical sensitivity* (i.e., the prior knowledge about a particular topic) of the researcher as an emergent theory begins and continues to develop (Charmaz, 2014; Glaser & Strauss, 1967). As the researcher gains theoretical sensitivity, they begin to advance through the various levels of grounded theory using a variety of research tools such as those presented in the previous section. Table 3.5 summarizes the order of this research process and outlines the overall methods used to conduct each round of analysis.

Table 3.5: Master List of Employed Methods

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 1 | Identifying Definition Negotiations | 32 | Initial Analysis | • Initial memos | • Electronic versions of transcripts<br>• Field notes |
| 2 | Exploring Shifts in Identity | 10 | Initial Coding | • Line-by-line coding<br>• Advanced memos | • Coding using MaxQDA Software<br>• Electronic participant summary sheets |
| 3 | Identifying Critical Incidents | 6 | Focused Coding | • Axial coding<br>• Incident by incident<br>• Advanced memos | • Clusters from Iteration 2<br>• Hand-written participant summary sheets |
| 4 | Understanding Identity Negotiations | 6 | Axial Coding | • Coding for incident properties<br>• *A priori* coding for theory components<br>• Advanced memos | • Manual coding on printed transcripts |
| 5 | Identifying Identity Orientations | 5 | Theoretical Coding and Categories | • Coding for incident relationships<br>• Integrated memos | • Typed summary sheets, printed transcripts, hand-written summary sheets, electronic transcripts |
| 6 | Abstracting a Theory | 0 | Theoretical Coding | • Examining incident type<br>• Visualizing theory components<br>• Integrated memos | • Typed summary sheets, printed transcripts, hand-written summary sheets, electronic transcripts<br>• Sketching |
| 7 | Achieve Theoretical Saturation | 4 | Theoretical Saturation | • Examine developed model<br>• Integrated memos | • Typed summary sheets, printed transcripts, hand-written summary sheets, electronic transcripts<br>• Model image |

AI# = Analysis Iteration Number, Size = Sample Size

In this section, I describe the multiple iterations of data collection and abductive analysis throughout this constant comparative inquiry. In particular, I guide the reader through my emergent research process, explicate developing logic and advancement through the grounded theory coding phases, and demonstrate my evolving theoretical sensitivity throughout theory development. To add clarity to this discussion, I provide a brief summary of the key research tools employed and the outcomes yielding from this iterative analysis. While this analytical process may read as a linear progression, these phases are not distinct and, in many instances, overlap with one another as analysis becomes increasingly abstract. I conclude this section with an introduction of the grounded theory abstracted as a result of this analysis.

### *3.6.1 Iteration 1: Exploring Participant Experience*

During the initial phases of grounded theory analysis, the researcher defines the data that reveals and forms the connections between data collection and an emergent theory (Charmaz, 2014). Aligning with this grounded theory tradition (Charmaz, 2014; Glaser & Strauss, 1967), I began analysis while conducting my interviews, attempting to identify a variety of concepts (i.e., units of analysis) as related to identity formation, the phenomenon under study. During this iteration, I embraced my semi-structured interview protocol and let go of any speculation of a potential theory. I freely and openly immersed myself in the data and allowed them to guide my inquiry. In particular, I asked the following questions to steer my investigation during this iteration:

- What are the prior experiences of these participants?
- How do participants perceive civil engineering?

While the primary aim of this iteration was to learn about my participants and their experiences, I also wanted to identify areas for further exploration. Writing field notes and memos prior to, during, and after each interview enabled me to identify key topics discussed by participants, which influenced follow-up questions for subsequent interviews and data analysis. From this first iteration, I identified a minor interview adjustment and two areas for further inquiry: 1) the vast array of ways by which students perceived civil engineering both prior to and during college and 2) the application processes through which students entered LLG and the civil engineering program. A summary of the outcome, analytical approaches, and research tools utilized during this iteration are presented in Table 3.6.

Table 3.6: Summary of Methods for Iteration 1

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 1 | Identifying Definition Interactions | 32 | Initial Analysis | • Initial memos | • Electronic versions of transcripts<br>• Field notes |

AI# = Analysis Iteration Number, Size = Sample Size

### *3.6.1.1 Implementing Adjustments to the Interview Protocol*

One necessary interview adjustment was identified during this iteration due to participants' tendencies to self-assess their answers during the interview, as captured by a memo from April 18th, 2016 after an interview with Linda, presented in Figure 3.6.

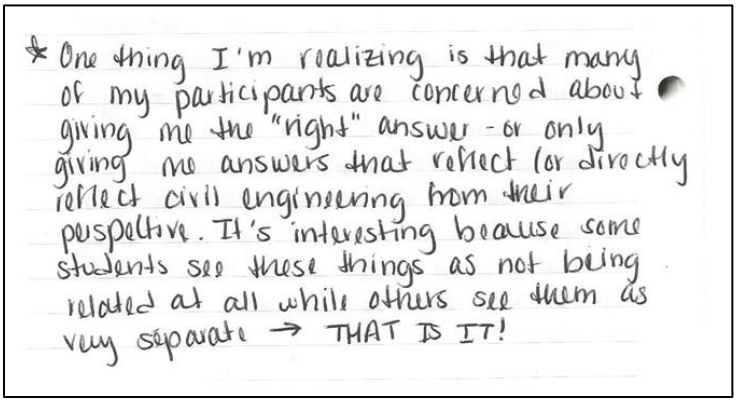



Figure 3.6: Initial Memo Noting Correctness of Answers

In this and other similar instances, students were very concerned about responding with the "right answer" to my questions, often asking me for feedback. For example, when asked to describe the land development sub-discipline of civil engineering, Layla expressed her own interpretations of the sub-discipline after which she asked, "I don't know if you probably know more about it than me? I was like, 'was that a quiz'?" Participants also apologized for shifting the conversation to other aspects of their lives. While Madison was explaining her parents' roles in helping her decide her engineering major at LLG,

> Madison: They were like, 'Do you want to put [industrial and systems engineering] as your second choice?' Because they really thought I was going to do [industrial and systems engineering] and I was like, not really. I really hated that programming class that they made me take [laughter].
>
> Interviewer: So, I'm going to transition us back a little bit.
>
> Madison: Sorry. I know I went off on a tangent.

While her rationale for not choosing industrial and systems engineering (ISE) shed light on her decisions for going into civil engineering at LLG, Madison did not perceive this as relevant information based on my response to continue the interview. In my conversation with Neil about important characteristics that engineers should possess, he talked about having a work life balance. He wanted to be proud of his work as well as support and spend time with his family. However, he expressed his uncertainty regarding the relevancy of this response:

> Like I said earlier, making sure anything I put in, I'm proud of. I put in a 110% effort. I feel like one value I should think of is not to get so caught up in work that I forget to have fun. I'm not sure that counts as a value or anything like that. *(Neil)*

From these observations, I realized that perceived levels of "responding correctly" was linked to the participants' ability to relate the topic to civil engineering and their knowledge of my background as a civil engineer. This encouraged me to continue to ask participants about multiple aspects of their lives. Using this form of inquiry enabled me to gain a deeper understanding of participants' lived experiences and the ways in which they were internalizing civil engineering. To mitigate this self-evaluation and promote a candid and natural dialogue with participants, I incorporated an introductory question at the beginning of the protocol in which I simply asked the student to tell me about themselves. This question immediately positioned the participant as the primary speaker at the start of the interview and situated their opinions and lived experiences as relevant sources of information. This allowed me to gain a deeper understanding of the development and integration of student perceptions of civil engineering as reflected in multiple areas of their lives.

#### *3.6.1.2 Identifying Interactions between Self and Civil Engineering*

Upon examining student backgrounds and perceptions of civil engineering, I began to identify another area of inquiry: the ways in which students described civil engineering at various points in their lives. While I initially introduced in this area of inquiry in RQ1, I began to explore this research question using an unanticipated approach. Upon asking participants to describe their prior-to-college perceptions of civil engineering in five words or less, most replied with traditional descriptors of the discipline (e.g., math, science, buildings, bridges). However, they

also offered more nuanced terms that highlighted variations among their diverse experiences. For example, Linda used the words "dad," "structures," and "construction" to define civil engineering prior to college. She then went on to explain that her father was a civil engineer and that he held a job in a construction firm. Similarly, Maynard used the words "regular" and "government" as inspired by his father's position as a civil engineer for a government entity. The term "regular" came from Maynard's childhood recollections of his father as having a routine, 40-hour work week. Other students utilized words to capture stereotypical engineering characteristics such as "dorky" and "antisocial." However, these students did not view these as derogatory phrases. Brandon embraced this definition as shown in our exchange, below.

Interviewer: What are five words you would use to describe the field or at least what you thought about it?

Brandon: […] So, I guess, brutal in high school. Math, science, physics… um, I heard all the dorky kids do it. So… dorky.

Interviewer: Do you consider yourself to be dorky?

Brandon: Of course I do. You know, at some point, I do. I get…I'm very fascinated by kind of…dorky things. You know? How things fit together and stuff.

Meg also embraced her cultural definition of "antisocial" in a similar manner. After being asked if she perceived herself as being antisocial, Meg responded, "I'm really an antisocial person. I'm definitely an introvert. And not only an introvert, but I definitely find that I need time to myself, often. I can be really outgoing, but it drains me really quickly if I'm doing that for any period of time." Other terms used by participants to define and describe civil engineering both prior to college and during college are shown in the Wordle™ in Figure 3.7. In this figure, the size of the word corresponds to the frequency in which it was used by participants to describe the discipline. As shown in the prior-to-college definitions, "math" was the most frequently used descriptor.

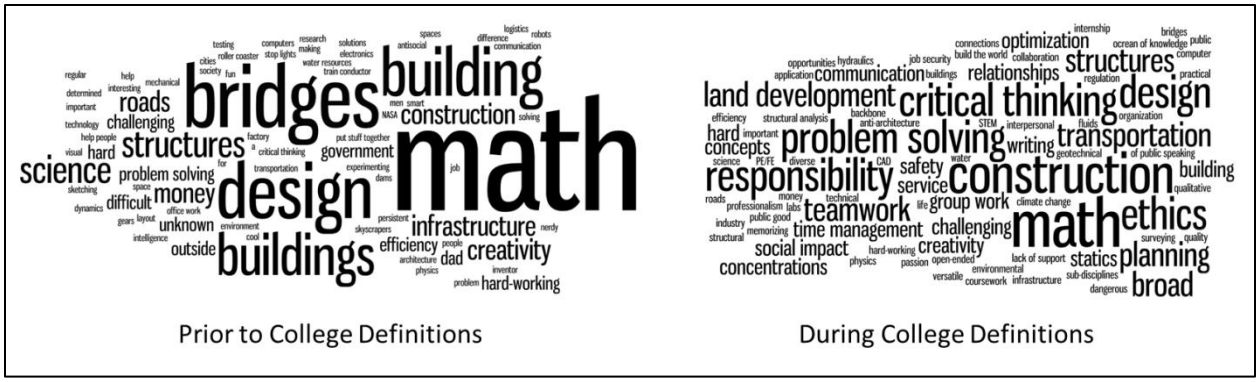



Figure 3.7: Summary of Participant Definitions

While "math" was also frequently used for during-college definitions, this term was used with a frequency similar to other terms such as "problem solving" and "critical thinking". During college, students began to move beyond traditional, topical descriptors of civil engineering to more abstract, skill-based terms. This shift demonstrated growth and an ability to better articulate the meaning of the field as students learned the language of the discipline. In some instances, students utilized the same descriptors for both phases of their lives and were able to elucidate differences in meaning. For example, Anders used the term "efficiency" to describe civil engineering both prior to and during college:

Anders: I put efficiency again; I still think that's important.

Interviewer: You still think about it. Do you think about it in a similar way, or has your view of efficiency changed at all from when you were younger?

Anders: I think some aspects of it are the same like energy efficiency. Then there's also cost efficiency, and cost efficiency is something I always thought about but not something I always understood just because I don't think I understood the magnitude of how much some things cost in civil engineering. That efficiency is really important. It's not just like, "Oh, we shouldn't build a bridge over a desert if you can build just a road on the ground," but it's like how do you minimize the cost for very complex projects where every little inch counts.

Other abstract terms students utilized to describe civil engineering were "ethics" and "responsibility". These descriptors caught my attention, in particular, due to the personal and professional implications that they held for students. In the middle of her interview while describing the ways in which she perceived civil engineering during college, Meg identified the social responsibility of civil engineers and was able to articulate the impacts of that realization on her day-to-day life as a college student.

> Meg: The meaning of [civil engineering] changes once you understand it better. I wouldn't just describe it as fun anymore because there's more responsibility to it than that. That's a good one, actually: responsibility. It's a huge responsibility to be a civil engineer. You're responsible for people's lives. That's one thing you don't realize until you get into school.
>
> Interviewer: How has that changed you as a person in terms of realizing that responsibility?
>
> Meg: It's definitely made me more careful with my calculations. I'm more likely to calculate everything out perfectly and make sure it's right rather than just being, "Oh, I think this is good." It makes me want to check my work back over.

As I discussed these definitions with participants, I found myself intrigued by their origins as well as their varied impacts on participants' identities, or definitions of self. In particular, I wanted to further explore how participants were interpreting their definitions of the civil engineering discipline and internalizing or applying them to their definitions of self. While Brandon and Meg aligned with civil engineering by using the same terms to describe themselves and the discipline, Meg also utilized her definition of the discipline to shape her everyday actions as a college student. Upon iteratively accumulating these observations, I realized the variety of interactions that were occurring between participants' definitions of self and the civil engineering discipline. I discuss my further exploration of this research area in Section 3.6.2.

#### *3.6.1.3 Considering Impacts of Institutional Structure on Definition of Self*

One final area of inquiry identified during this iteration included the application process by which students gained entry into the civil engineering program at LLG and the structure of the curriculum. As previously described in Section 3.5.1, this application process and curriculum structure was unlike any I had encountered during my academic career. Drawing from my sensitizing concepts, I wanted to further explore these institutional characteristics at both the university and program levels for potential impacts on definition of self. Throughout participant interviews, I asked participants about their life transitions as they became students at LLG and were accepted and entered into the civil engineering program. While I proposed that this institutional structure influenced how participants were becoming civil engineers, as inspired by my sensitizing concept of institutional identity (Gee, 2001), I could not consistently identify nor articulate these impacts. Therefore, further analysis of this topic was necessary.

#### *3.6.1.4 Exploring Interactions of Self and Civil Engineering: Identifying Directionality*

As a result of my on-going inquiry, I identified an existing, influential interaction between two primary concepts, or units of analysis: definitions of self and definition of profession. To continue my initial analysis, I wanted to further investigate the potential impacts of institutional structure on these definitions by asking the following questions:

- How do participant definitions of civil engineering influence or interact with their definitions of self?
- How does the university and program structure influence participants' definition of self?

Similar to my previous analytical approaches described in Sections 0-3.6.1.2 , I further analyzed field notes and initial memos that were recorded immediately prior to, during, and immediately after participant interviews. From these observations, I began to identify characteristics of the interactions existing between participant definitions of self and the profession and their institutional influences.

As I further explored participants' evolving definitions of the civil engineering discipline and the self, I realized that these interactions maintained a sense of directionality based on the context in which the interaction occurred. While some participants were actually using, or enacting

disciplinary definitions in their own lives (e.g., Meg's demonstration of "antisocial" and "responsibility" ), others imposed definitions of self onto the civil engineering discipline. Amy, for example, expressed that while she enjoyed civil engineering and wanted to stay in the field, she did not want the discipline to define who she was. For the remainder of this study, I refer to *directionality* as a dominant influencer that controls the interaction of a perception or definition, as related to the individual. Definitions controlled by perceptions of the individual are considered to maintain an internally-influenced directionality, while definitions controlled by external influencers such as learned content and interpersonal interactions are considered to maintain an externally-influenced directionality.

As I noted and observed this directionality in Amy and Meg, I identified other instances of directionality as participants described who they were and their perceptions of civil engineering across multiple aspects of their lives. Drawing from my prior knowledge of social identity theory (Tajfel, 1974), I noticed that some participants would align themselves with other individuals in their major or in the engineering field while others would not. This dichotomy was demonstrated through the following quotes by Yvonne and Macy:

> […] we're all struggling with the same thing and we're all going down that same civil engineering road. *(Yvonne)*

> […] I really don't like female engineers. Some of them are kind of mean. They're very competitive. I'm a competitive person, but I'm also very like… if you do something really good for yourself, I'll be the first person to be like, 'Oh my gosh, that's great! Congratulations!' But some girls aren't like that […] *(Macy)*

In Macy's quote, she discusses how she did not get along with the other women in civil engineering, and was able to identify a distinguishing characteristic (i.e., competitiveness) that separated her from her female civil engineering peers. Yvonne, on the other hand, maintained a more unifying message by revealing her struggle with civil engineering courses while acknowledging that her peers were encountering the same issues. Not only were observations such as these recorded regarding others in civil engineering, but participants also maintained this internally-influenced directionality while comparing their childhood backgrounds to the discipline, itself.

> Um, I think since literally over half my family is engineers that I always kind of knew about the field and saw the applications. I don't know […] when you're raised with engineers and by engineers you just kind of think like one. *(Cecilia)*

As demonstrated through the quote above, Cecilia aligned herself with civil engineering via the inherent trait of *thinking like an engineer* as a result of growing up with engineers in her family. Therefore, when choosing a major for college, Cecilia already felt confident that engineering was what she wanted to do. Jimmy, in contrast, separated himself from the civil engineering discipline during high school. Upon expressing his disinterest in civil engineering and engineering work, he was pressured to go into engineering, or another related field, by his parents as he entered college:

> So, we got those out of the way and a lot of people ended up dropping out of the programs because like all of those classes were incredibly tedious. Like, you'd be doing like four hours of just unit conversions or something, you know, something that seemed like pedantic and like that. Something that was repetitive, tedious. And then you realize that the majority of things are repetitive and tedious. But, I guess where I'm going with this is like, it kind of pushed away from engineering, and then I got back into it just because I was kind of forced into it. *(Jimmy)*

He further explained that his parents' pressure came from his family's Asian culture in which law, medicine, engineering, and other STEM fields are highly valued professions. While Cecilia's background fostered her interest in civil engineering, Jimmy felt as though he wanted to separate himself from the field due to his initial perceptions of discipline-related work.

As I identified and began to further articulate the directionality of the interactions occurring between definitions of self and civil engineering, I also realized these interactions were happening at different points throughout participants' lives. I observed directionality for Meg and Yvonne during their time in college; for Jimmy and Cecilia, observed and traced back their directionality to prior to college. My current approach exploring interactions as isolated events throughout participants' lives revealed interesting and nuanced insights about the interpretation and internalization of the civil engineering discipline. However, it became apparent that these

isolated interactions could not reveal further insights of participant identity formation at a holistic level; therefore, a more integrative analysis that combined these concepts was necessary.

#### *3.6.1.5 Shifting to a Gestalt Approach: Examining Longitudinal Interactions*

A gestalt approach linking the dynamic interactions of evolving disciplinary definitions and sense of self was inspired by a memo recorded during an interview with Jimmy. This memo is shown below in Figure 3.8.

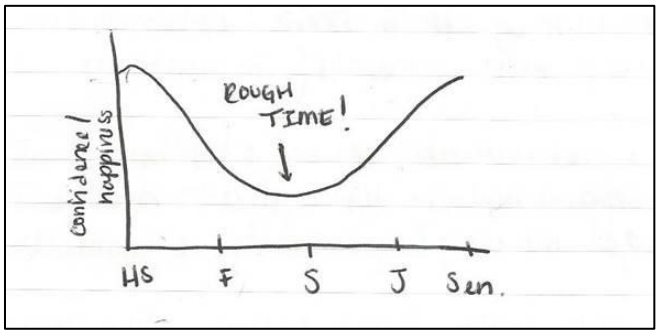



Figure 3.8: Recorded Memo Capturing Jimmy's Confidence through College

During this conversation, Jimmy explained significant shifts in his character due to his transition into and experiences during college. Upon graduating high school, he described himself as being "cocky," anticipating that college was going to be "easy" and "not a problem." However, upon entering college as a math major, Jimmy realized that he was not at the top of his class, nor were his courses easy. He dropped two classes during his freshman year, concerned that he would not be able to compete with the other students throughout his academic career. Prior to his sophomore year, he revisited the idea of majoring in engineering. After being rejected from the mechanical engineering program and a bad experience during an industrial and systems engineering internship, Jimmy was accepted into civil engineering, his third, off-the-cuff major choice. Due to his low grade point average and realizing the financial responsibilities of paying for one's own education, Jimmy was unable to apply to another engineering major, as he explains:

> [Paying for my own schooling] plus not a great freshman campaign, you get humbled a lot, you know? Like I was having a bit of a rough time, so after a certain point, I was locked in. I was like, "I'm already in Civil. My GPA is too bad

> to transfer out. I can't do anything else, so I have to ride it out." So, I just kind of rode it out until... you know, I'm here now. I have a job, graduating, and I'm really happy where I am. *(Jimmy)*

At the point of the interview, Jimmy felt very happy with the direction in which his life was going and was appreciative of the prior struggles that he faced as an undergraduate student. As a senior civil engineering student on the cusp of graduation, Jimmy was able to holistically reflect on his experiences in such a way that prompted me to re-frame my thinking. Previously, I was exploring identified research concepts as isolated interactions with unique contexts, causes, and outcomes. However, Jimmy's ability to thread all of his experiences into one cohesive narrative encouraged me to broaden my perspectives as a researcher and explore how participants' continuously-evolving definitions of self and discipline propagated and influenced one another. This analytical abstraction is depicted in Figure 3.9.

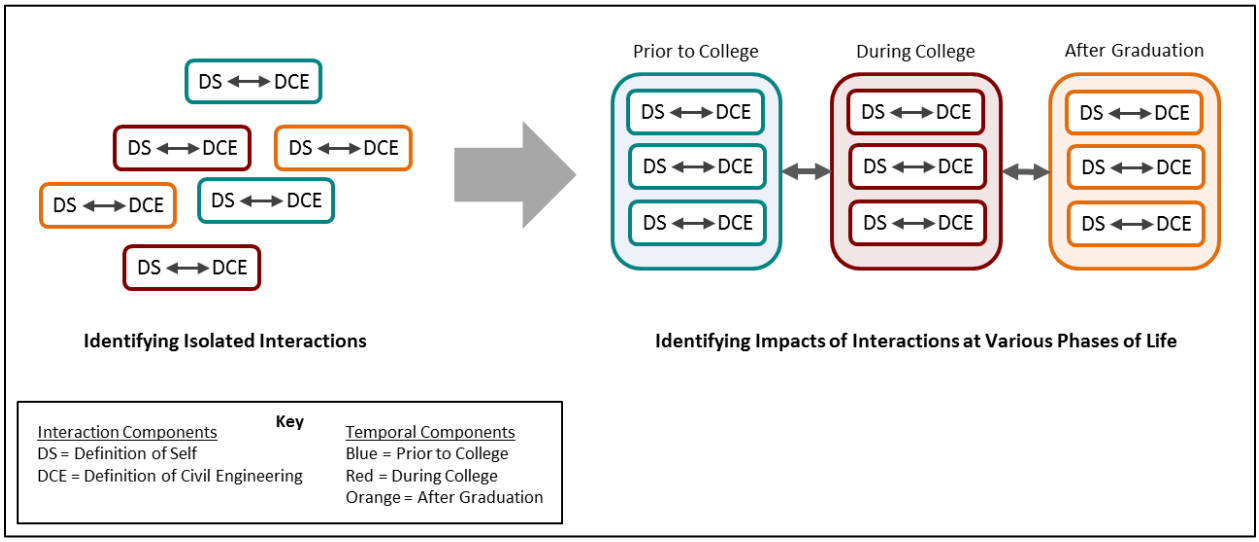


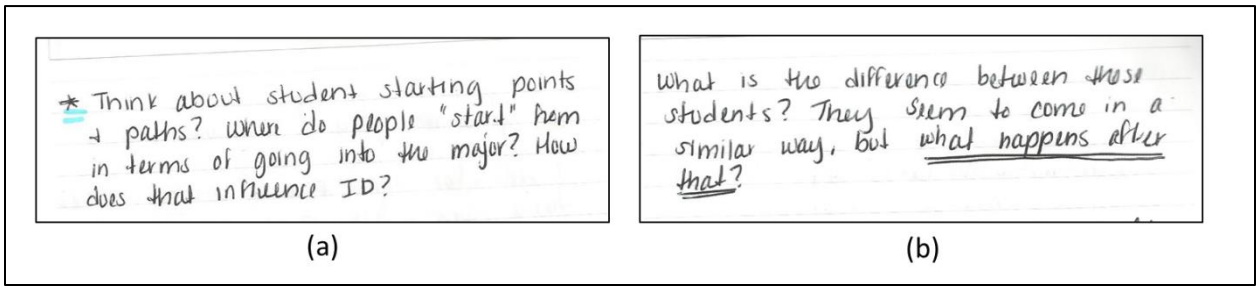

Figure 3.9: Conceptual Framework to Capture Continuously-Evolving Definitions

This approach was also bolstered by another interview with Yvonne, who was also weeks away from graduation. In this interview, Yvonne discussed the different strategies that she utilized in her attempt to determine her future career plans and aspirations as she grappled with her own definitions of self and civil engineering:

> So I did a lot of research in school because I wanted to go to grad school when I was trying to figure out what I wanted to do. But I guess before I came to college I

> was like, 'oh I want to help people and do civil engineering,' and now I'm just like, 'I want to get a job in civil engineering.' I guess the helping people side is just not a priority anymore… I guess, sort of. It's just not as realistic as I thought. It was just… you have to build more experience first before you actually do anything. *(Yvonne)*

Upon completing Yvonne's interview, I realized that I wanted to know more about participant pathways as they moved into and through their civil engineering career. This note is captured in a memo recorded immediately after Yvonne's interview (Figure 3.10a), and was recorded again after my interview with Linda (Figure 3.10b). Acknowledging that each participant may embark on a unique path to and through civil engineering, I also wanted to identify potential commonalities that could transcend context and promote the development of an emergent theory. To accomplish this, I needed to be able to identify and articulate the characteristics of the interactions existing between participants' evolving definitions of self and the civil engineering discipline. I continue my discussion of this analysis in Section 3.6.2.




(a) (b)

Figure 3.10: Pathways Field Notes from Interviews with Yvonne (a) and Linda (b)

*3.6.1.6 Shifting Analytical Focus Away from Institutional Impacts*

Upon learning about the application process and the curriculum outline of the civil engineering program at LLG, I wanted to further explore the ways in which this institutional structure could potentially impact students' emerging professional identities. Throughout the interviews, I began to ask participants about the transitional phases during their lives, particularly those relating to their application process to get into the civil engineering program at LLG. This investigation yielded unanticipated results. While I proposed that some students would mention difficulties navigating this institutional structure, most students were able to move throughout this process with minimal impact, as captured in a quote by Cecilia:

> I was like, “I know I want to do civil engineering. I already chose it by my awesome process,” so this was like, “Why am I [attending these seminars]?” Then I knew I was going to get above a 3.0, so I knew I was automatically going to get what I wanted. I was never worried about it or anything like that. So then, it was just like a survey I filled out at the end of my freshman year. *(Cecilia)*

Other students, such as Corey, provided more background information regarding the ways in which students are prepared for major application during their freshman year. During that time, Corey felt a pressure to do well in his freshman courses out of fear that he would not be allowed to choose his own major. Upon achieving the minimum 3.0 GPA for major application, he was also able to directly enroll in the civil engineering program.

> From the beginning of freshman year, they tell you that you have to have a certain GPA to be guaranteed [your desired major] and make sure that you get [the GPA] because if you don't, who knows what you're going to get and blah, blah, blah. So they really emphasize that from the get go. So, I was like, “I really need good grades, I really need good grades,” and I had freakin’ killer grades. I think I had a 3.7 at the end of my freshman year, so I was guaranteed wherever I wanted. So, I was like, "Okay, so… civil." And then I listed other choices but civil, number one and I got into it. So, yeah… so that's how you get into it. *(Corey)*

From this perspective, Corey focused his efforts to get the grades that he needed in order to freely enroll in civil engineering, the major of his choice. Due to the similarities in participants’ responses to this inquiry and the institution’s seemingly minimal impacts on definitions of self at that time, I decided to temporarily shift my analytical efforts elsewhere. However, I recorded this topic as an area for further consideration as analysis progressed and theoretical components began to emerge.

#### *3.6.1.7 Iteration 1 Summary*

During these early phases of this grounded theory analysis, I identified two areas for further inquiry: 1) the influential interactions existing between participants’ definitions of self and profession and 2) the potential for institutional impacts on participant definition of self via university and program structure. While my exploration of the interactions between participant

definition and profession yielded further areas of inquiry, my examination of potential institutional impacts on participant definition revealed no impacts of institutional identity on participants' definitions of self and profession.

Upon identifying a variety of interactions among participants' definitions of self and the civil engineering discipline, I gained a greater understanding of their properties. By exploring individual interactions as isolated events occurring throughout individuals' lives, I found that these they maintained internally-influenced and externally-influenced directionalities. However, during this portion of the inquiry, I was still unable to integrate these concepts and interactions to capture participants' identity development at a holistic level. To explore this longitudinal development, I expanded my analytical lens to not only examine interactions between definitions of self and discipline at each occurrence, but also to investigate the longitudinal influences of these concepts on one another as they evolved over time. While this gestalt approach did not immediately yield observable trends that could be used to integrate these definitions of self and discipline into a cohesive narrative of identity development, I realized that I needed to dive back into my data and further explore potential commonalities via nuance within each interaction. I continue my discussion of this analysis in the next section.

### *3.6.2 Iteration 2: Identifying Negotiations of Identity*

During Iteration 1, I identified existing *definition interactions* between participants' definitions of self and the civil engineering discipline and realized their lasting impacts on one another as they evolved throughout participants' lives. However, despite these analytical advancements, I was unable to articulate how these definitions could be integrated to holistically capture professional identity formation across participants. As a means to gain a more abstracted understanding of these interactions, I decided to revisit my transcripts and explore, in detail, the characteristics of identity-related concepts. Throughout this iteration, I utilized the following question to guide my analytical process:

- What are common characteristics of concept interactions that influence identity development across multiple participants and contexts?

Aligning with its use in Iteration 1, I refer to *context* as a specific situation in which a definition interaction occurs during a participant's life. This is not to be confused with the grounded theory

term *context,* which refers to an environment in which a grounded theory is situated (Charmaz, 2014). To answer this question, I resorted back to the basic processes of grounded theory analysis: initial coding, line-by-line coding of participant interview transcripts. Initial codes are useful at this phase of analysis because they may be assigned to the data using *in vivo* codes (i.e. codes consisting of participants' terms) or gerunds (i.e., codes to capture participant actions) (Charmaz, 2014; Creswell, 2014). Now aware of definition interactions and their influences on one another throughout participants' lives, I sought to gain an understanding of the nuance of these interactions as a means to identify broader trends that could be abstracted during later iterations of analysis. In essence, this iteration served as another exploratory analysis to gather more information about my participants and their experiences. A summary of this iteration is shown in Table 3.7.

Table 3.7: Summary of Methods for Iteration 2

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 2 | Exploring Shifts in Identity | 10 | Initial Coding (Round 2) | • Line-by-line coding<br>• Advanced memos | • Coding using MaxQDA Software<br>• Electronic participant summary sheets |

AI# = Analysis Iteration Number, Size = Sample Size

#### *3.6.2.1 Understanding Definition Interactions through Initial Coding*

For this analysis, I sampled 11 interviews from Stratum 1. Participant interviews were sampled from this stratum because they contained obvious or significant changes in definitions of self or profession. As such, these interviews enabled me to capture a wide variety of instances in which participants described changes in their definitions of self and civil engineering. For example, Jimmy initially perceived civil engineering as being fairly non-technical and unimportant due to its low-paying status as compared to other engineering disciplines:

> I never, honestly, until about like 3 years ago, I didn't really think of going into civil. I always thought about going into something a little bit more technical because one of the things I thought, at least when I was younger, is that it's a little bit more blue-collar than other engineering is; what a lot of people think. When people want to joke around about civil engineering, they always call it 'close

> enough' because the technical ability is ... I mean, it's obviously necessary to an extent but, there are a lot more careers and a lot more opportunities out there if you're not so strong, technically. And you can get away with construction management and things like that. You won't have to be… you don't have to kill it in dynamics to be able to run Excel and do a few spreadsheets and talk to people. So, when I was younger, I kind of equated technical skill to money, and that was one of the things. *(Jimmy)*

This conversation was also significant to the rest of Jimmy's narrative. At the time of the interview, Jimmy was less than a month from graduation and was happy and excited to begin his career in civil engineering at his new job. Therefore, I was intrigued by the fact that he maintained a negative perspective of civil engineering at the start of his college career. While Jimmy's perceptions of the technicality and prestige of the civil engineering field shifted throughout his undergraduate career, Macy's perceptions of who civil engineers are and who could become civil engineers also shifted. When asked to describe a typical civil engineer, Macy replied:

> Um, my mom's boss, who I love dearly. His name is Freddy. He's a great guy. He is like…well, now he's old. But he's white, male, wears glasses, bald head, always very put together, kind of nerdy…that sort of thing. Definitely not me. Like, I would never say engineer… [points to herself] me.

Later in the interview, I asked Macy about her decision to go into engineering, even though she did not necessarily see herself as one when she was younger. Macy explained:

> I have just realized…well, I've also had professors confirm it too, which definitely helped. […] Um, but I think just by doing it and realizing that I can do it and that I can be good at it has made me be like, "No, I am an engineer and that is what I want."

While Jimmy's perception of the entire field of civil engineering had changed, Macy went from viewing people similar to her mom's boss as being civil engineers to perceiving herself as a civil engineer. Other students in this sample experienced similar definition-altering events throughout their lives that included topics of disability, gaining emotional and academic support, academic

performance, and career plans. For this reason, I chose this sample as a means to capture a vast array of experiences and the contexts that promoted shifts in definitions of self and the civil engineering discipline.

Initial codes emerged from a line-by-line analysis of participant interviews using descriptors that simultaneously and succinctly summarized the concept or action performed within each segment of data. To complete this initial coding phase, I utilized the MaxQDA™ coding software as a means to monitor emergent code type, number, and frequency. Figure 3.11 provides a screenshot of this coding process in the MaxQDA™ program.

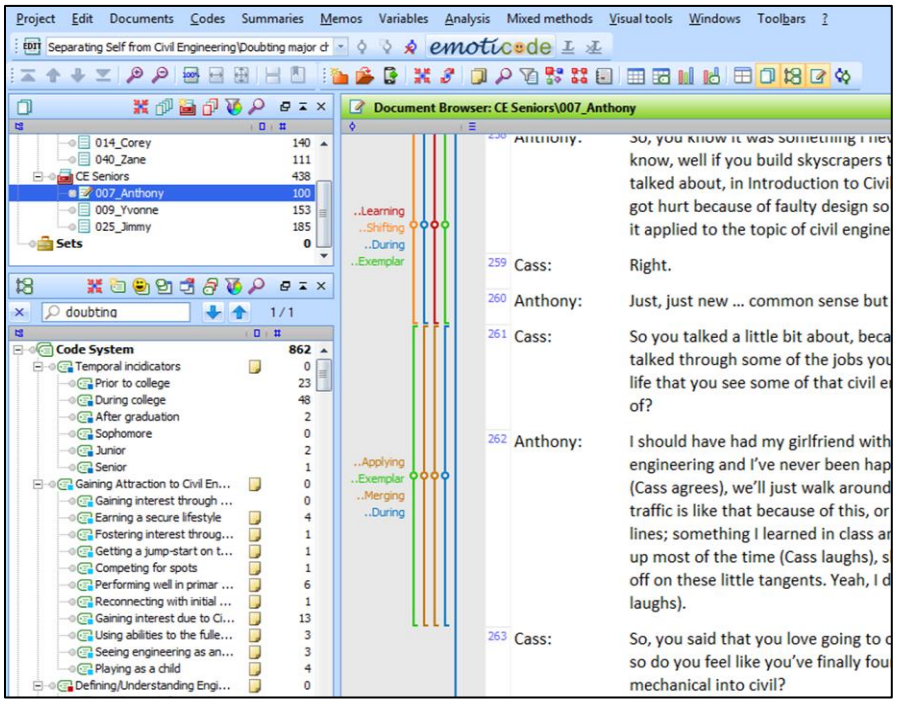



Figure 3.11: Screenshot of Coding Process in MaxQDA™ Software

From this initial coding process, approximately 90 codes were identified for six participants. Codes were then clustered into 12 categories based on similar actions performed during a participant's life and contribution to an outcome. For example, *taking ownership of work*, *correcting others' perceptions of civil engineering*, *legitimizing self to others*, and *being happy in the present* were all observed to contribute to the outcome of *connecting self to civil engineering.* Another identified category was *iterative comparison*, which consisted of codes such as *comparing desire, interest, and skill*; *articulating non-engineering characteristics*; *identifying*

*contradictions to perceptions of engineering*. Figure 3.12 presents a truncated view of this clustering process. Emergent categories with example codes are presented in Table 3.8.

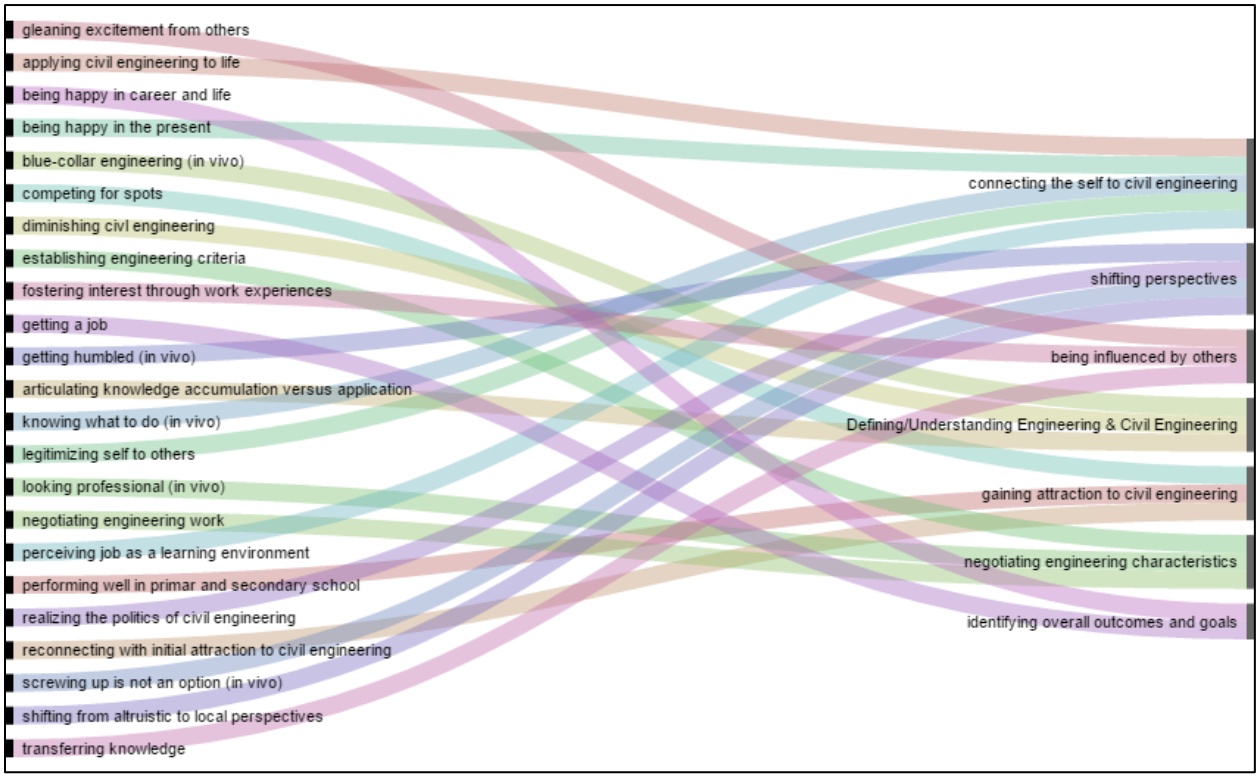



Figure 3.12: Formation of Initial Clusters

Table 3.8: Emergent Categories from Initial Coding

| Category Name | Description | Example Codes |
|---|---|---|
| Gaining an attraction to civil engineering | A category containing codes that discussed how participants became interested in engineering or civil engineering. | • Getting a jump-start on curriculum<br>• Competing for spots |
| Defining/understanding engineering/civil engineering | A category that captured how participants came to know engineering and civil engineering. | • Reflecting on misconceptions<br>• Identifying societal implications |
| Negotiating engineering characteristics | A category that captured how participants negotiated their perceptions of engineering and civil engineering. | • Negotiating engineering work<br>• Establishing engineering criteria |
| Iterative comparison | A category containing codes that captured how participants compared themselves to the civil engineering discipline and vice versa. | • Presenting yourself (in invivo)<br>• Comparing desire, interest, and skill |
| Connecting the self to civil engineering | A category containing codes that described participant strategies used to connect themselves to civil engineering (and vice versa) and the feelings resulting from that connection. | • Taking ownership of work<br>• Applying CE to life |

Table 3.8 (Continued)

| Category Name | Description | Example Codes |
|---|---|---|
| Separating the self from civil engineering | A category containing codes that captured the ways in which participants separated their own skills, values, and behaviors from those traditionally belonging to the civil engineering profession. | • Remaining undecided<br>• Doubting major choice |
| Shifting perspectives | A category containing codes that captured the ways in which participants' perspectives or conceptions of civil engineering shifted as they learned about and engaged in the profession. These shifts could occur holistically regarding their perceptions of the field of engineering or be more localized to the participant themselves. | • Shifting from altruistic to local perspectives<br>• Realizing roles |
| Managing life as a college student | This category captured those individuals who influenced participants' professional identity formation and the contexts in which they are being influenced. | • Getting through *(in vivo)*<br>• Enjoying learning |
| Identifying overall outcomes and career goals | A category capturing instances in which the participant discussed or identified their overall outcomes or goals for career or life. | • Being happy in career and life<br>• Getting a job |
| Being influenced by others | A category containing codes that captured how participants handled themselves within the educational context of college. Codes in this category captured multiple strategies that participants employed to be successful both academically and professionally. | • Relating to others<br>• Acquiring passive validation from others |
| Navigating life decisions and plans | This category captures the ways in which students navigate making their life decisions and plans based on a variety of contexts. | • Mitigating pigeonholes<br>• Going with the flow |
| Miscellaneous | A category consisting of codes that captured items that I coded, but did not fit into any existing categories. | • Giving advice to past self<br>• Credentialing |

As shown in the examples above, codes were clustered into categories to capture broad, overarching actions that exhibited an encompassing meaning of its constituents. Codes included within the *miscellaneous* category were kept during this iteration, as they could potentially be used in later, more abstracted analyses. These categories and their subsequent codes were applied to the four remaining participants in this sample while allowing for new codes to emerge. Codes with similar meaning were also combined to streamline the coding process. For example, the *establishing career alternatives* code was merged with the *analyzing future options* code under the *navigating life decisions and plans* category. While these codes were context-dependent, they conveyed very similar meanings that could not be easily separated, thus mitigating the need for two separate codes. This coding decision is demonstrated in a quote by Zane in which he simultaneously analyzes his future options while identifying and establishing potential career alternatives within the civil engineering field:

> I couldn't see myself doing [computer aided drafting] all day and the calculations all day. I could do it better than I could do structures, but it's still not what I want to do; and I've started to realize that within the past three weeks or so. So, that's when I've started to realize that construction engineering and management makes more sense, and then I found something called BioBuild, which I can do within construction engineering that's focused on bio-mimicry for buildings and communities in general; and so, I've found that that's more of what I have a passion for… sustainability and helping people in general, but also for a Ph.D. so that will be really helpful. *(Zane)*

Upon combining these codes and categories, a temporal component emerged that enabled me to organize my data to loosely depict participant pathways into and their evolution throughout the undergraduate civil engineering experience. I further discuss this data organization in the next section.

#### *3.6.2.2 Identifying Strategies through Coding Abstraction*

As I established an initial list of codes and categories capturing the interactions of participants' definition of self and the civil engineering discipline, I realized that a temporal component was emerging that would help me better organize my data. Some categories, such as *gaining attraction to engineering/civil engineering* and *managing life as a college student*, could be easily identified as taking place prior to college and during college, respectively. However, the remaining categories, such as *iterative comparison* and *shifting perspectives* (shown in Table 3.8), could occur over multiple periods of participants' lives. Due to the ambiguity of these categories, I "questioned my data" (Charmaz, 2014) by comparing codes, categories, and the interactions they represented. To aid in this questioning, I referred to my pathways memos (previously shown in Figure 3.10a) and the *participant summary sheets* (as discussed in the *Descriptive Research Elements* section) that were completed during this initial phase of coding. These summary sheets were designed to align with my research questions and bolstered my thinking about broader relationships and comparisons among my codes and categories across participants. While summary sheets consisted of six writing prompts, I included the three prompts that fostered my questioning during this iteration, below.

1. How have the students' conceptions of civil engineering changed or shifted?
2. What are the outcomes that resulted from these changes?
3. How may these topics be connected to those presented by other students?

From my pathways memo and participant summary sheets, I began to further cluster and relate codes and categories to capture an initial process of identity formation throughout my participants' lives. This analytical approach served as a continuation of my analysis during Iteration 2, in which I began to relate interactions across participants' lives. However, in this iteration, I let go of these time constraints and ordered my data based on the type of action performed by my concepts. The conceptual process of this analytical approach is shown in Figure 3.13.

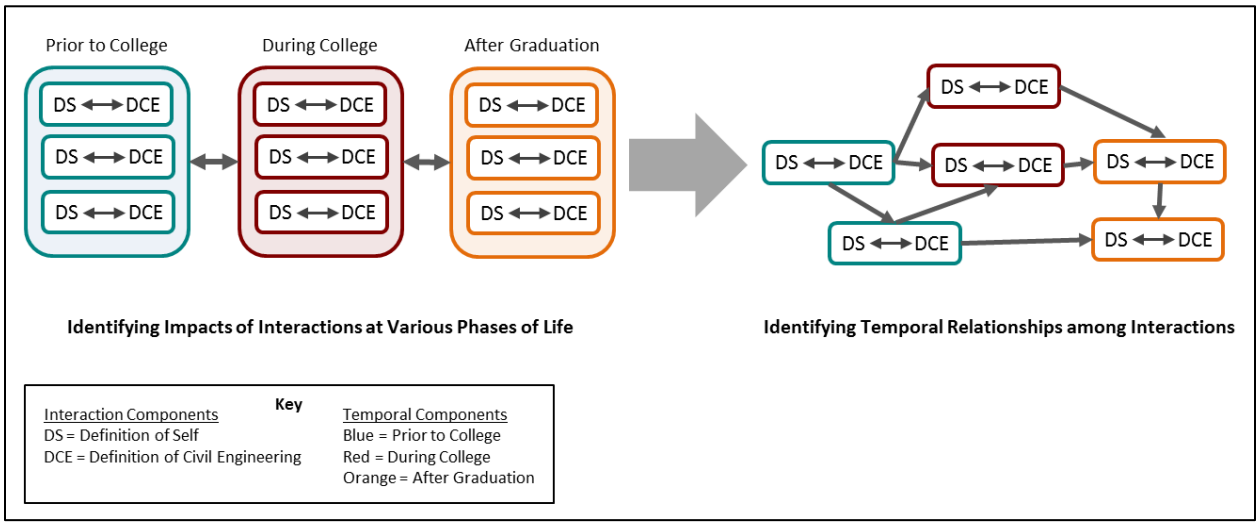



Figure 3.13: Conceptual Framework for Iteration 3 Analysis

To further abstract meaning, integrate miscellaneous codes, and identify new pathways through the data, I exploded my categories and codes to allow for unanticipated re-structuring of code and category relationships. Category or code placement was determined based on two characteristics: 1) the cause of the concept or action, and 2) the consequence of the concept or action. Upon identifying these characteristics, the category or code was then placed in an appropriate location to capture its relationship with other concepts and actions. For example, the initial category of *negotiating engineering characteristics* was disassembled and codes were shifted to other categories. The *connecting non-engineering activities to engineering* code was moved to the *connecting the self to civil engineering* category. In the event that neither of these

characteristics could be identified, the code or category was considered to be the link that connected two or more concepts together. This analytical reorganization was performed using the approach shown in Table 3.14.

Figure 3.14: Restructuring of Coding Relationships

As a check for research quality, I enlisted the assistance of a peer research associate to discuss observations, review developed categories, and examine progress toward an emergent theory. During this research check, the peer research associate challenged my thinking and promoted further abstraction of data meaning. For example, the category *being stuck* was created to capture codes such as *doubting major choice*, *expressing fear*, and *remaining undecided* to better situate these codes as negative outcomes resulting from the initial *iterative comparisons* category. These adjustments were made to code and category placement as agreed upon by myself and my research associate. A complete list of these newly-emerging categories, codes, and relationships are presented in the next section.

Upon conducting a level of abstraction as a result of the quality check, I began to disassemble prior codes and categories to better capture the actions completed and the outcomes created by these codes. As I disassembled the *negotiating characteristics* category and began to organize these codes with other categories, I realized that *negotiating characteristics* was an underpinning action that could more broadly capture the interactions that were occurring among definitions of self and discipline. For example, *being stuck* was the result of participants' *expressing fear* and *regretting path* as they grappled with negotiating their definitions. Other pre-existing categories were situated as outcomes of participants' negotiations. For example, the category *connecting to the civil engineering/engineering profession* was the outcome as participants discussed *valuing civil engineering courses* and *having an engineering personality*. In these instances, participants

integrated their definitions of self and civil engineering as they demonstrated these discipline-related characteristics as descriptors of who they are. From this discovery, I wanted to articulate why and in what contexts these negotiations were occurring. This inquiry is continued in the next section.

#### *3.6.2.3 Iteration 2 Summary*

Throughout Iteration 2, I identified and clustered codes using an initial coding technique that was conducted line-by-line for 10 participant interviews to capture a wide variety of instances in which participants described changes in their definitions of self and civil engineering. Further exploring the relationships among these emergent codes created the basis on which my grounded theory could be derived. With the help of a peer research associate, I began to loosely link concepts (i.e., coded segments) together to develop the logic for an initial framework of identity formation. As a result of this data reorganization and abstraction, I unveiled an underpinning strategy that drove my theory development forward. I realized that the interaction among definition of self and the civil engineering discipline existed in the form of definition negotiations. While I identified this negotiation, I could not identify a unifying catalyst that underpinned these relationships nor determine how they occurred. Therefore, I embarked on an initial form of axial coding to further sort and reassemble my data, as discussed in the next section.

### ***3.6.3 Iteration 3: Moving Toward a Grounded Theory***

Within Iteration 2, I developed an initial framework of professional identity formation and identified a variety of ways in which participants were negotiating definitions of self and discipline. From this framework, I was able to abstract the *negotiating characteristics* category as a primary strategy by which participants adjusted their definitions of self and the civil engineering discipline over time. However, while this framework began to reveal new insights and further theory development, I could not situate these negotiations within the broader context of professional identity development. Therefore, I wanted to identify the underpinning catalyst that was prompting these negotiations and their contributions to the emerging theory. To guide this phase of analysis, I asked the following question:

- What is the key catalyst that prompts these relationships to occur?

To identify and explore the nature of this catalyst, I utilized axial coding (Corbin & Strauss, 1990) to reassemble codes and improve the coherence of the emerging theory (Charmaz, 2014).

Axial coding is a coding technique used in grounded theory to relate codes and categories to reassemble data "fractured by data analysis" (Charmaz, 2006, p. 61) As the relationships among codes and categories were further established, I applied this developing model to my current framework from Iteration 2. Through this application, I was able to identify areas in which my current logic fell apart. These areas of disconnect served as the primary concepts to be further explored via a focused coding analysis. A summary of this iteration is shown in Table 3.9.

Table 3.9: Summary of Methods for Iteration 3

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 3 | Identifying Critical Incidents | 6 | Focused Coding | • Axial coding<br>• Incident by incident<br>• Advanced memos | • Clusters from Iteration 2<br>• Hand-written participant summary sheets |

AI# = Analysis Iteration Number, Size = Sample Size

#### *3.6.3.1 Identifying Conflict as a Catalyst for Negotiations: Increasing Analytic Abstraction*

After identifying definition negotiations as a key strategy of my emerging grounded theory, I wanted to gain a better sense of action and sequence surrounding these strategies as situated within the larger context of professional identity formation. Drawing from the work of Corbin and Strauss (1990), I employed axial coding, an *a priori* scheme that consisted of identifying causal conditions, intervening conditions, strategies, and consequences (Charmaz, 2014; Corbin & Strauss, 1990; Creswell, 2013) to organize my data. The axial codes I utilized for this analysis and their definitions are provided in Table 3.10.

Table 3.10: Axial Codes for Organizing Emergent Categories

| Axial Code | Definition |
|---|---|
| Causal Conditions | Factors that cause the core phenomenon |
| Intervening Conditions | Broad and specific situational factors that influence strategies |
| Strategies | Actions taken in response to the core phenomenon |
| Consequences | Outcomes that result from strategies |

Axial codes were assigned to pre-existing categories based on their roles in promoting or hindering professional identity formation. To identify these roles, I utilized the same questioning

process as previously described to determine and assign the appropriate axial code to the category. For example, upon identifying grounded theory strategies from Iteration 2, I examined their origins (i.e., causal conditions) and why they were changing (i.e., intervening conditions). During this process, the category and its inclusive codes were placed into a process flow diagram (shown in Figure 3.15) based on the axial code to which it was assigned and the context in which the category existed. For example, the initial category of *managing life as a college student* was identified as a strategy, and the emergent categories from Iteration 3, *perceptions of college* and *institutional navigation*, were designated as intervening conditions. Despite their varying axial codes, these three categories were clustered together to create the *life as a college student* theme based on their relevancy to the college context. The presence of strategies, intervening conditions, causal conditions, and outcomes within a single theme was used to enhance the versatility of the model and allow it to encompass multiple participants and experiences.

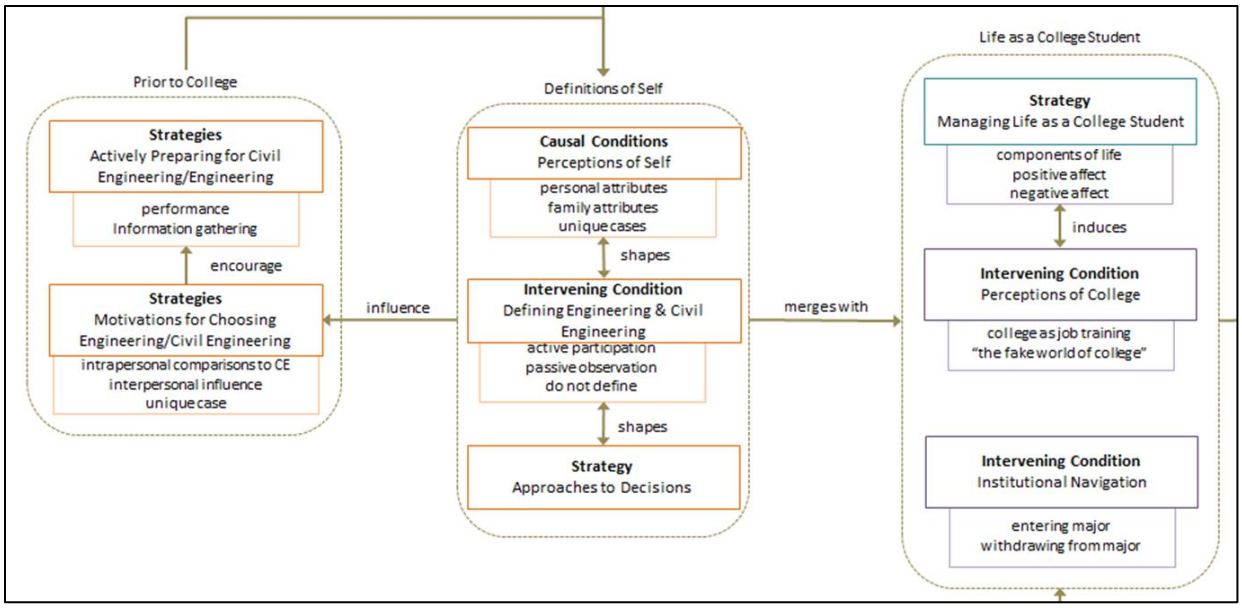



Figure 3.15: Excerpt from Process Diagram

Throughout this iterative process of clustering and mapping, new meaning was simultaneously abstracted to capture the movement and action among categories. Overall, seven themes that captured multiple aspects of participants' lives were identified: 1) *prior to college*, 2) *definitions of self*, 3) *life as a college student*, 4) *learning and shifting perspectives*, 5) *alignment of professional and self*, 6) *outcomes*, and 7) *guidance and support*. As shown in Figure 3.15, these themes were connected to create an initial process diagram of professional identity formation.

For example, the *prior to college* and *definition of self* themes were linked to *life as a college student* to capture participants' transitions as they prepared for and entered into college. However, upon finalizing this diagram, I identified a disconnect between the *alignment of professional and self* and *outcomes* categories. Through this analytical approach, I had identified multiple ways in which participants were aligning their definitions of self with those of the discipline (e.g., through coursework, personal traits, family backgrounds, etc.) and the outcomes resulting from that alignment or lack thereof (e.g., taking ownership of work, doubting major, etc.). However, I could not articulate the junction at which participants determined when a negotiation needed to be made or if an alignment was deemed as successful or not. For this reason, I chose this disconnect as the primary concept to frame my focused coding analysis.

#### *3.6.3.2 Exploring the Disconnect*

To further explore the disconnect as identified via my process diagram, I employed focused coding techniques to "test significant batches of data" (Charmaz, 2014, p. 343). However, this coding process differed from initial coding phases discussed in previous sections; incidents relating to significant concepts were coded in lieu of line-by-line segments. For this analysis, six participant interviews were sampled from Stratum 2 (previously discussed on page 69), which consisted of interviews that appeared to contain minor changes in definition of self or civil engineering. While Stratum 1 provided a breadth of concepts and contexts from which to initialize theory development, focus coding Stratum 2 interviews enabled me to dig deeper into the nuance of these interactions with a focused analytical lens and further encouraged questioning of the data.

From this coding phase, I began to abstract a greater meaning from the disconnect between the *alignment of profession and self* and *outcomes.* As I reviewed and coded this sample, I focused my analytical efforts on instances in which a participant attempted to align themselves with the discipline and vice versa. One observation that I made during this process was that these alignments were happening at multiple stages throughout the participants' lives as they gathered new information that conflicted with their prior definitions. For example, Shawn initially wanted to go into mechanical engineering based on prestige, but then decided to go into civil engineering as he felt it better aligned with his skill set:

> So I was thinking, first thought mechanic; and then slowly I figured out mechanic isn't a really prestigious job, so I kind of wanted to do something with a little higher goals. So it slowly developed into mechanical engineering; and then I figured out that's really hard so I figured civil was more my speed; and the more I go into it, the more I like it. *(Shawn)*

As Shawn learned more about the engineering disciplines, he identified a conflict with his skills (i.e., definition of self) and those required for mechanical engineering (i.e., definition of profession). Anticipating that mechanical engineering may be too difficult for him, he found a new interest in civil engineering. Similarly, Jack revealed his identification of conflicting information while talking about his first internship in transportation with a government agency during his junior year. While he was excited to gain work experience and apply concepts he had learned in class, Jack realized that his definition of self did not align with the disciplinary definition he had learned through his internship experience. In particular, Jack realized that there "weren't a lot of opportunities to advance". Thus, he negotiated his evolving definition of profession to only include positions in non-government agencies. This negotiation brought his definition of profession back into alignment with his definition of self by realigning his career trajectory out of the government arena.

While Shawn and Jack identified conflicting information and negotiated their definitions of self and discipline at different points in their lives, their experiences were not without commonalities. Both of these participants assessed and reflected upon their experiences prior to negotiating their definitions, utilizing their career trajectories as a reference point on which to base that assessment. As long as their overarching career goals did not change or were not drastically impacted by conflicting information, they did not need to negotiate their definitions. Upon observing and identifying the relationship between conflicting information, definition negotiations, self-assessment, and career trajectories, I further established another level of analytical abstraction aimed toward theory development. I further my discussion of these relationships in the Iteration 4 analysis.

#### *3.6.3.3 Iteration 3 Summary*

Throughout this iteration, I utilized axial coding techniques to restructure and organize my data into a process diagram depicting participants' pathways of identity formation. However, upon comparing my logic model from Iteration 2 to the process diagram, I revealed a disconnect among the *alignment of professional and self* and *outcomes* categories. To further explore this gap, I utilized focused coding to identify characteristics of incidents in which participants attempted to align their definitions of self and discipline. As a result, I identified conflicting information as a primary source of definition negotiation and was able to articulate this relationship as operationalized through reflection and self-assessment in reference to career trajectories. However, to strengthen these connections and better communicate the action completed by this relationship, I needed to further abstract these concepts and structure their relationships to further grounded theory development.

### *3.6.4 Iteration 4: Abstracting Meaning to Enhance Theoretical Cohesion*

In the previous iteration, I identified an abstracted a loose relationship among five pre-existing categories and concepts: 1) *identifying conflicting information*, 2) *reflection and self-assessment,* 3) *aligning self and profession*, 4) *negotiating definitions of self and profession,* and 5) *career trajectories.* This relationship was initially identified through an iteration of focused coding around conflict in which participants attempted to align definitions of self and civil engineering. While this analytical approach established the existence of these relationships, I could not yet structure these components toward a cohesive grounded theory that explained the process of professional identity formation. In this section, I asked the following question to further explore this topic:

- What are the relationships among these components that would constitute a grounded theory?

To answer this question, I utilized axial coding, a prescriptive type of coding that specifies the properties and dimensions of a category surrounding a core phenomenon and further organizes codes and categories (Charmaz, 2014; Corbin & Strauss, 1990; Creswell, 2013). At this point in the analysis, I tentatively positioned *aligning self and profession* as the core phenomenon in my model and assigned *negotiating definition and self* as an overarching description of the type

strategies used to complete that alignment. However, other components of my grounded theory model had yet to be identified. In this iteration, I explicate my process for abstracting and identifying these components and structuring them within a grounded theory framework. A summary of this iteration is shown in Table 3.11.

Table 3.11: Summary of Methods for Iteration 4

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 4 | Understanding Identity Negotiations | 6 | Axial Coding | • Coding for incident properties<br>• *A priori* coding for theory components<br>• Advanced memos | • Manual coding on printed transcripts |

AI# = Analysis Iteration Number, Size = Sample Size

#### *3.6.4.1 Axial coding to Enhance Transferability*

From Iteration 2, I developed initial concepts to be included within a grounded theory and began to articulate the relationships among them in Iteration 3. However, to further understand these relationships, I needed to learn more about them and the contexts in which they occurred. To further this analysis, I sampled another group of six participant interviews from Stratum 2 to continue to explore these codes and attempt to abstract higher-level relationships among them as a means to develop a grounded theory. In particular, I was interested in not only what participants were saying, but also what they were *doing* with what they were saying. Therefore, I temporarily abandoned my coding strategies within the MaxQDA™ software and abstracted my coding of participant interviews at the document level. By coding the interviews in this way, I could maintain the overall narrative presented by the participant in which they situated and organized their definition negotiations to align themselves with the civil engineering discipline. From this process, I began to reorganize previously-arranged clusters with my loose grounded theory framework in mind. Drawing from my identified codes in Iteration 2 and grounded theory structure in Iteration 3, I continued to focus my analysis on those codes related to identifying conflict and definition. A figure illustrating this categorization is shown in Figure 3.16. Due to the number of codes that created each category and theme, Figure 3.16 shows code combinations for the *definition of self* and *alignment of profession and self* categories. A summary of the emergent codebook resulting from this analysis is shown in Table 3.12.

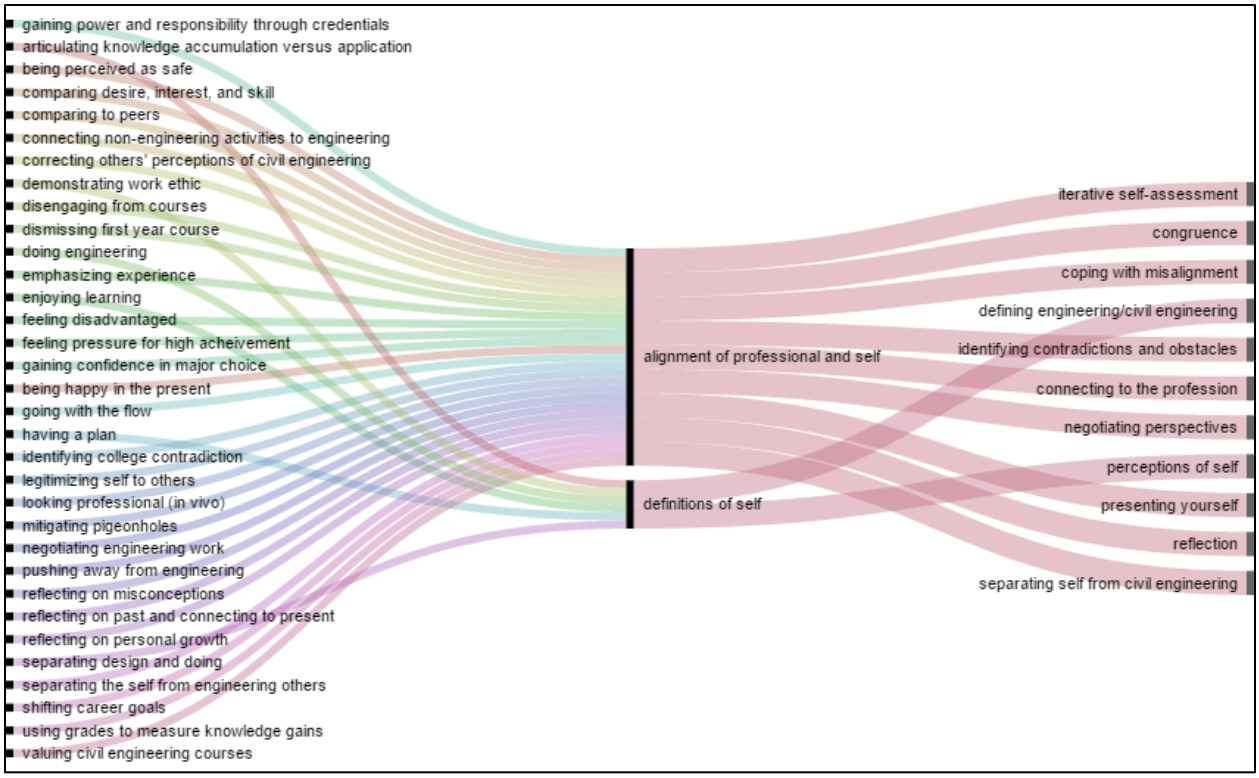



Figure 3.16: Iteration 4 Code Clusters from Initial Code to Theme to Category

Table 3.12: Emergent Focused Categories and Themes from Iteration 4 Analysis

| Theme/Category | Definition |
|---|---|
| *Definitions of Self* | |
| Perceptions of self | This category contains codes that describe how participants perceive or initially perceive themselves. |
| Defining engineering and civil engineering | This category captures how students initially define engineering or civil engineering. This is not a descriptive code, but rather identifies where student conceptions of civil engineering come from. |
| *Life as a college student* | |
| Managing life as a college student | These codes capture how participants handle themselves within the educational context of college. |
| Perceptions of college" | This category contains codes that describe how participants position their college career when pursuing an undergraduate degree in civil engineering |
| Institutional navigation | This category contains codes that describe how participants position their college career when pursuing an undergraduate degree in civil engineering |
| *Learning and Shifting Perspectives* | |
| Learning about engineering/civil engineering | This category includes codes that capture participants' motivations for going into engineering or civil engineering. |
| Outcomes | |
| Identifying overall outcomes and goals | The participant talks about or identifies their overall outcomes or goals for career or life. |

Table 3.12 (Continued)

| Theme/Category | Definition |
|---|---|
| Learning and Shifting Perspectives | |
| Shifting perspectives | This category captures the ways in which participants' perspectives or conceptions of civil engineering shift as students learn about and engage in the profession. |
| Alignment of professional and self | |
| Connecting to CE profession | This category captures codes in which the participant uses strategies and experiences feelings that connect themselves to civil engineering and vice versa. |
| Separating self from civil engineering | This category captures the ways in which participants separate themselves from civil engineering. |
| Presenting yourself (in vivo) | The student discusses strategies for presenting yourself as a civil engineer or safe civil engineer. |
| Iterative self-assessment | This category includes codes that capture participants' self-assessment strategies as a means to judge their performance within and outside the classroom. |
| Congruence | This category captures outcomes that arise when participants do not identify contradictions and feel that they belong in civil engineering |
| Identifying contradictions and obstacles | This category includes codes that capture the contradictions and obstacles that students internally and externally identify difficulties during their undergraduate career. |
| Coping with misalignment | This category captures strategies that participants use to cope with their misalignment as embodied in their obstacles and contradictions. |

A complete list of these themes and their encompassing categories are summarized in Appendix I:. As I began to gain a sense of when and how participants were negotiating their definitions throughout their lives, I could begin to identify *causal conditions* (i.e. the events or experiences that influence a phenomenon) (Charmaz, 2014; Creswell, 2013; Hachtmann, 2012) and *strategies* (i.e. the strategic actions or interactions that influence the outcome of a process) (Charmaz, 2014; Creswell, 2013) and *consequences* (i.e., the outcome of using a specific strategy) (Creswell, 2013) of their identity formation processes, as described in the next section.

#### *3.6.4.2 Identifying the Components of a Grounded Theory*

Upon conducting this axial coding and gaining a greater understanding of participant context and narrative, I identified multiple trends in my data that enabled me to establish the context in which my grounded theory is situated. Drawing from the seven themes identified in Iteration 2 and the axial coding conducted in this iteration, I realized that negotiations relevant to the civil engineering profession were primarily committed during college as participants began to learn about the discipline, itself. Therefore, the level of a participant's prior knowledge of civil

engineering prior to college was not an indicator of the negotiations they performed during college. However, as previously discussed in Section 3.6.1, these backgrounds did provide insight as to how and why specific negotiations were being made. In some instances, such as in Maynard's case, his lack of civil engineering knowledge prior to college enabled him to more freely move throughout the civil engineering program with few definition negotiations. Hence, clustered prior to college concepts into an initial *definition of self* that captured the background of the individual. I then scoped my theory development to consider the context of undergraduate civil engineering education from the time participants entered college up to the point at which the interview was conducted.

Throughout this analysis, categories were clustered based on their relationships with one another and the definitions of grounded theory components by Charmaz (2014), Creswell (2014), and (Corbin & Strauss, 1990). While simultaneously considering participant contexts and the definitions of key grounded theory components, I began to consolidate categories and themes with one another to abstract a greater meaning and capture a more holistic view of professional identity formation throughout the civil engineering undergraduate experience. From the axial coding conducted in this iteration, I was able to further articulate the relationships among emergent grounded theory components as shown in Figure 3.17.

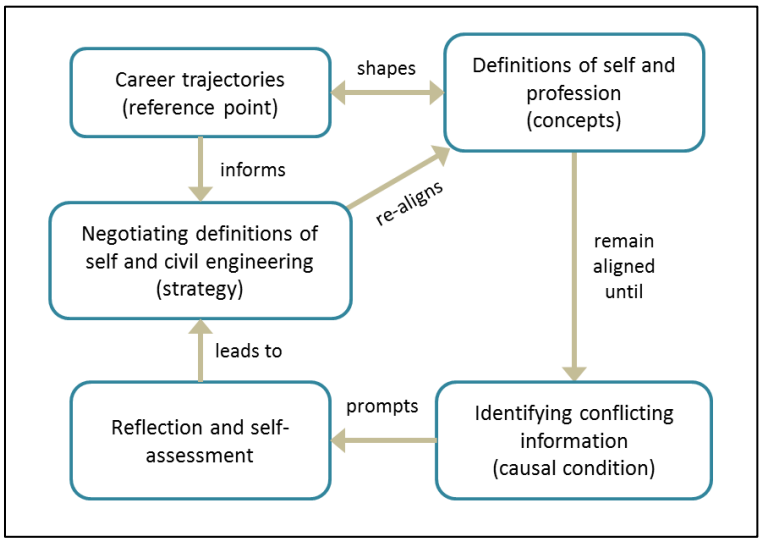



Figure 3.17: Initial Relationships among Identified Grounded Theory Components

This framework became the abstracted foundation of my grounded theory. While I felt as though this model was fairly complete and was capable of capturing abstracted negotiations occurring

across individual contexts throughout participants' lives, it could not be used to fully capture the dynamic nature of participants' evolving identities. At this point in time, the model could not yet be used to capture the variety of aspects from which multiple participants began to negotiate definitions nor identify the internal sources from which they came. Drawing from my prior knowledge in identity saliency (Abes & Jones, 2004; Abes et al., 2007), I posited that these negotiations may be occurring from multiple identity dimensions. Therefore, I needed to determine how shifting identity saliency could also be integrated into the model.

#### *3.6.4.3 Iteration 4 Summary*

In this iteration, I further abstracted and restructured my categories based on the primary components of a grounded theory: 1) the core phenomenon, 2) strategies, 3) causal conditions, 4) intervening conditions, and 5) the outcome. However, discrepancies still existed within the data that were not currently captured by the model. I realized that the alignment between definition of self and civil engineering impacted multiple aspects of participants' lives. As such, I further proposed that the more a participant internalized and aligned themselves with the profession, the more identity dimensions (i.e., aspects of who a person is) would be impacted by these negotiations. To further delineate the ways in which these dimensions were influenced by definition negotiation, I turned to existing literature in identity and discourse to explain this trend in the data. To accomplish this, I conducted an iteration of theoretical coding, as discussed in the next section.

### *3.6.5 Iteration 5: Identifying Theoretical Categories via Salient Identity Orientations*

As I developed an abstract and cohesive model of professional identity formation in Iterations 2-4, I observed that these interactions were not only happening at different points throughout participants' lives, but they were impacting different aspects of their lives, as well. Currently, my abstracted model captured occurrences that related to similar contexts (e.g., school, job, etc.), but I could not bring these interactions together into a comprehensive narrative across participants. To further understand how participants' negotiations were impacting different aspects of their lives and identify nuances that could potentially strengthen the model's structure, I asked the following question:

- Why are interactions between definition of self and profession occurring in different contexts in participants' lives?

To answer this question, I sampled 5 participants from Stratum 3 to further explore less nuanced orientations that students were experiencing. Because these participants remained identified with civil engineering, my hope was that I could learn from their less obvious identity dimensions to further push my data analysis forward and identify ways in which to articulate my current model. To accomplish this, I utilized theoretical coding to examine these less nuanced negotiations. A summary of this iteration is shown in Table 3.13.

Table 3.13: Summary of Methods for Iteration 5

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 5 | Identifying Identity Orientations | 5 | Theoretical Coding and Categories | • Coding for incident relationships<br>• Integrated memos | • Typed summary sheets, printed transcripts, hand-written summary sheets, electronic transcripts |

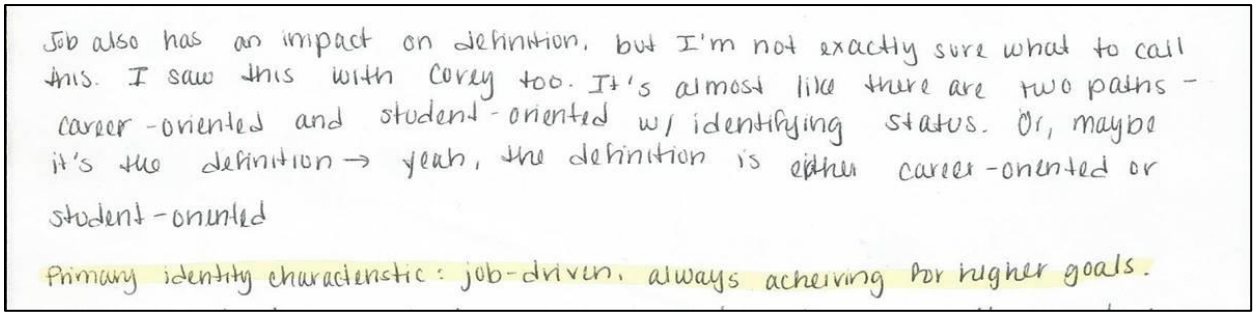
AI# = Analysis Iteration Number, Size = Sample Size

Theoretical coding has not yet been strictly defined as an applied or emergent process; however, grounded theorists are expected to utilize their *theoretical sensitivity,* or prior knowledge about a particular topic, to "render the subtleties of the relationships in the data" (Glaser & Strauss, 1967). Drawing from my prior knowledge in identity theory, I utilized theoretical coding techniques drawn from research on identity saliency (Abes & Jones, 2004; Abes et al., 2007), discourse analysis (Gee, 2011), and social identity theory (Tajfel, 1974). A discussion of the coding implementations for these pre-existing constructs is presented in the following sections.

#### *3.6.5.1 Defining Salient Identity Orientations*

During this analytical phase, I utilized theoretical coding to identify theoretical categories that captured the multiple aspects participants' lives as they negotiated definitions of self and profession. Upon completing this analysis, three theoretical categories were identified: *self-oriented, learner-oriented,* and *career-oriented*. Drawing inspiration from Abes, Jones, and McEwen's (2007) *meaning-making filter* in their *Reconceptualized Model of Multiple Dimensions of Identity* (p. 7), I observed that my participants were also applying a "filter" to the

negotiations in which they were performing. This observation was captured in an analytical memo recorded while reviewing Jack's interview, shown in Figure 3.18:


Job also has an impact on definition, but I'm not exactly sure what to call this. I saw this with Corey too. It's almost like there are two paths - career-oriented and student-oriented w/ identifying status. Or, maybe it's the definition → yeah, the definition is either career-oriented or student-oriented

Primary identity characteristic: job-driven, always achieving for higher goals.

Figure 3.18: Orientation Memo from Jack's Interview

In this memo, I began to observe and identify the different orientations by which participants approached their negotiations. Particularly, I recognized Jack's job-oriented negotiations and was able to contrast them to Corey's student-oriented negotiations. To further establish this link, I reviewed each participant's transcript to corroborate these observations. Participant statements aligning with these orientations are shown below:

> I like having a plan in place. I guess now I would say right now I like having a plan because it sort of takes out some of the stress. I don't really like the unknowns. I mean throwing them in that's fine. Maybe that's not the right way to say that. I don't like the idea of leaving something just sort of on the burner and letting it let me stress out about it, like knowing like I need to do this. I need to do this. That's what gets me worked up and not enjoying what I do. *(Jack)*

> From the beginning of freshman year, [the academic advisors] tell you that you have to have a certain GPA to be guaranteed [entrance into your major] and like, make sure that you get it because if you don't, who knows what you're going get […] So they really emphasize that from the get go. So all through fall semester, I was really stressed. Like, 'I need really good grades. I need all these things and I need to make sure I get my engineering major' and then I got like a 3.7 something GPA because I got tutoring every week and I was really studying my hardest and doing all these things in the classes that really aren't that hard. Like, it's a lot of

work and it's challenging to adjust to college, but once you do, the classes aren't hard. It's freshman classes. *(Corey)*

However, it was also observed that participants did not only approach negotiations utilizing a single orientation throughout their lives. While Corey was learner-oriented during his freshman year of college, this turned to a career-orientation as he began to integrate what he was learning as a career-trainee, rather than a student. A more nuanced discussion articulating the nuances of these orientations is presented in Chapter 4. A summary of these identity orientations are presented in Table 3.14.

Table 3.14: Identity Orientations

| Orientation | Salient Identity | Origin | Example |
|---|---|---|---|
| Self-Oriented | Personal | The Individual | "Just because I didn't realize that civil engineering was that…had that much variety. And then, I would say kind of…I think a lot of people when they think of civil engineering now, and partially I do, is land and roads, even though that's not necessarily true, I don't want to go that route." *(Lizzy)* |
| Learner-Oriented | Student | Education | "This semester I'm in construction management, intro to environmental, deforms, and classes that can actually … environmental and construction I'm actually learning a lot about real world stuff, or relevant information." *(James)* |
| Career-Oriented | Career Trainee | Career Expectations | ". . . I shouldn't be dissuaded or discouraged because of a single grade or single class. You know? I want to say at this point, since I kind of have an internship and a couple things lined up right now, for me, college is a game of survival." *(Chad)* |

Similar to the directionality of negotiations identified during Iteration 1, participants would grant authority to these different salient orientations based on their own backgrounds, prior knowledge, career aspirations, and the context in which the negotiation occurred. This relationship could also be further explained through my earlier dismissal of the impacts of institutional structure on identity formation in Iteration 2. Because participants are required to obtain a minimum 3.0 GPA in order to freely choose their engineering major, and essentially their career, I found that participants primarily maintained a learner-based orientation during their freshman year of college. They are focused on achieving their immediate goals so that they may enter into the civil

engineering program as a sophomore. Notably, these theoretical categories serve as an adaptable link that enables the model to capture the multiple contexts in which participants' negotiate and align definitions of self and profession. From this perspective, the model can simultaneously consider how some dimensions of an individual change while others stay the same.

#### *3.6.5.2 Advancing from Outsider to Insider*

Another observation I encountered throughout this analytical process was the command of the language and meaning by which the participants began to speak as interviews continued. Drawing from my prior knowledge and existing literature in discourse analysis (Gee, 2001), I noticed that as participants continued to speak with me, they began to take command of the language used by the discipline, often reinforcing their demonstrations of knowledge via the tone of their voices and use of acronyms. For example, upon telling me about his career aspiration, Sid explained to me the emergent field of work that he was interested in pursuing:

> After that I want to consult in a field that's non-existent right now. It's called V2V and V2I technology. Have you heard of it? Most people haven't. It's Vehicle to vehicle, vehicle to infrastructure. I'm more interested in vehicle to infrastructure which doesn't exist right now. If you Google search vehicle to infrastructure firms, you won't get anything because the infrastructure part isn't there right now, especially for the past year or so the automotive market has really switched towards autonomy… *(Sid)*

Throughout this explanation, Sid's tone of voice changed to a more formal, explanatory tone. While vocal tone is difficult to capture in transcribed interviews, this observation was made as recordings were revisited to clarify participant meaning by identifying indicators of feeling and emotion such as sadness or sarcasm. From a more direct discourse analysis approach, I also observed and noted use of pronouns while participants were speaking with me. In some instances, participants specifically stated that they were engineers. By making this claim, participants are explicitly identifying themselves as members of a civil engineering group, as further explained via social identity theory (Tajfel, 1974). Another way in which participants demonstrated command of civil engineering content was by asserting themselves as educators of the discipline, a role in which they would teach non-civil engineering individuals civil

engineering content. In Dave's description of Concrete for Kids, an extra-curricular club to which he belonged on campus, he demonstrates both positions as an educator and as belonging to the civil engineering discipline:

> [Concrete for Kids is] where basically we just go to elementary schools and middle schools and just make concrete with kids, teach them about it. We make these like, little beams, where you get all your aggregate and your cement and you just mix it, then you put it in this little cast for a beam and you test it a week later and you do a little presentation, and it's basically just to teach the kids about engineering and what we do. *(Dave)*

By placing himself as an individual who teaches children about concrete, Dave exhibits that he maintains knowledge belonging to the civil engineering discipline and can now pass that information on to others.

#### *3.6.5.3 Iteration 5 Summary*

Throughout Iteration 5, I identified two primary components to drive my theory forward: theoretical categories in the form of salient identity orientations and a theoretical code of advancing from outsider to insider. Drawing from prior identity work by Abes et al. (2007), I know that participants are orienting themselves prior to negotiating their definitions of self and the profession. The individual context experienced by the participant at any given time influences the orientation they take as they perform the negotiation. This allows the participant to flexibly adjust multiple aspects of their lives as they learn about the civil engineering discipline and attempt to align with it. This alignment is also captured as participants begin to take command of the language inherent within the civil engineering discipline and positioning themselves as civil engineers via teaching opportunities in everyday communication. Upon identifying these key pieces to the emergent grounded theory, I was able to identify negative cases for which my theory did not currently uphold. This final process of analysis and theory adjustment is further discussed in the next section.

### *3.6.6 Iteration 6: Articulating a Theory*

Throughout this analytical process, every iterative step enabled me to make advancements toward an abstracted theory. Beginning from exploring participant experience in Iteration 1 to identifying grounded theory components and theoretical categories in Iterations 4 and 5, these analyses enabled me to identifying pieces of a grounded theory that could be loosely structured to capture identity negotiations of undergraduate civil engineering students as they become professionals. In particular, this process included the following components: *aligning definitions of self and profession*, *identifying conflicting information*, *reflecting and self-assessment*, and *performing identity negotiations* using *career trajectories* as a reference point. This relationship has been previously depicted in Figure 3.17. Despite identifying this overarching structure, I felt as though one question still remained unanswered:

- What am I trying to accomplish with this model?

During this final iteration of analysis, I wanted to identify an overarching goal of the model. Because I was developing a grounded theory of professional identity formation, I knew that I needed to capture the ways in which participants *became* civil engineers. Drawing from my definition of *professional identity* used in this study (Downey & Lucena, 2004; Dryburgh, 1999; Holland et al., 1998; Tonso, 2014), I wanted to visualize the iterative integration of personal and professional identities. I also wanted to pay careful attention to not represent the individual as a static entity in the relationship, as I could track participants' changes in identity throughout their interviews. Upon identifying these goals, I returned to my participants' interviews and supporting documents (i.e., field notes, memos, and summary sheets) to gather more information that could articulate the relationships among the components of the emerging grounded theory and further model visualization. A summary of the methods employed during this phase of analysis is presented in Table 3.15.

Table 3.15: Summary of Methods for Iteration 6

| AI # | Outcome | Size | Coding Phase | GT Analytical Approach | Artifacts Analyzed |
|---|---|---|---|---|---|
| 6 | Abstracting a Theory | 0 | Theoretical Coding | • Examining incident type<br>• Visualizing theory components<br>• Integrated memos | • Typed summary sheets, printed transcripts, hand-written summary sheets, electronic transcripts<br>• Sketching |

AI# = Analysis Iteration Number, Size = Sample Size

To articulate the process by which my participants' were constructing their professional identities, I returned to my observations from Iteration 1 and conducted theoretical coding on all previously-analyzed interviews from Iterations 2 through 5. As a *Theoretical coding* is a sophisticated level of coding to theorize data and existing codes (Charmaz, 2014), theoretical coding enabled me to search for current gaps in my data that could provide useful information for final theory structure and model visualization. Upon analyzing interviews to examine existing incidents of identity shifts, causes, negotiations, and consequences, I started to sketch multiple drafts of my model. One of my initial sketches is shown in Figure 3.19.

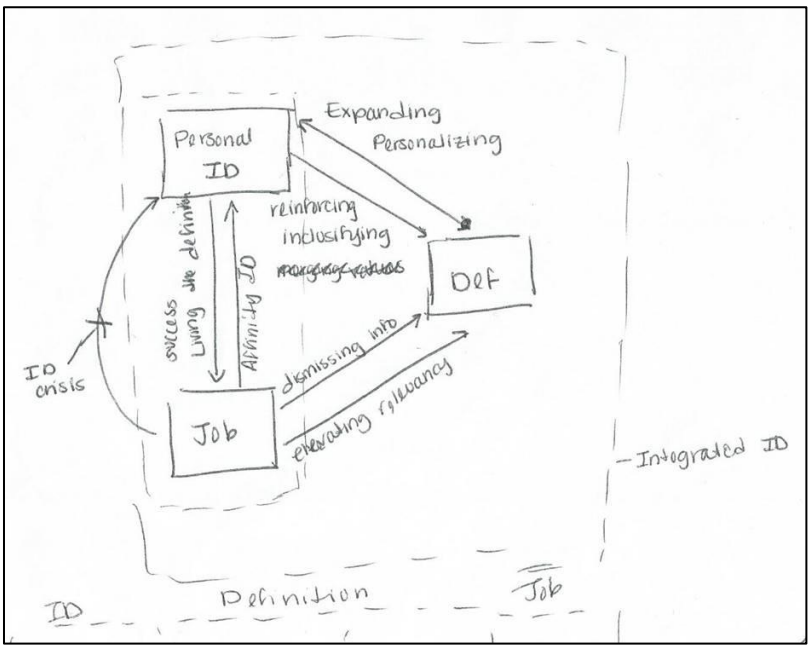



Figure 3.19: Initial Sketch of the Emergent Grounded Theory Model

As shown in Figure 3.19, I started to apply different dimensions of identity, as indicated by the dashed lines to capture participants' movement from a solely personal identity to one that integrated personal and professional identity. However, due to a number of *negative cases* identified within my participants, I knew that individuals did not simply shift from a personal to an integrated identity. I explain these negative cases in the next section.

### *3.6.6.1 Identifying Dynamics of Disciplinary Definition via Negative Cases*

Negative cases are data that sharply contrast the emerging themes that are accounted for in the majority of the data (Charmaz, 2014). Negative cases are valuable to grounded theory research

because they test the robustness of the developing theory and compel the researcher to ask further questions of the data. While applying the current theory to the data, I observed negative cases in Amy and Neil. Previously, I had assumed that participants were becoming more identified with the civil engineering profession through an increased integration of negotiated definitions with the sole purpose of being defined as a civil engineer. However, upon reviewing Amy and Neil's interviews, I identified an unanticipated turn in their narratives. While both participants were doing well in their civil engineering courses, they enjoyed civil engineering work, and wanted to pursue careers in civil engineering in the future, they did not want their career to define who they were. Throughout their interviews, both Amy and Neil exhibited strong definitions of self as related to family and work life balance:

> […] I think that [family/balance] … like I do want a career and everything, but I don't want that to define me, I want to do other stuff too. I think it's all a balance like I said. *(Amy)*

> [My grandmother passing] was definitely a wake-up call. Thinking, "Hey, I should look… I should think about what's life going to be like after the rest of my family goes on? How can I have a future for the family?" And I definitely feel like getting some sort of grounding in whatever career, really it doesn't have to be civil, just something I can be proud and successful in, and something that I can probably pass on to my kids or something like that. So they can be proud and carry on the torch, sort of. *(Neil)*

While these participants both identified with civil engineering and intended to stay in the field, they did not position civil engineering as a career to which they devoted their entire being. Rather, they defined civil engineering as a job that they could use to support their families and other aspects of their personal lives. This observation brought to the fore the dynamic nature of interactions between definition of self and the profession as participants accept or reject relevant information based on their overarching career aspirations. They had identified who they wanted to be in the future and how civil engineering may be a useful career option for getting them there. Despite examining these negative cases for identity formation, Amy and Neil maintained a similar trend as compared with those of other participants: they still assessed their performance

in school and maintained some form of career aspiration throughout their undergraduate experiences. I articulate these two observations in the next section.

#### *3.6.6.2 Establishing Career Aspirations as Foundation of Identity Formation*

Throughout the duration of this research study, I learned about multiple aspects of my participants' lives – particularly their hobbies, extra-curricular activities, internship experiences, and academic careers. I did not want to exclude these characteristics and environments from the model because I felt that they maintained too large of an impact on how participants carried out their everyday lives. Upon reviewing these environments as a miscellaneous cluster, two quotes from Macy and my notes from Dave (discussed in the previous section) allowed me to fully realize the importance of these seemingly ordinary aspects of life as a college student. For example, after discussing gender bias within engineering classrooms, Macy solidified her position as an engineer in the following comment:

> Um ... but I think just by doing it and realizing that I can do it, and I can be good at it has made me be like, 'No, I am an engineer and that is what I want to do with my life. I don't really care what you say anymore.' It doesn't affect me. *(Macy)*

In this situation, Macy empowered herself to combat critics of women in engineering through a self-assessment of her own course performance. Because she was able to perform well in her courses, she legitimized herself as an engineer and emphasized that she did not need validation from other individuals to pursue her chosen career path. Similarly, participants also exhibited these same assessment practices within non-academic settings in the form of outreach activities, internships, and co-ops. These out-of-class activities enabled participants to apply what they were learning in class to other contexts. While Dave used Concrete for Kids as an outreach activity, he was able to apply his knowledge from the classroom to teach elementary school children about the basics of concrete. Similar stories were described as multiple participants, such as Chad, discussed their experiences on mission trips with local churches. During these trips, they were able to conduct civil engineering-related work in other countries:

> I went to El Salvador [on a church mission trip], so that's kind of the first time I worked heavy construction. So that's when I kind of learned that I would be interested in making buildings because we built a daycare center. We helped build

> a daycare center by mixing concrete third-world fashion, laying bricks, and doing stuff like that, so I guess looking back that's probably what originally got me thinking that civil engineering would be a good profession for me. And then when I made the decision, I probably came back to that a lot, remembering that I like to help people and help the needy. *(Chad)*

Chad later went on to discuss many of the values and skills (e.g., management and leadership) that he had learned during these trips and the ways in which they influenced his future career aspirations. While many students go to class out of necessity for a degree or participate in extra-curricular activities out of enjoyment, many participants in this study also value these opportunities to practice, apply, and self-assess their performance and use of the content and skills they were learning. From this observation, I realized that it was necessary to incorporate some form of self-assessment, practice, and application component within the model. Upon identifying this component, my prior conceptions of *career as reference point* were further confirmed as many individuals also used these out-of-class experiences to identify their future career paths. Jack demonstrated this connection in his statement, "This past summer I was doing highway design with the federal government. Maybe it sort of helped me realize that transportation isn't going to be my thing. I'm going to go structural." From this experience, he realized that transportation was not a career path that he wanted to pursue. Hence, Jack switched his focus from transportation to another civil engineering sub-discipline of structural engineering. As analysis continued, participants constantly referred to their potential careers as they performed definition negotiations during various points in their lives, indicated by three comments from Jared, Sid, and Lizzy:

> Yeah, because I feel like I should pursue a more serious career, so I feel like engineering was something I wanted to do. I thought about teaching, but I feel like I was more interested in engineering. *(Jared)*

> But no, my career goals aren't driven profit. More about what I want to do. I'm really passionate about transportation safety technology and it really makes me mad when I see people screwing up. *(Sid)*

> I knew I could be good at engineering, and I knew it was a good route to take in school just from what people had told me. Obviously, there's a good job field for that, and I knew that and I didn't want to base my decision off of that. So what I wanted to do was try it out, and if I liked it that would be great because it was something I was good at, it would be something that I'd most likely have a job in after I graduated and it was something that I liked. If I didn't like it, I would find something else. *(Lizzy)*

Notably, not all of the comments are the same. Each participant positions their career, or defines their view of the profession, as relevant to their linked personal and career goals. While Sid's career goals are based primarily on interest, Lizzy has established her career goals based on her skill levels and expected success in the civil engineering field. From this analysis, it became apparent that career aspirations formed the foundation of the model that influenced the ways in which participants approached the assessment, practice, and application of their learned knowledge throughout their undergraduate experiences. The role of each of these concepts and their impacts on the emergent grounded theory model is further discussed in Chapter 4.

#### *3.6.6.3 Articulating Definition Negotiations*

During Iteration 1 of this analysis, I identified a directional interaction between definitions of self and the profession. From my analysis in Iterations 2 and 5, I was able to identify these interactions as identity negotiations that participants approached from different orientations. By combining these negotiations and orientations, participants were able to manage, or align, their definitions of self and profession using a single dimension of their life without holistically changing who they were. Upon re-examining codes from my prior analyses and their local contexts within the participant's individual narrative, I realized that the negotiation interactions were inherently present within multiple iterations of coding. While the negotiation *reinforcing self* and *inclusifying engineering* existed as initial codes, others such as *elevating academic relevancy for future career* and *humanizing profession* were derived from a cluster of codes, shown in Figure 3.20. A final list of the identified negotiations are further presented and discussed in Chapter 4.

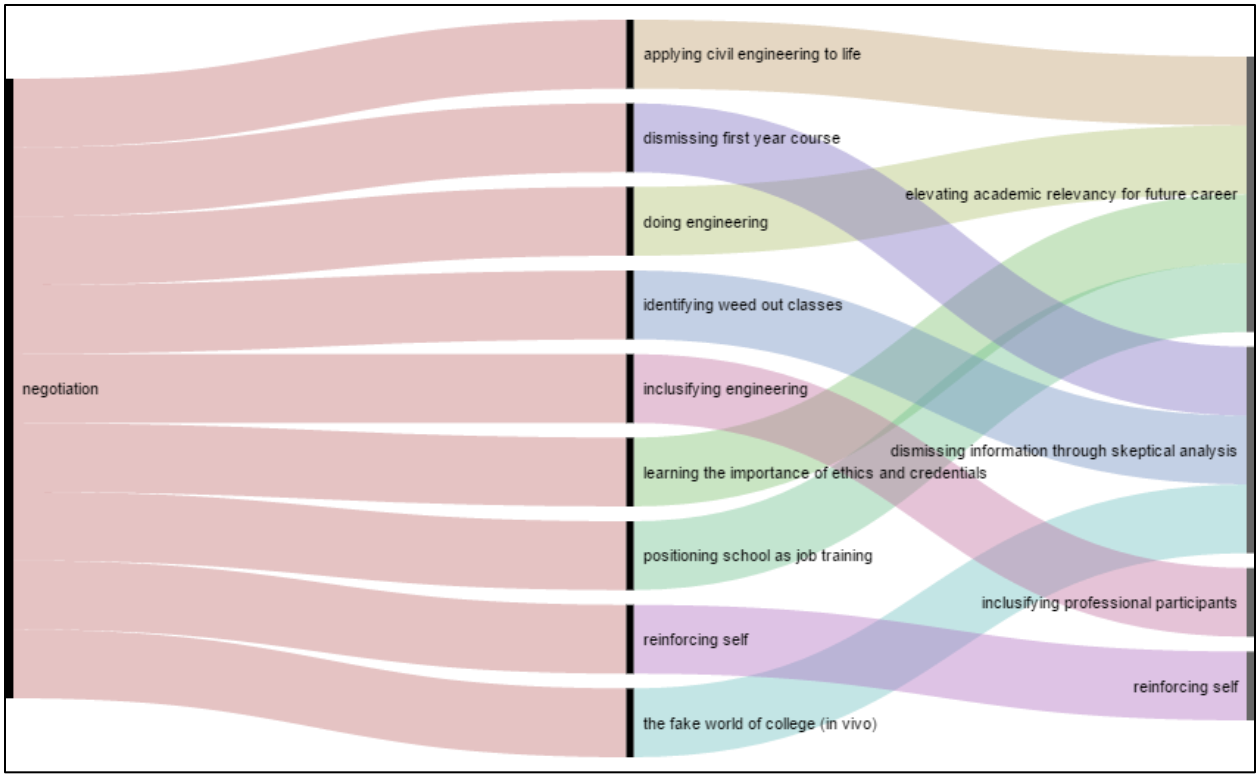



Figure 3.20: Example of Negotiation Code Clusters from Initial Code to Final Negotiation

### *3.6.6.4 Balancing Self and Professional: Living the Definition*

As I identified the identity negotiations between definitions of self and profession in Iteration 1 and articulated their characteristics during Iterations 2 and 5, I was able to identify their origins and the reasons for their occurrence. Drawing from my analysis in Iteration 6, I realized that these negotiations were occurring in various contexts as participants received conflicting information with their prior conceptions. These negotiations were then enacted from different identity orientations as a means for participants to regain alignment between these definitions. These negotiations enabled participants to adjust and readjust their definitions of self and profession to remain aligned with one another and their overarching career goals. This grounded theory component titled, *Self as Professional: Living the Definition*, is further discussed in Chapter 4.

### *3.6.6.5 Iteration 6 Summary: A Unifying Outcome*

Drawing from my prior iterations of this analysis, I combined key themes, ideas, and concepts to finalize and shape my emergent theory. During Iterations 1 and 2, I conducted an initial analysis

using a combination of line-by-line and broad initial coding to immerse myself in participants' stories and experiences. From this analysis, I identified an interaction between definition of self and identity that maintained a directionality that was either internally- or externally-influenced in the form of identity negotiations. Iteration 3 served as a means to shift from initial coding to focused coding as I utilized axial coding to identify conflicts in which participants had to reconcile the disconnect between established versions of their definitions, the receiving information that conflicted with those versions, and maintain identification with the civil engineering profession. Using focused coding in the same iteration, I focused my analysis on these events in which identity shifts occurred due to these conflicts. During Iteration 4, I applied my emergent focused codes and grounded theory component codes (i.e., outlined components of a grounded theory) (Charmaz, 2014; Hachtmann, 2012) to further organize, sort, and make meaning of my data. From this analysis, I developed an initial framework for my grounded theory, on which I expanded during Iterations 5 by developing theoretical categories in the form of identity orientations that captured the approaches by which definition negotiations were performed. During Iteration 6, I sought to add more flexibility into the model, particularly regarding the relationship between participants' definitions of self and profession and career expectations and aspirations. To achieve this, I identified an assessment component in which participants adjust their negotiations, definitions, and career aspirations based on internal (i.e., identified by self) or external (i.e., receiving from others) feedback from their experiences. These feedback sites may exist in the form of formal classroom settings to informal settings such as church mission trips. This component enabled me to identify the feedback component necessary to link the model together in an iterative manner. A summary of the emergent grounded theory components derived from this study are presented in Table 3.16. I introduce the emergent theory in its entirety in Section 3.6.8.

Table 3.16: Summary of Emergent Grounded Theory Components

| Grounded Theory Component | Component within Model | Discovered In |
|---|---|---|
| Context | Undergraduate engineering education | Iteration 4 |
| Core Phenomenon | Self as professional | Iteration 7 |
| Strategies | Negotiating definitions of self and the civil engineering discipline; negotiating careers aspirations and expectations | Iteration 1<br>Iteration 2<br>Iteration 5 |
| Causal Conditions | Identifying conflicting information; questioning; reflecting | Iteration 3<br>Iteration 4 |
| Intervening Conditions | Self-assessment, practice, and application of definitions inside and outside the classroom | Iteration 4 |
| Outcomes | Advancing from outsider to insider | Iteration 5<br>Iteration 6 |

### *3.6.7 Iteration 7: Achieving Theoretical Saturation*

Within grounded theory research, data is continuously collected and analyzed until the researcher achieves *theoretical saturation.* Theoretical saturation occurs when, upon collection new data, no new categories or properties emerge (Charmaz, 2014; Corbin & Strauss, 2007). In this final iteration of data analysis, the four remaining participant interviews were coded a priori using the coding scheme developed to correspond with the emergent grounded theory. From this analysis, it was determined that the coding scheme and the resulting grounded theory were abstracted such that they could accurately capture participants' professional identity formation as no new themes or categories emerged. In the next section, I briefly introduce the emergent grounded theory, with an in-depth description of this theory and coding applications further explicated in Chapter 4.

### *3.6.8 Negotiating Equilibrium: Advancing from Outsider to Insider (the AOI Model)*

By employing an iterative analysis approach that consisting of constant comparative methods and abductive reasoning, I slowly integrated and abstracted concepts and anomalies identified in participant interviews to develop a grounded theory of professional identity formation, shown in Figure 3.21.

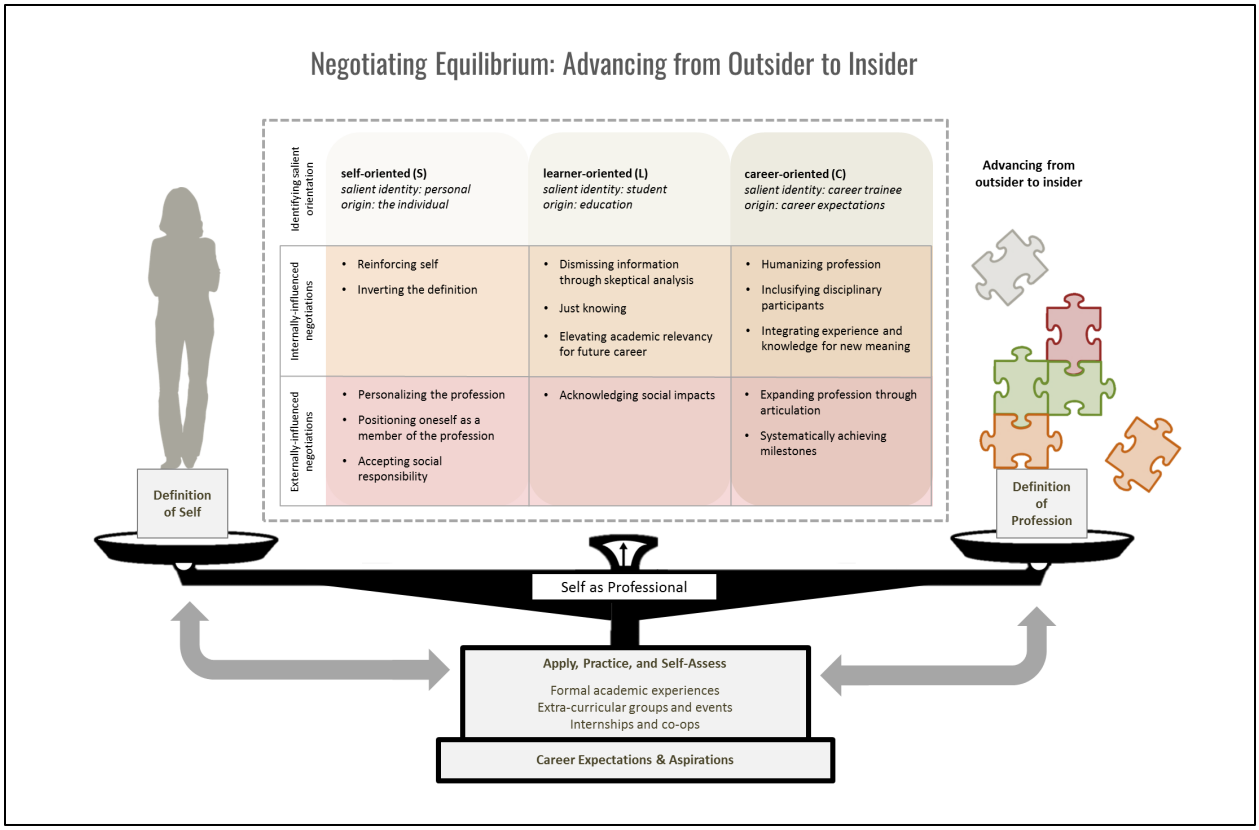



Figure 3.21: The Emergent Grounded Theory

Titled *Negotiating Equilibrium: Advancing from Outsider to Insider (the AOI Model)*, this grounded theory captures the dynamic process of identity formation in which civil engineering students advanced from an *outsider* (i.e., an individual not belonging to a civil engineering group) to an *insider* (i.e., an individual belonging to a civil engineering group). This formation was demonstrated through iterative negotiations of definitions of self, the civil engineering discipline, and future career aspirations. During these negotiations, students merged personal identity dimensions such as gender, family culture, religion, and personal values with learned information acquired during their education. These negotiations occurred as participant attempted to maintain balance among their definitions of self and the civil engineering discipline to remain identified with the civil engineering discipline. To aid in this negotiation process, students utilized three salient identity orientations (i.e., the self, the learner, and the career trainee) as reference points for controlling internally-influenced negotiations or managing externally-influenced negotiations. As students continued through this process of negotiation,

they began to take command of their definitions of self and civil engineering as related to future career goals.

In this section, I merely introduced my resulting grounded theory. Further discussion explicating each theoretical component and demonstrations of its applicability to participant experiences is presented in Chapter 4.

### *3.6.9 Data Analysis Summary*

Drawing from the distinguishing characteristics of grounded theory, I conducted an iterative, constant comparative analysis and utilized abductive reasoning to develop an emergent theory grounded in the data. In total, I completed eight iterations in which data collection and analyses were simultaneously conducted and abstracted through five levels of coding: 1) initial coding, 2) focused coding, 3) axial coding, 4) theoretical coding, and 5) development of theoretical categories until theoretical saturation was reached. The result of this analysis is a grounded theory of professional identity formation captured by the AOI Model. As I abstracted my developing theory, it began to gain explanatory power that captured the meaning of local participant contexts while maintaining the ability to travel across participant narratives to accurately depict negotiations between definitions of self and civil engineering.

## 3.7 Research Quality

Due to the varied definitions of a grounded theory product and its applications, it is important to reflect on the resulting theory and the process by which it was developed (Charmaz, 2014). These varied perspectives shape the standards by which the quality of a grounded theory study is established, particularly when considering the disciplinary contexts in which the study was conducted. For these reasons, I introduce this section by defining the properties of a high quality grounded theory followed by a discussion of the criteria by which it is evaluated.

Emanating from their positivist perspectives, researchers such as (Glaser & Strauss, 1967) identify a quality grounded theory as generated theory that is a general, modifiable explanation of process, actions, and interactions (Creswell, 2013). Alternatively, other researchers suggest that generated grounded theories are sophisticated and informed explanations of process, actions, and interactions that are context-dependent and rely on individual situations to which the theory

may be applied (Charmaz, 2014; Creswell, 2013; Guba & Lincoln, 1994). In alignment with my worldview and the purpose of this study, I adopted Charmaz (2014) and colleagues' definition of a quality grounded theory and thus utilized her quality criteria to evaluate the research quality of this study.

The resulting grounded theory from this work was heavily focused on the civil engineering discipline and may not apply to every disciplinary context within engineering or education. However, this is not to say that this theory may not be applied to other contexts nor be evaluated for research quality. While typically discussed in quantitative research as *validity* and *reliability*, I adopted qualitative terms to address research quality (Borrego, Douglas, & Amelink, 2009). In particular, I utilized the quality criteria developed by Charmaz (2014) for evaluating grounded theory as generated from a constructivist/subjectivist perspective: credibility, originality, resonance, and usefulness (Charmaz, 2014; Corbin & Strauss, 1990). A definition of each criterion and how it was addressed within my study is presented in Table 3.17. These criteria assumed that any conclusions developed by the resulting grounded theory were suggestive and context-dependent (Creswell, 2013); therefore, the applicability of the theory to a specific situation should be determined by the reader wishing to employ it.

Table 3.17: Quality Criteria for Grounded Theory Research

| Criterion | Definition Summary | Quality-Enhancing Strategies |
|---|---|---|
| Credibility | Findings are trustworthy and believable and accurately capture participants' experiences with and researchers' claims about a phenomenon and their plausible explanations (Charmaz, 2014; Corbin & Strauss, 1990). | • Member-Checks with participants<br>• Constant Comparison<br>• Peer-Debriefing<br>• Grounded Theory Memos |
| Originality | Findings that reveal and offer new insights and conceptual understandings that inform current ideas, concepts, and practices (Charmaz, 2014). | • Abductive Reasoning<br>• Sensitizing Concepts |
| Resonance | Findings portray the fullness of the studied experience and make sense to participants and individuals who share that experience (Charmaz, 2014). | • Rich, Thick Description<br>• Member-Checking |
| Usefulness | Findings that can be practically applied to individuals' everyday worlds through a generic process and spark future research (Corbin & Strauss, 1990). | • Theoretically-Abstract Findings |

Similar to validity, the quality criterion of credibility prompts researchers to inquire about their own data regarding the believability and accuracy of their data and reported findings. With this criterion, Charmaz (2014) also encourages researchers to evaluate their own research methods and processes by which they arrived at their findings by questioning methodological topics such as the researcher's familiarity with the data, sufficiency of data to support claims, logical links between categories and observations, and ability to allow the reader to form an individual assessment in agreement with the researcher's views. To address this quality criterion, I utilized member-checks, peer-review, constant comparison, and an audit trail to ensure credibility throughout the study.

First, member checks occurred during the Fall 2016 semester that consisted of a follow-up interview with six participants. These participants were chosen based on key statements made during their first interview. During these semi-structured interviews, I identified confusing or vague comments, presented them to participants, and asked them to clarify their meaning. This ensured that their experiences were being accurately captured and interpreted throughout analysis (Creswell & Miller, 2000).

Second, two peer reviewers were utilized at the beginning of the initial and axial coding phases of analysis and upon final theory development. Peer Reviewer 1 reviewed codes once the initial codebook was established (Iteration 3) and the classification of axial codes into categories to determine grounded theory components (Iteration 5). Peer Reviewer 2 reviewed a draft of the final grounded theory model and suggested necessary changes to enhance its clarity. A peer reviewer is an individual who is somewhat familiar with the research or phenomenon being explored and supports and challenges the researchers' interpretations and assumptions (Creswell & Miller, 2000). By reviewing my coding schemes and grounded theory model, these external researchers served as sounding boards for ideas and assisted me in critically evaluating my work as it was conducted (Creswell & Miller, 2000). Particularly useful for a grounded theorist was the ways in which these individuals challenged my thinking and encouraged analytical abstraction.

Third, the constant comparative nature of grounded theory research also contributed to the credibility of the research study. Due to multiple comparisons between the data and the analysis, I was able to repeatedly test emerging codes and themes against my findings. When these two

methodological components did not agree, I reviewed my data and reconsidered specific coding decisions or theoretical interpretations. Finally, I utilized an audit trail in the form of memos (Charmaz, 2014) that captured all research decisions and activities as the study was conducted (Creswell & Miller, 2000). Through these multiple strategies, I was able to enhance the credibility of my data collection, analysis, and findings.

As previously discussed in the introduction, the primary reasons for utilizing grounded theory are to expand theory and/or modify it to better suit a specific population or phenomenon (Creswell, 2013); therefore, the criterion of originality is inherent within grounded theory tradition. In particular, original findings should offer new insights and conceptualizations of the topic and challenge, extend, or refine current ideas, concepts, and practices (Charmaz, 2014). To promote the originality of the findings of this study, I utilized sensitizing concepts and performed abductive reasoning throughout the study. Unlike a theoretical framework, sensitizing concepts serve as departure points for the research and are meant to serve as a guide; they do not frame or bound inquiry and analysis (Charmaz, 2014). Using these concepts allowed me to identify unanticipated results and explore them through abductive reasoning. Abductive reasoning is a characteristic of grounded theory that allows a researcher to imagine all possible explanations for its existence (Charmaz, 2014). From this perspective, the design of grounded theory methods promoted the identification and exploration of concepts that had not yet been established within the literature and ensuring originality of the findings.

The criterion of resonance establishes that high-quality grounded theory research makes sense to people who share the same experiences as the participants within the study (Charmaz, 2014). Essentially, study findings should be able to account for multiple explanations regarding the occurrence of a phenomenon and reveal taken-for-granted meanings (Charmaz, 2014). To address this criterion, I utilized rich, thick description of participant accounts and findings throughout the study (Creswell & Miller, 2000). While this strategy promoted the credibility of the findings, it also provided enough information to readers so that they may determine if these findings resonate with them or not. For those individuals who have not experienced the phenomenon, this description provides enough detail to the reader so that they may metaphorically position themselves as experiencing and managing the phenomenon in a similar

way (Creswell & Miller, 2000). This criterion also enhanced the usefulness of the findings, as discussed in the next section.

Usefulness, as implied by its name, is similar to *transferability* (Borrego et al., 2009) and is particularly important because it requires the researcher to reflect on the ways in which the resulting grounded theory may be used by others. Rather than simply conducting research for its own sake, this criterion inherently drives researchers to determine ways in which the grounded theory, as well as the findings derived from the process of its development, may be practically applied within a variety of contexts.

### 3.8 Ethical Considerations

Prior to the start of the recruitment process for this study, I obtained Virginia Tech Human Subjects Research Approval through the Institutional Review Board (IRB). Participant consent was obtained prior to the initiation of data collection procedures. The current IRB approval for this project is IRB 15-1208 and was obtained to collect participant interviews and questionnaire responses. The IRB protocol for this study remains open.

A number of ethical implications were considered throughout the design of this study, particularly during the recruiting, interviewing, and recording phases. First, to diminish the feeling of coercion from myself, the instructor, or their peers during recruitment efforts, the recruitment surveys (located in Appendix C:) were distributed to each student in the course. The survey was designed such that the participant could anonymously select to volunteer or decline participation. All participants were required to return the completed survey to me with their response at the end of the recruitment session. Second, to protect confidentiality during in-person interviews, each interview was conducted in a private, on-campus location (e.g., office, conference room, or laboratory) to protect the identity of the participant as well as maintain their confidentiality during the interview as they responded to and discussed a multiple life topics. Lastly, to protect the anonymity of participants during research dissemination, pseudonyms were assigned to each participant and identifying information scrubbed or not reported within this work. Examining one's own identity can be an intense experience. Thus, maintaining the anonymity of my participants throughout these multiple research phases was of upmost importance.

### 3.9 Researcher Bias

While we treat our data as facts, we as researchers construct them in ways that are influenced by individual backgrounds, assumptions and disciplinary perspectives (Charmaz, 2014). These inherent individual characteristics maintain the potential to influence how researchers collect, analyze, and present their data, particularly by alerting them to certain processes and possibilities that may have not been identified otherwise. For these reasons, researchers need to be aware of how and to what extent they draw on such assumptions and perspectives. In this section, I present my researcher bias by discussing three defining characteristics of constructivist grounded theory (Charmaz, 2014): 1) the role of researcher values, 2) researcher reflexivity, and 3) the role of researcher interpretation.

Regarding the role of values in constructivist grounded theory, Charmaz (2014) maintains a non-neutral researcher perspective and acknowledges personal priorities, positions, and values. As indicated by the introduction of this section, I too align with her perspective. I believe that researchers' positions, prior experiences, and values influence the topics we study and how we choose to study them. For example, the topic of this dissertation research was based on my own past experiences as a civil engineering student who struggled with developing a professional identity. While I passed all of my courses, held multiple internships throughout my undergraduate career, and participated in a variety of engineering-related activities such as building the concrete canoe and serving as a member of the local American Society of Civil Engineers (ASCE) student chapter; I still did not feel prepared to enter the civil engineering workforce. I was scared and unsure of my skills; I didn't know if I could actually serve as a civil engineer without potentially hurting someone. However, many of my peers throughout my undergraduate experience who had achieved grades similar to mine, participated in fewer activities, and never completed an internship were excited to enter the profession as a natural career progression. They already considered themselves to be civil engineers while I did not. I wanted to know why that was. What did it mean to be a civil engineer? When did they know that they were civil engineers? This path of questioning led me to my research interests of identity research and my primary research topic. Upon developing a grounded theory that captures the formation of professional identity, I can begin to answer many of these questions and identify ways in which we, as educators, can positively influence it.

Similar to the role of researcher values within a grounded theory study, the worldview assumed by the grounded theorist will also influence the importance of researcher reflexivity throughout the process (Charmaz, 2014). From the constructivist viewpoint, as previously discussed, reflexivity is a necessary facet of grounded theory that may be used throughout the entire research process to enhance and further analysis while the researcher is in dynamic, continuous dialogue with themselves and their data (Charmaz, 2014). From this perspective, it is acknowledged that the researcher's viewpoints may change throughout the research process and influence analysis. To actively reflect on my changing viewpoints throughout this study, I maintained continuous reflexivity in the form of memos and journaling. These strategies were employed as a way for me to maintain dialogue with myself and my data throughout the entire research process. While memos primarily captured analytical approaches and observations, journal entries provided a space to write about my personal life that could potentially influence the ways in which I viewed and analyzed my data.

Another issue when analyzing data in grounded theory research is that a researcher may adopt participants' worldviews, which commonly occurs when individuals are researching participants from the same discipline or possess other similar characteristics (Charmaz, 2014). This awareness of worldview adoption throughout the research process was particularly relevant in this study as I shared very similar backgrounds with my participants. During interviews, participants would often describe events, experiences, or feelings similar to those that I encountered during my undergraduate career. To mitigate the effects of this shared experience on data interpretation and analysis (Creswell, 2014), I asked participants to elaborate on these various topics to minimize my personal bias when discussing and exploring these topics throughout the research process. Utilizing multiple levels of data abstraction also enabled my separation from participants' stories (Charmaz, 2014) as data was taken apart and reassembled to abstract meaning from codes and categories.

Within constructivist grounded theory, and aligning with my own worldview, is the continuous role of interpretation throughout the entire research process and the nature of the resulting theory. From this perspective, the research process, in itself, is an interpretation constructed by the researcher. As the researcher interprets what is happening during data collection and analysis, they create a theory that is produced from those processes and is also considered as an

interpretation (Charmaz, 2014; Corbin & Strauss, 1990). Therefore, my assumptions, biases, and background are embedded within the grounded theory that was produced from this study. In particular, my prior experience as an undergraduate civil engineering student influenced many of the follow-up questions that I asked participants during interviews, thus impacting the quality and type of data collected throughout this study. While this may appear as a limitation to some researchers, I found my similar background as a way to build rapport with my participants and provide to them a safe space for candidly speaking of their experiences. From these commonalities and established rapport, I could collect rich data that enhanced the overall quality of the resulting grounded theory.

The methodological framework of grounded theory possesses multiple tools to help researchers be transparent about their biases within their work and bring their perspectives and assumptions to the fore. Sensitizing concepts proved useful for not only guiding this grounded theory research, but also provided an anchor to pull me back to the purpose of the study when my analyses began to drift to other topics(Charmaz, 2014). I also utilized *bracketing memos* before I began to analyze the data. As previously discussed in this section, these memos were used as a reflexive tool by which I disclosed preconceived notions about the context, participants, and my own role within the research study (Charmaz, 2014). By utilizing these tools, I was be able to keep myself aware of my own researcher bias as I conducted this study (Creswell, 2014).

### 3.10 Limitations

Based on the methods presented in this chapter, there are five primary limitations to this study: 1) the single university at which this study was conducted, 2) the time duration in which this study took place; and 3) the nature of the designed intervention. In this section, I discuss each limitation identified upon conducting this study.

The first limitation identified for this study was the single location at which it was conducted. As evidenced from participant interviews, the institutional structure played a significant role in the orientations by which students negotiate their identities. Students enrolled at universities with structures differing from the one explored in this study may not experience the same institutional, identity-informing experiences. To further broaden our understanding of the institutional influences on identity negotiation, this study must be conducted across multiple

institution types (e.g., teaching-focused universities, historically Black institutions, Hispanic-serving institutions, etc.).

The second limitation was the time duration in which this study was conducted. While this study utilized a quasi-longitudinal design as implemented via the semi-structured interview protocol, participant interviews only took place during the course of a single semester. For the purposes of this study, participant discussions regarding their lives prior to college and after graduation served as approaches for understanding participant backgrounds and their future career plans, respectively. To more accurately capture the identity formation and personal development of these students throughout their academic careers, a longitudinal study must be designed to follow participants from their freshman through to their senior years to gather a more authentic and holistic perspective of professional identity negotiation. However, the retrospective nature of student interviews prompted participants to reflect, construct, and process their own narratives of identity formation before my eyes. This enabled me to observe participant reactions to their developing narratives, thus adding to the richness of the collected data.

The last limitation identified for this study was the interview techniques used to explore identity formation. As a researcher, I am influencing their identities and how they perceive themselves by conducting the interview and prompting their reflection. One telling indicator of this instance was through feedback that I had received from participants in the follow-up questionnaire or at the end of the interview. While some participants expressed awe in their own growth as individuals and as civil engineers, others simply expressed gratitude for taking the time to ask them questions that they may not think about nor express on a daily basis. Another limitation aligning with the implementation of interview techniques was the self-assessment practices that participants employed during their interviews. While I took steps to mitigate self-assessment during interviews, these practices may still have ensued, thus potentially shifting participant responses to questions.

### 3.11 Summary

The grounded theory research methodological framework (Charmaz, 2014) was used to guide my data collection and analysis procedures for this study. The study was conducted using eight constant comparative analytical iterations in which a total of 31 sophomore-, junior-, and senior-

level civil students were interviewed using intensive semi-structured interviews as informed by the Critical Incident Technique (Flanagan, 1954; Grant & Trenor, 2010; Gremler, 2004; Simmons, 2012) and the constructivist interviewing approach (Charmaz, 2014). Data collection and analysis were conducted simultaneously and in multiple iterations using constant comparative methods and were used to streamline theory development as the study progressed.

The grounded theory resulting from this work, the AOI Model, is an interpretation that cannot stand outside of the researcher's views or bias (Corbin & Strauss, 1990). To address this characteristic of grounded theory research and make the findings of this study accessible and relevant to other individuals, I not only delineated a process of identity formation, but also identified key elements that promote its development as relevant to civil engineering faculty and students. Chapters 4 and 5 of this study will discuss the findings generated from these methods and situate them within current literature.

# CHAPTER 4: RESULTS

## 4.1 Introduction

The purpose of my study was to further understand and explore the processes by which civil engineering students negotiate disciplinary perceptions to form professional identities. The overarching question that guided my work was: how do undergraduate civil engineering students negotiate disciplinary perceptions to form identities as professional engineers? To address the purpose of this study and answer this question, I designed a grounded theory investigation guided by the following research questions:

RQ1. What are students' initial perceptions of the civil engineering profession?

RQ2. How do students' perceptions of the civil engineering profession change as they enter college and navigate their undergraduate experiences?

RQ3. What are the outcomes resulting in these changes in perception?

RQ4. How do these perceptions intersect with their personal identities?

In this chapter, I present the findings resulting from the methodological procedures described in Chapter 3. The overarching result of this work is embodied in an emergent grounded theory model of identity formation for undergraduate civil engineering students titled, *Negotiating Equilibrium: Advancing from Outsider to Insider* (also referred to as the *AOI Model*). As such, the findings for each research question are not necessarily presented in numerical order; rather, each are presented with the corresponding grounded theory component of the AOI Model by which it is addressed, as shown in Table 4.1. A summary mapping each research question to the emergent model is presented in Section 4.4.

Table 4.1: List of Research Questions with the AOI Model and GT Components

| RQ# | Model Component | GT Component | Section No. |
|---|---|---|---|
| 1 | Definition of Self and Profession | Contributes to Context | 4.2.1 |
| 2 | Definition Negotiations | Strategies | 4.2.3 |
| 3 | Advancing from Outsider to Insider | Outcome | 4.2.4 |
| 4 | Salient Identity Orientations | Strategies (Theoretical Categories) | 4.2.3.2 |

To begin this chapter, I provide an overview of the emergent theory. Next, I explicate each component of my theoretical model, beginning with the two concepts by which it is underpinned: definition of self and definition of profession (RQ1). I then describe the ways in which participants negotiate their definitions of self and the profession (i.e., *strategies*) as they learn unanticipated information (i.e., *causal condition*) during their undergraduate education experience (i.e., *context*) (RQ2). Next, I explain the ways in which these strategies are balanced to promote participants' perceptions of themselves as professionals (i.e., *core phenomenon*) via three salient identity orientations: self, learner, and career trainee (i.e., *theoretical categories*) (RQ4). I then present the overarching outcome of this grounded theory model: advancing from outsider to insider (i.e., *outcome)* (RQ3) as participants self-assess, practice, apply, and parse out their learned knowledge in relation to their overall career goals (i.e., *intervening conditions*). To demonstrate the functionality and highlight various aspects of the model, I present three vignettes that capture participant experiences as related to the emergent theory. I then map and provide a discussion of each research question as related to the emergent theory. To conclude this chapter, I address the transferability of this model and its practical application to other fields, particularly considering the inherent role of causality by which this model was constructed.

## 4.2 Achieving Equilibrium: A Grounded Theory of Professional Identity Formation

The overarching result of this study is the AOI Model. This grounded theory, presented in Figure 4.1 on page 134, captures the dynamic process of professional identity formation in which civil engineering students advance from an *outsider* (i.e., an individual not belonging to a civil engineering group) to an *insider* (i.e., an individual belonging to a civil engineering group). This formation resulted from an iterative process of negotiations occurring between participants' definitions of the self, the civil engineering discipline, and future career aspirations. During these negotiations, participants merged personal identity dimensions such as gender, family culture, religion, and personal values with the information they acquired during their undergraduate education experiences. These negotiations occurred as participants attempted to maintain a balance among their definitions of self and civil engineering as a means to remain identified with the discipline and achieve their career aspirations. To cope with this negotiation process, participants utilized three salient identity orientations as reference points for controlling

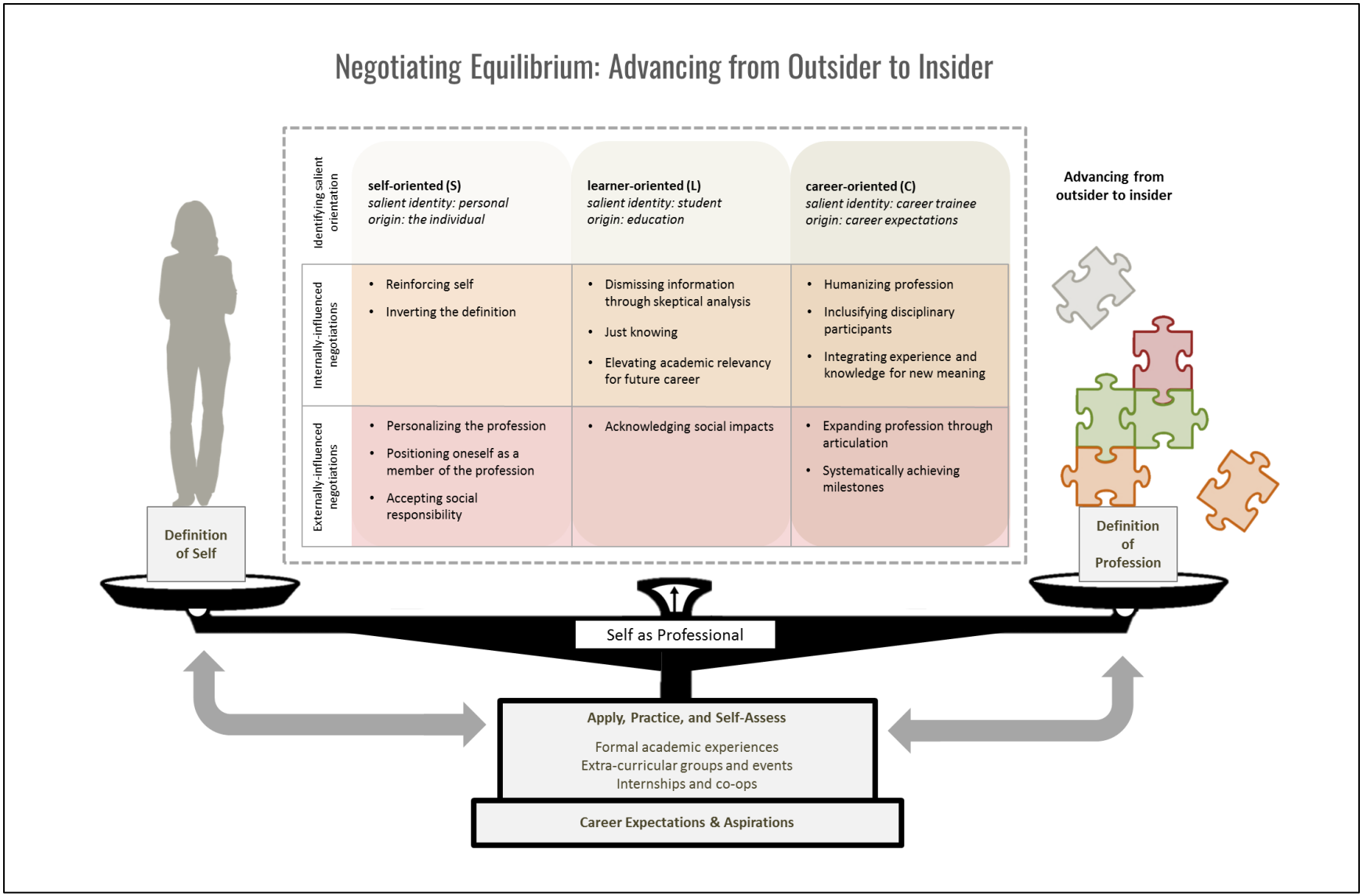



Figure 4.1: The AOI Model

internally-influenced negotiations or managing externally-influenced negotiations. As participants continued this process of negotiation, they began to take command of and integrate their evolving definitions to enact, or present, varying degrees of belonging to the civil engineering profession as they embarked on their careers in civil engineering.

The overall premise of this grounded theory is that individuals attempt to balance their definitions of self and profession to maintain identifications with the civil engineering discipline and achieve their career goals. This balance is conducted as students learn new or conflicting information during their undergraduate careers and negotiate various aspects of these definitions. Assessments of balance are also iteratively conducted as individuals apply, practice, and self-assess their knowledge in their courses, extra-curricular activities, and internships. According to the AOI Model, definitions of self and profession are considered to be balanced when the individual is able to live or simultaneously enact aspects of both definitions and advance from an outsider to an insider. In the following sections, I articulate this process in detail by elaborating on three primary components of the model: definitions of self and profession, identity negotiations, and perceiving self as professional (i.e., living the definition). I then bring this model together by summarizing the overall purpose of the model: to capture the initial formation and evolution of professional identity via negotiated perceptions of self and the civil engineering discipline.

### *4.2.1 Definitions of Self and Profession*

*Definition of self* and *definition of profession* (i.e., civil engineering) are the two components that underpin the emergent theory. These concepts were derived from participant descriptions of themselves and the civil engineering discipline throughout interviews. Initially, these concepts were utilized to indirectly discuss identity with participants. However, further analyses revealed these concepts to be indicators of identity, capable of capturing the evolution of the self and its integration with the discipline as participants shifted from "ordinary members of society" (Dryburgh, 1999, p. 666) to members of the civil engineering profession.

Aligning with prior literature defining personal identity (Brewer, 1991; Jones, 2009; Jones & McEwen, 2000; Vignoles, Schwartz, & Luyckx, 2011), the definition of self refers to the unique conceptualizations that are assigned to oneself or those that exist as an inherent core that

incorporate “valued personal attributes and characteristics” (Jones, 2009, p. 287). Definition of the profession refers to the ways in which a participant describes their chosen profession (i.e., civil engineering in the present study). For the purpose of this study, this definition consisted of terms used by the participant to describe the civil engineering discipline (e.g., math, hard, problem-solving, buildings) or ways in which the participant places value on or situated the profession within their lives (e.g., positioning civil engineering as a job versus a self-defining career). Definition of self is represented using an image of a woman’s silhouette to capture the individual as a whole, complete with her own background, values, skills, and prior knowledge. Definition of the profession is represented using puzzle pieces that are in the process of being linked together. Each puzzle piece is represented using a different color, thus indicating that multiple forms of knowledge are pieced together to create a definition of the profession. This representation is significant in that it also captures students’ agency in constructing a definition as they gain a more complete understanding of the civil engineering discipline that is relevant to their own lives. Therefore, each student maintains individual perspectives that promote the unique constructions of a variety of civil engineering definitions. That is, each puzzle may look different. The representations for both definitions of self and profession are shown in Figure 4.2.

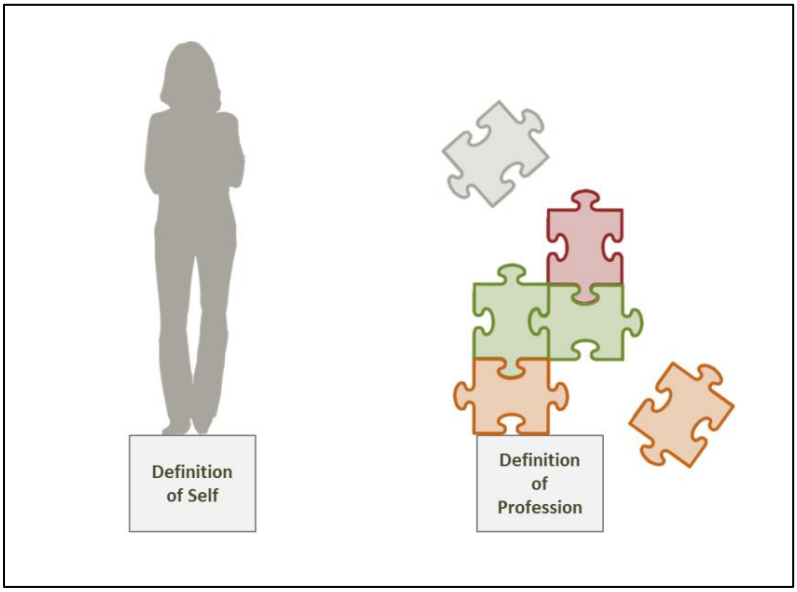



Figure 4.2: Definition Representations

This conceptualized process is dynamic and, in this study, continuously evolved as the individual and their knowledge about the civil engineering discipline developed. As students entered

college, they had already constructed a definition of self and a definition of civil engineering in some form. In this study, I explored these prior constructions or conceptions of the civil engineering discipline to address RQ1. The initial definitions that students possessed prior to college consisted of fairly general descriptors (e.g., math, buildings, and design), aligned with the students' perceived skills and interests, and introduced them to potential career aspirations. Multiple students such as Zane and Corey described civil engineering using the terms *math* and *buildings*, a skill and an interest, respectively, that they perceived to possess prior to entering college. This perception is also demonstrated in the following discussion with Cecilia:

> Interviewer: If you could describe civil engineering […] any time before college in five words, what would those be?
>
> Cecilia: Building bridges and buildings.
>
> Interviewer: So you really saw it more as like the structural side of civil engineering?
>
> Cecilia: Yeah. That's kind of what I thought it was.
>
> Interviewer: Okay. Why do you think that is?
>
> Cecilia: It's probably just what you see. I mean you see building and a bridge and you're like, "A civil engineer did that," but you don't see a water pipe every day and think like, "Oh civil engineering did that." You think a plumber did it. The environmental side of things, you don't. It's not tangible – you don't see it. Then… I don't know. I think we take roads for granted. You don't really think that a lot of design work went behind the roads because we're stuck in traffic and they don't make sense sometimes and they're like, "No one designed this. They just plopped it down." I think that's why. It's just a very easy and significant thing to see.

Upon aligning these skills and interests, students were then able to identify, in a general sense, their career aspirations that seemingly aligned with the civil engineering discipline. Corey, for

example, associated building roller coasters with civil engineering. This association was encouraged by his parents and his uncle, who is also a civil engineer.

> Um, I, well from a very young age I wanted to build roller coasters, and that's what I wanted to do with my life. And my parents were like, "That's what civil engineers do." And my uncle was also a civil engineer and they're like, "That's what Uncle Bob does." And I was like, "Oh my gosh, he's the best." *(Corey)*

A summary of students' prior conceptions of civil engineering is shown below in the Wordle™ in Figure 4.3. In this figure, the size of the word corresponds to the frequency in which it was used by participants to describe the discipline.

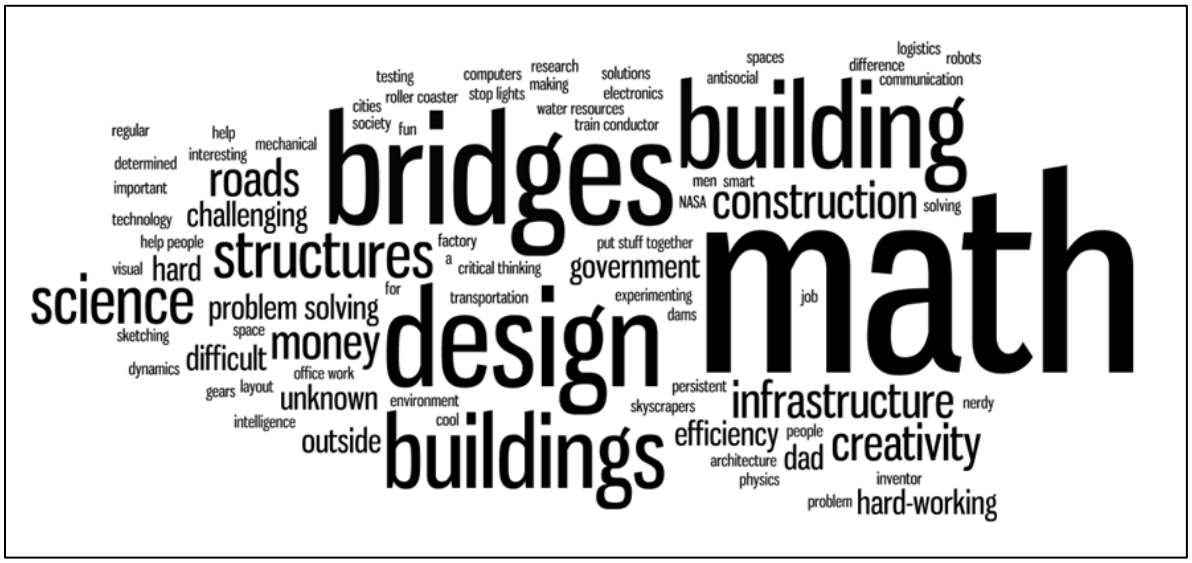



Figure 4.3: Summary of Student Conceptions of the Civil Engineering Discipline

As participants entered into college and learned about the civil engineering discipline, they retained or discarded different types of information as it related to their perceptions of their overall career goals. During this process, participants attempted to balance definitions of self and the civil engineering discipline to maintain identifications with the profession and remain in the field, as further described in the next section.

### *4.2.2 Self as Professional: Living the Definition*

The core phenomenon of a grounded theory is identified as the central concept or phenomenon on which the process under study is based (Hachtmann, 2012). For the purpose of this study, the

core phenomenon is represented as a scale that balances or compares the definition of self with the definition of profession, as shown in Figure 4.4.

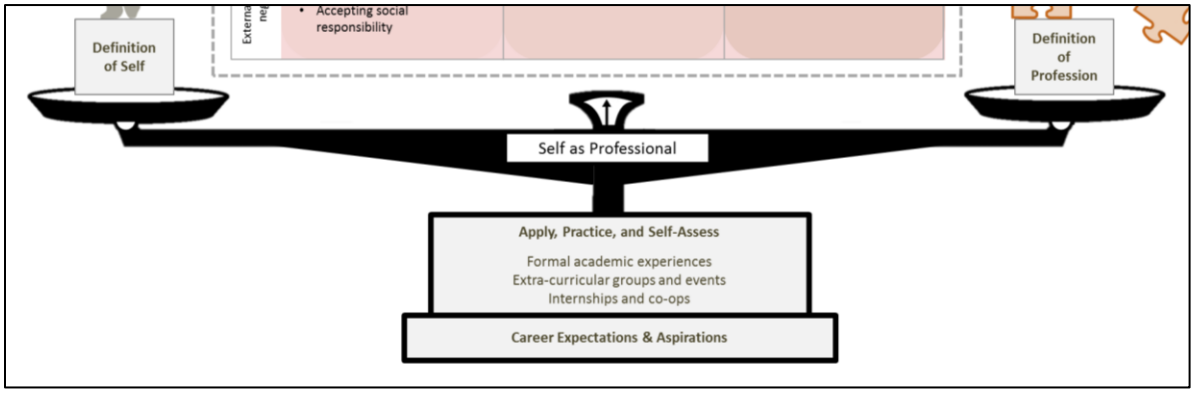



Figure 4.4: Representation of the Core Phenomenon

This representation of the core phenomenon consisted of three inextricable components: 1) the scale that balances definitions of self and professional, 2) the supporting pedestal of application, practice, and self-assessment, and 3) the foundation of career expectations and aspirations. Inspired by constructivism (Charmaz, 2014; Guba & Lincoln, 1994; Jonassen, 1991; von Glasersfeld, 1995), a balance scale was intentionally chosen to represent the reciprocal relationship between an individual's definition of self and definition of profession. According to constructivist theory, knowing is a process of actively making meaning and interpreting the interactions and actions of others (Charmaz, 2014; Guba & Lincoln, 1994; Jonassen, 1991; von Glasersfeld, 1995). Therefore, constructions of identity and perceptions of institutions, such as the civil engineering profession, are "dependent on one's own conceptualizations, presentations, and re-presentations" (von Glasersfeld, 1995, p. 141). To situate this philosophical perspective within this particular study, it was recognized that as an individual's perception or definition of self shifted and developed throughout the undergraduate learning experience, so too would their interpretations or definitions of the civil engineering discipline.

This relationship is underpinned by the supporting pedestal of application, practice, and self-assessment and the foundation of career expectations and aspirations. Career expectations and aspirations were identified as the foundation upon which participants constructed their professional engineering identities as they began to balance their definitions of self and profession. Without the career goal of becoming a civil engineer or pursuing a career in the civil

engineering field, the entire model ceases to exist. Because the primary purpose for individuals attending college is to prepare for a future career (Klass, 1961), it can be rationalized that without these civil engineering-related career aspirations, participants cannot identify a set of skills, knowledge, values, or behaviors to internalize; that is, they cannot develop a professional identity. This rationalization was further evidenced by participants' acceptance or rejection of specific types of information. As a freshman, Maynard rejected certain types of information in one of his projects in his first year engineering course as he did not perceive them as directly related to his aspirations to be a civil engineer:

> It felt like they are trying to turn something that wasn't engineering into engineering almost. It's really hard to describe because you could see where that would be engineering but, at the same time, we don't know anything and it's like they're expecting us to know something that we have no way of knowing. *(Maynard)*

In his explanation, he acknowledges that while he did not have a firm grasp of what engineering was, he was certain that the project did not simulate engineering-related work. Therefore, despite participating in a project that has been intentionally designed to foster the skills and content knowledge necessary for engineers, he dismissed the project as "dumb" and deemed it ineffective for advancement toward his future goals.

The supporting pedestal of the AOI model consisted of the application, practice, and self-assessment of participants as they engaged in formal academic experiences, extra-curricular activities, and internships and co-ops. As participants acquired information about their chosen career path, they began to apply and practice that knowledge in a variety of contexts. For example, Sid, who worked part-time at a local civil engineering firm during college, often applied the knowledge he gained in class to his job tasks. He would then draw from the knowledge he was gaining from his job experience to complete his coursework. Other participants, such as Zane and Cameryn, utilized internships and co-ops to pilot their current career paths. While they did not maintain vast amounts of knowledge regarding the civil engineering sub-discipline on which their internship was based, they sought out these job opportunities to practice what they were learning and examine current career interests. Dave and Brandon applied their knowledge of civil engineering to extra-curricular organizations. Concrete

for Kids and Bridges to Prosperity were both local campus groups in which students participated that provided opportunities for global service learning and community outreach. While participants applied and practiced their knowledge in these contexts, they also assessed their own learning throughout their undergraduate careers. For many students, such as Macy and Meg, academic coursework and exams were considered to be a measure of learning and self-improvement. In these instances, participants moved beyond the passive accumulation of knowledge and actively engaged in their learning to monitor their development as emerging professionals.

When considering the balance, the pedestal, and the foundation in tandem, we can identify the core phenomenon of *self as professional: living the definition.* As individuals developed their definitions of self and profession and related them to their overarching career aspirations, they were able to apply, practice, and assess these definitions in a variety of contexts within the undergraduate civil engineering experience. To articulate the balance of definition of self and profession, I revisited the fundamental definition of identity aligning with the purpose of this study. *Identity*, as defined by Holland and colleagues and cited in Tonso (2014) states, "Identity is a concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations" (Holland et al., 1998; Tonso, 2014). In order for an individual to maintain identification with civil engineering and their career goals and integrate their definitions of self and discipline, they needed to maintain a balance between these definitions. That is, they needed to possess the ability to enact or live their definitions and perceive themselves as civil engineering professionals. However, in order to maintain that balance, participants engaged in definition negotiations as prompted by new, unanticipated, or conflicting information. These negotiations are discussed in the next section.

### *4.2.3 Definition Negotiations*

Previously introduced in Chapter 3, the negotiations performed by participants during their undergraduate careers are framed as *strategies*, or actions taken in response to the *core phenomenon* in a grounded theory process (Charmaz, 2014). For the emergent grounded theory presented herein, the strategies were represented within the model as shown in Figure 4.5. In particular, they are indicated by the definition negotiations circled in red.

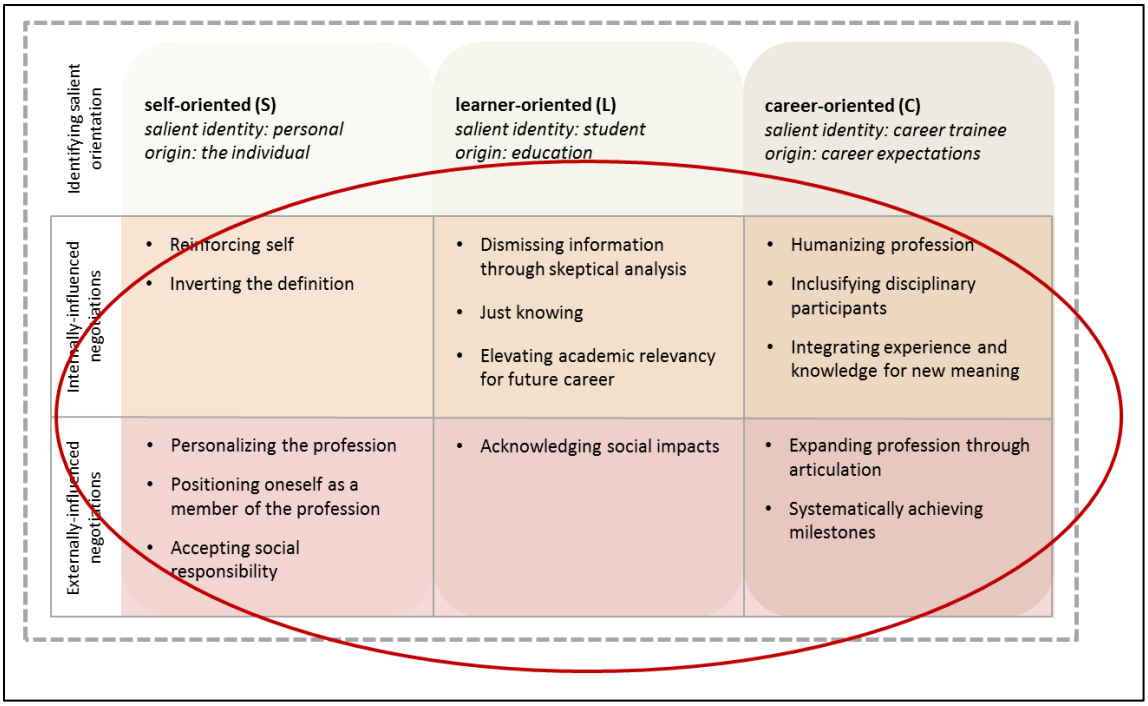



Figure 4.5: Negotiation Representations

The identification of these negotiations addresses one portion of RQ2, particularly regarding the strategies by which students' perceptions of the civil engineering profession change. Definition negotiations were directly observed and coded as actions within raw data captured during each participant interview. Actions such as *thinking like an engineer*, *accepting social responsibility*, and *struggling together* are examples of codes that were iteratively abstracted throughout data analysis to form definition negotiations. I defined these actions as *negotiations* due to the subjective nature by which they influenced various aspects of participant definitions. For example, *dismissing information* was identified as a negotiation related to civil engineering content knowledge, whereas *positioning school as job training* was related to participants' perceptions of the college experience. Negotiations such as these served as the primary mechanism by which participants' perceptions, or definitions, of civil engineering changed. They can occur randomly, simultaneously, or not at all based on the individual's context, pre-existing definitions, and learned information.

To capture the ways in which these negotiations were enacted, they were represented within the model via a large matrix situated between the definition of self and the definition of profession. As students attempted to align or balance their definitions, they could choose to enact any

negotiation relevant to their particular situation. Notably, the appearance of these negotiations does not imply any form of order or importance; rather, this representation serves solely as a visual representation of the type of negotiations individuals may employ. The matrix cells delineating these negotiations were determined based on the characteristics possessed by each negotiation. These characteristics include directionality and identity orientation, which are further discussed in the following sections.

#### *4.2.3.1 Directionality of Negotiations*

As participants enacted definition negotiations, it was first observed that these negotiations maintained a form of directionality based on the context in which they were performed. This directionality of definitions is captured in the model on the left side of the negotiation matrix, as shown in Figure 4.6, below.

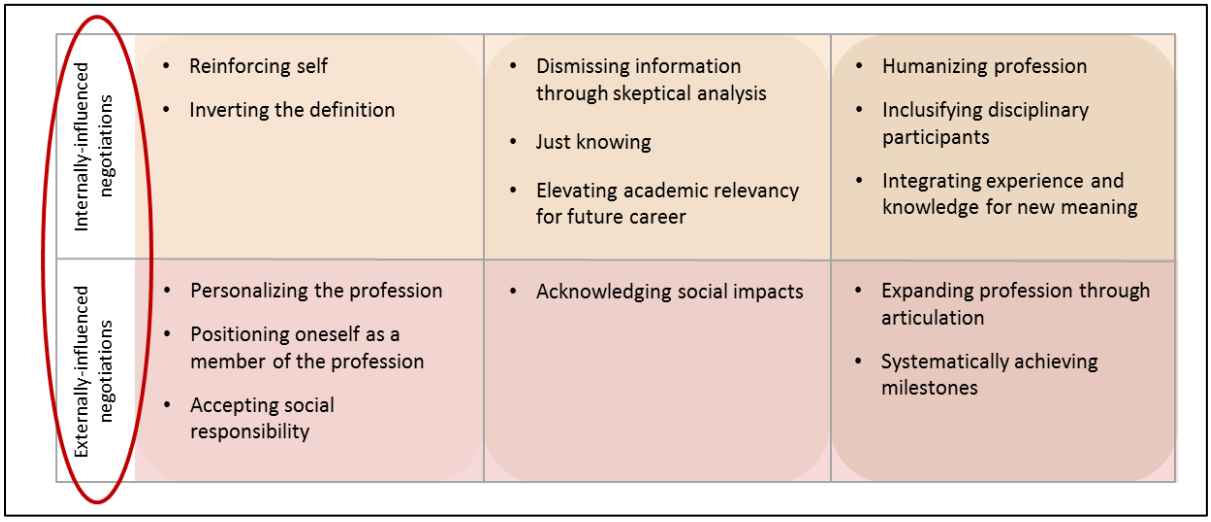



Figure 4.6: Representation of Directionality

This characteristic was inspired by multiple constructs existing within the identity literature: the "double-sided approach to engineering identity" (Stevens et al., 2008, p. 360), discourse identity (Gee, 2001; Spears, 2011), social identity theory (Abrams, 2015; Spears, 2011; Tajfel, 1974; Tajfel & Turner, 1979), and institutional identity (Gee, 2001). The double-sided approach to engineering identity addresses the perspective of identity construction in which individuals position themselves and are also positioned by others (Stevens et al., 2008). Similarly, Gee (2001) and Spears (2011) also identify discourse identity as a means to enact an identity while engaging with others; however, for an identity to be enacted through discourse, this identity must

also be acknowledged by others. Aligning with the double-sided perspective and communicative aspects of identity construction, social identity theory (SIT), or group identity, implies that membership in a group is framed through comparisons of values and behaviors that members make between each other and individuals belonging to other groups (Abrams, 2015; Spears, 2011; Tajfel, 1974). While other individuals and groups are positioned as constructing identity from these perspectives, institutional identity situates an institution in a position of power that consist of authorities that grant specific identities to an individual (Gee, 2001). While these constructs did not directly dictate how directionality was defined in this study, they did influence the ways in which directionality was interpreted. When considered simultaneously, these constructs highlight the external influences of identity formation. Not only is an individual's identity internally defined by oneself, but it is also socially constructed in that it must be engaged in by other individuals, groups, and social establishments. Therefore, the identities of both the self and the profession concurrently shape and are shaped by one another.

Drawing from this literature, the role of others was applied to this study by examining the source from which a negotiation originated and its impacts on student definitions of self and profession. In particular, I used the term *directionality* to capture the direction of an interaction between a dominant influence and a participants' perception of self or profession. Definitions controlled by perceptions of the individual were considered to maintain an internally-influenced directionality, whereas definitions controlled by external influencers were considered to maintain an externally-influenced directionality. That is, some negotiations were identified and applied to the individual's definitions (e.g., a woman realizing that women can become civil engineers as she performs well on coursework) while other negotiations were imposed onto the individual by an outside source (e.g., a woman realizing that women can become civil engineers because her classmates tell her that she is a civil engineer).

#### *4.2.3.2 Identifying Salient Orientations*

Within the grounded theory framework of this study, salient identity orientations served as *theoretical categories*, or common themes that abstract an analysis to a theoretical level (Charmaz, 2014). These categories were represented on the top row of the negotiation matrix, as shown in Figure 4.7.

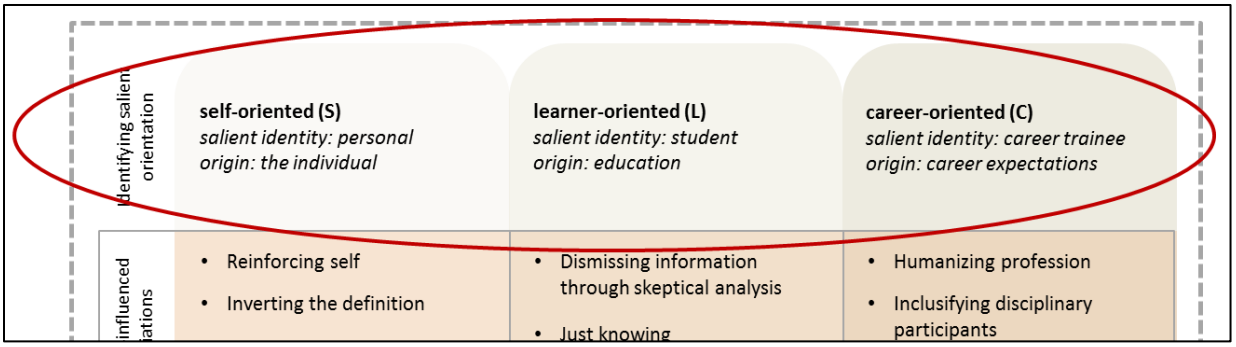



Figure 4.7: Representation of Salient Identity Orientations

Identifying these salient orientations enabled me to organize my model in such a way that I could garner a greater meaning of definition negotiations regarding context and motive. While directionality captured the sources from which negotiations were instigated, *salient orientations* identified specific identity dimensions by which negotiations were approached. Drawing from Abes, Jones, and McEwen's (2007) *Reconceptualized Model of Multiple Dimensions of Identity*, it was observed that participants enacted negotiations from the perspective of a salient identity or dimension. While some participants approached identity negotiations from more personal dimensions such as disability or gender, other individuals pragmatically enacted definition negotiations as students and as emerging civil engineers. In particular, three salient identity orientations were identified: self-, learner-, and career-oriented. Similar to Abes and colleagues' (2007) meaning-making filter, participants applied a "filter" or specific orientation to their negotiations based on the context in which it was occurring. In the following, I summarize these orientations and provide an example for each.

#### *4.2.3.3 Salient Orientation: Self*

A participant exhibiting a self-oriented approach to definition negotiation maintained a salient personal identity. From this particular orientation, the participant positioned the self as the primary reference point for which negotiations occured. This applied to how they are interpreted, applied, and integrated into pre-existing definitions of self and profession. Participants maintaining this orientation enacted negotiations that reinforced or shifted an individual's personal identity. Internally- and externally-influenced negotiations performed by individuals with a self-oriented approach are presented in Table 4.2.

Table 4.2: Self-Oriented Negotiations

| | Code | Definition | Example |
|---|---|---|---|
| *Internal Negotiations* | Reinforcing self | Identifying personal characteristics that are non-negotiable and are integrated into perceptions of civil engineering. | "If you want to live close to a city, then live in the city. If you don't, then don't. But don't waste land that can never be used again. It's just not logical. I wasn't going to sit there and pretend like [the job interview] was still on. I was like, 'Honestly, there's better ways to do things,' and [the interviewer] was like, 'okay,' and then we moved on." – Madison *[describing interview with land development firm]* |
| | Inverting the definition | Incorporating one's own characteristics into the definition of civil engineering. | "One of the most important values I have is just making sure I do a good job, anything that has my name on it, I always put 100% effort in something that I can be proud of at the end of the day. So now I guess, I sort of see that as being one of the … an engineer's value sort of." – Neil |
| *External Negotiations* | Personalizing the profession | Developing a personalized definition of civil engineering by associating learned characteristics to their lives. | "I never thought about it before, like where I lived and grew up. That was designed by somebody and their considerations and things probably shaped what I did." – Dave |
| | Accepting social responsibility | Accepting or assuming a role of social responsibility as an inherent practice of civil engineering work. | "[. . .] I just know that if temperature rises and water level rises then people are going to have to squeeze up. As a land development engineer, I'm going to have to figure that out or try to help figure that out." – Craig |
| | Positioning oneself as a member of the profession | Enacting discursive moves that exhibit belonging to the civil engineering group or maintaining civil engineering characteristics. | "I guess we ... I want to say that a lot of civil engineers do things with structures but that's not necessarily true I guess." – Linda |

#### *4.2.3.3.1 Salient Orientation: Learner*

Participants that exhibited learner-oriented approaches to definition negotiation maintained a salient identity as a student. That is, the primary reference point from which orientations occured was through learned information that was received by, interpreted, applied, and integrated to existing definitions from a student perspective. With this orientation, knowledge learned within a formal academic context but is not transferred to contexts outside of the university setting. In this particular study, participants typically positioned themselves as college students who received and applied information to their identities as students. However, the identity of a *student* may take on multiple forms. For example, an individual may learn that they need to do well in their

freshman engineering classes to be allowed access into their chosen major (i.e., civil engineering). Therefore, the participant positions their coursework as a requirement to achieve entrance into a major rather than as practice for a future engineering career. A more subtle example included a participant, Linda, who was not sure what the civil engineering discipline was, but because she was not learning anything outside of her existing profession definitions, she "just knew" that civil engineering was something that she wanted to pursue and had not considered other options for a college major. Examples of learner-oriented negotiations observed in this study are presented in Table 4.3.

Table 4.3: Learner-Oriented Negotiations

| | Code | Definition | Example |
|---|---|---|---|
| *Internal Negotiations* | Dismissing information through skeptical analysis | Dismissing learned information as irrelevant to prior conceptions and current identifications with civil engineering and future career expectations. | "It's such a dumb project, honestly, in my point of view that it just ... I'm trying to think. It felt like they are trying to turn something that wasn't engineering into engineering almost." – Maynard *[describing a project in an engineering course]* |
| | Just knowing | Maintaining a feeling that civil engineering is a destined career despite not having a clear definition of it. | "I don't know. I didn't really know what else. I still don't know what else I would do." - Linda |
| | Elevating academic relevancy for future career | Realizing the relevancy of learned content and its implications for future career aspirations. | "I took the land development class and it was … I found it really interesting and I liked what we were doing and I really felt that was a class that really was similar to how the real career would be." – Chad |
| *External Negotiations* | Acknowledging societal impacts | Acknowledging the social impacts as a result of civil engineering work. | "I would say civil engineers do everything. All the projects are, or most of the projects are, for the public like wastewater, groundwater, everyone's tap water. Engineers are behind that. Bridges to cross over stuff – civil engineers; buildings – civil engineers, geotechnical engineers, and all that stuff." – James |

This orientation is different than a learner orientation with a lifelong learning perspective. Within the context of this grounded theory, undergraduate engineering education, and participants' abilities to transition and manage life as college students were observed to be a significant portion of who these participants were. However, this is not to say that a learner orientation can be experienced only by those individuals enrolled in college. While *learner orientation* in this

study positions *the college student* as a salient identity, this orientation may be transferred to other contexts that position individuals outside of academic settings as lifelong learners. For example, a civil engineer within their first year of work at an industrial firm may need to attend professional development seminars or learn on-site management skills that shift their definitions of self and profession. Therefore, this orientation may serve as a particularly useful orientation as individuals enter into and continue in the field of civil engineering or other professions. Similar observations may be identified in individuals outside of college; however, they may manifest themselves in different forms and in different contexts.

*4.2.3.3.2 Salient Orientation: Career*

Participants approaching definition negotiations from a career-oriented perspective maintained a salient identity as a career trainee. The knowledge that they received, interpreted, and applied was positioned toward the individual's development as a future civil engineer or engineer-in-training (EIT). Meg, for example, began to perceive her homework problems as practice for her future career rather than as a course assignment, thus altering her approaches to engineering coursework. Examples of career-oriented negotiations are shown in Table 4.4.

Table 4.4: Career-Oriented Negotiations

| | Code | Definition | Example |
|---|---|---|---|
| *Internal Negotiations* | Humanizing the profession | Describing civil engineering or civil engineering work as being conducted by individual people rather than the profession. | "It took someone to make that sign and it took someone to say that they wanted that sign there, and it took someone to put up that sign. So, it took three people that should know these standards [. . .]" – Sid |
| | Inclusifying participants | Expanding perceptions of in-group members to include demographics not traditionally associated with civil engineering. | "Definitely not me. Like I would never say engineer ... me. I mean, now I do. But like, when I was younger, I would never be like, oh, the girl. I would always be male, I guess." – Macy *[describing who an engineer is]* |
| | Integrating experience and knowledge for new meaning | Integrating civil engineering-related and unrelated experiences resulting in gaining a new meaning of the discipline. | "It's like one of those things where you look at something and you can't look at it the same way again after you learn something about it. That's sort of me with everything now; like a road or a building or something, I bet it's a truss holding up that bridge or something like that." – Neil |

Table 4.4 (continued)

| | | | |
|---|---|---|---|
| *External Negotiations* | Expanding the profession through articulation | Articulating the nature of the civil engineering discipline while simultaneously expanding its meaning. | ". . . but it's like, there's so many different things that I can do as a civil engineer that it just makes me feel good." – Eleanor *[describing civil engineering]* |
| | Systematically achieving milestones | Systematically achieving goals that are driven by career aspirations and expectations. | "I don't like the idea of leaving something just sort of on the burner and letting it let me stress out about it, like knowing like I need to do this. I need to do this. That's what gets me worked up and not enjoying what I do." – Jack |

Examining each of these orientations revealed the ways in which multiple identity dimensions intersected with participants' definitions of self to form a professional identity, a question posed in RQ4. Intersectionality theory maintains that entities such as gender, race, sexuality, and ethnicity are not mutually exclusive but rather reciprocally and simultaneously contribute to identity construction (Collins, 2015; Crenshaw, 1989). For the purpose of this study, intersectionality was adapted to capture identity dimensions exhibited by participants as they navigated their undergraduate careers. Therefore, as individuals formed professional identities, they learned to not only negotiate their definitions of selves and profession, but also drew from specific dimensions of self, learner, and career to maintain identifications with civil engineering and their future career aspirations. However, as participants completed these negotiations, they were also developing as members of the civil engineering profession. This development is further discussed in the next section.

### *4.2.4 The Outcome: Advancing from Outsider to Insider*

While each component of the grounded theory model has been explored in isolation, the process of negotiating definitions achieves a higher outcome related to balancing of self and profession. The *outcome* of a grounded theory is identified as the *consequences* from employing strategies (Charmaz, 2014). For this particular theory, the outcome resulting from negotiating definitions was *advancing from outsider to insider* and was represented in the model as shown in Figure 4.8.

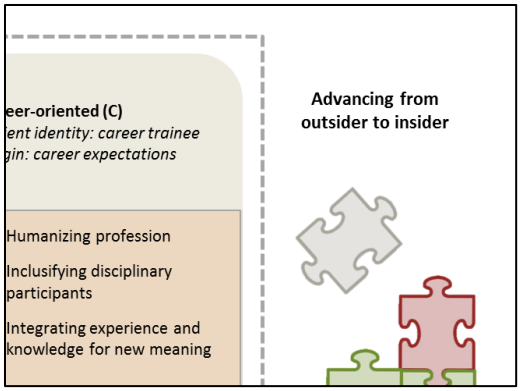



Figure 4.8: Representation of Outcome

As shown in Figure 4.8, *advancing from outsider to insider* was located to the right of the negotiation matrix and just above definition of profession. The position of this outcome was significant in two ways. First, its placement to the right of the negotiation matrix signified its outcome status as a result of employing definition negotiations. Second, its position above the definition of profession symbolized the advancement from outsider to insider as an individual constructed a more sophisticated perception of the civil engineering discipline. However, capturing this advancement was not achieved solely by observing increasingly-articulate definitions of the profession. As an individual existing outside of the self of the participants, I observed this advancement using an analytical approach combining discourse analysis (Gee, 2011) and speech acts (Austin, 1975). This analytical approach enabled me to identify utterances in which participants positioned themselves as civil engineers or as belonging to a civil engineering group, particularly through pronoun usage and declarative statements. These utterances can be identified in the following quote from James:

> A lot of people are ignorant and don't understand [civil engineering]. Your tax dollars actually go to stuff that you use every day. Some stuff gets frustrating, but I can always bring [that] up if I need to come at someone. It's like, disrespecting engineers. *(James)*

During this interaction, James was describing civil engineering as a less glamorous, behind-the-scenes engineering discipline in which hard work often goes unnoticed. While he exhibited his knowledge of the civil engineering discipline regarding the use of tax dollars, he also positioned himself as a defender of the discipline by applying that knowledge to conversations: "…I can

always bring [that] up if I need to come at someone." In other instances, participants would take on an educator role during the interview both in vocal tone and content. When identifying his interest in transportation as a future career, Sid was able to articulate a specific research area that involved vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies. During this conversation, Sid described both interfaces and explained their implications for the future of transportation. Despite their awareness of my background in civil engineering, they would still explain various aspects of the civil engineering discipline in an instructive manner.

Drawing from literature in discourse identity (Bamberg et al., 2011) and SIT (Spears, 2011; Tajfel, 1974), these discursive moves were interpreted as identities enacted through talk as participants positioned themselves as being a member of the civil engineering group (Gee, 2011; von Glasersfeld, 1995). As evidenced through these discursive moves, the outcome of the strategies in this grounded theory model, *advancing from outsider to insider*, was identified. Throughout iterative negotiations of definitions of self and profession, participants began to gain agency and take command of common civil engineering-related discourse and explanations. From this advancement, participants developed a professional identity as they learned and internalized these disciplinary characteristics and maintained the ability to enact that identity to individuals inside and outside the civil engineering discipline. While the outcome of definition negotiations resulted in advancement from outsider to insider, the development of a professional identity was the outcome of the holistic process captured by this emergent grounded theory.

### 4.3 A Tale of Three Students: Demonstrating Various Components of the Model

To demonstrate the use and application of this grounded theory model, I present participant vignettes that exemplify varying aspects of the emergent grounded theory. In particular, three characteristics of this model are highlighted using three vignettes: 1) balancing definitions of self and profession, 2) coping with a definition imbalance, 3) and experiencing an identity crisis (i.e., when the model breaks down). These vignettes highlight and demonstrate the vast array of pathways through which individuals may move throughout the AOI Model and, when considered together, demonstrate the iterative and evolutionary nature of identity negotiation.

### *4.3.1 Balancing Definition of Self and Profession: Craig*

Craig, a junior, was a first generation college student who came from a lower-middle class family. While his initial interest in engineering came from his father, his high school guidance counselor and his girlfriend's mother served as primary resources for learning about different college majors and the application process. Upon entering college, Craig was inspired by his first-year physics instructor and initially enrolled in the physics program. However, as Craig began to take advanced physics courses his sophomore year, he learned about the theoretical nature of the field and came to the realization that he wanted to pursue a career that aligned with his perceptions of who he was:

> I guess I just realized that engineering was more my cup of tea, and physics was interesting but not something I wanted to make a career out of. Like I said earlier, I was creative and I like designing and I can put a lot more of that into engineering than I can into physics.

Drawing on our prior conversation, Craig articulated his definition of the physics profession:

> It was just a lot of theory and a lot of stuff that I was just like "eh". I took a summer class in freshman year I think, and they talked about what you could do as a physics major. A lot of people that came in were dealing with cool stuff like dark matter and things like that, and I was like, "Oh, that's really awesome," but [other physics majors were] like, "You might never see your work done or anything, or get it ..." I can't. I need something tangible, and so I was like, "All right, I like physics, but I want engineering still."

As exhibited by this explanation, Craig identified a mismatch between his definition of self (i.e., creative, interest in design, desire to participate work resulting in tangible outcomes) and the definition of the physics profession (i.e., theoretical and abstract). Upon learning more about the civil engineering discipline, Craig identified an alignment, or balance, between his definition of self and the civil engineering profession. He then enrolled into the civil engineering program the second semester of his sophomore year. While taking courses, Craig learned about the social responsibility of the civil engineering profession, thus altering his definition of profession. Then, through the *accepting social responsibility* negotiation, Craig integrated his adjusted profession

definition with his definition of self, as demonstrated in his quote, "[My professors] definitely influenced me as well as just the world influencing me. It's touched a certain part of me that wants to help people." In this statement, Craig internalized this learned civil engineering characteristic (i.e., helping people) and applied it to his overarching career goals as a civil engineer with a focus on land development. This integration was further demonstrated in his description of his anticipated duties in this capacity:

> People are going to start migrating north I feel like, and as a land development engineer, I'm going to be responsible for fitting all these people. I'm going to have to come up with creative ways. I think there's going to be advancements pertaining to the whole engineering world and all that. I just want to be a part of that. I want to make sure that people have a place to go.

To further strengthen the connection between definition of self and profession, Craig countered this externally-influenced negotiation with an internally-influenced negotiation of *reinforcing self* near the end of the interview:

> I knew that engineering filled those [future plans] and also met all of the criteria of who I am, what I'm good at, what I like. It was just a good fit for me and what I wanted.

In this negotiation, Craig took ownership of learned civil engineering characteristics and not only positioned civil engineering as a viable career path, but as a reflection of who he is.

#### *4.3.2 Coping with Imbalanced Definitions: Amy*

Amy, a sophomore, had developed a general definition of the civil engineering discipline from her father, who owns a civil engineering firm. However, she did not necessarily make an attempt to learn about the discipline through him, and primarily based her perceptions of civil engineering around topics of design and observations of structures in her surroundings. As a sophomore, Amy felt that while she had been exposed to the engineering field in her courses, she had not yet learned about the discipline of civil engineering. Therefore, she was excited to participate in extra-curricular activities as a means to broaden and apply what she was learning in the classroom:

> I'm going to be the captain [of concrete canoe] next year. […] I didn't do it freshman year because I didn't even know if I was going to go into civil, and I was just so overwhelmed with freshman things. [This year] I got pretty involved […] and I absolutely love it. It's totally low-key nerdy, but it's so much fun because it is kind of applying things that you're learning … like "how does concrete float?" And then we explain how it works.

In our conversation, Amy negotiated her definition of the profession through *elevating academic relevancy for future career.* While her definition of the civil engineering discipline was still evolving, she contextualized learned information through her participation on the concrete canoe team. Further, Amy began to establish her *advancement from outsider to insider* as she was anticipating taking a leadership role on team. However, upon achieving seemingly balanced definitions of self and profession, Amy disclosed an internally-influenced negotiation that had not been previously discussed in her interview:"I do want a career and everything, but I don't want that to define me." This reinforcement of self articulated Amy's definition of profession by positioning civil engineering as a job, rather than a career that dictated her definition of self. In our discussion, Amy highlighted the vast differences among participant definitions of the civil engineering profession. While some participants, such as Craig, integrated the profession as a way to define who they were, Amy kept these concepts separated while still maintaining an identification with civil engineering. One possible explanation for this shift in profession definition may originate from Amy's past experiences as a child. While she excelled in school and was interested in civil engineering prior to college, her brother, who was approximately a year younger than she, was repeatedly told by her family that he was going to be an engineer. This lack of support experienced by Amy at an early age may have led her to position civil engineering as a job, rather than a defining characteristic of self. However, this explanation is only presented as speculation and further exploration of this relationship would need to be conducted.

### *4.3.3 Experiencing an Identity Crisis: Macy*

Macy, a sophomore, knew at an early age that she wanted to be an engineer. While she initially wanted to be a chemist, she switched her career aspirations toward chemical engineering after writing a report that prompted her to explore her career interests in middle school. As Macy

entered into college, she maintained this career trajectory, and came to LLG with the intent of pursuing a chemical engineering degree. However, as Macy continued to learn about the discipline of chemical engineering, she realized that this profession did not align with who she was:

> So then I did chemical engineering. So then from 7th grade up until this past summer, I was like, 'I'm going to be a chemical engineer.' I was like, 'That's my job.' I knew what I wanted to do with it, what direction I wanted to go in. I had everything planned. And then this time last year, I realized I didn't want to spend my entire life in a lab by myself. And I had this huge ... basically I had no idea what I'm doing with my life. I almost switched out of engineering entirely. I almost transferred schools. I didn't know what I wanted to do. But I had two criteria for my future job: I had to be happy and I had to help people in some way.

Macy further explained her rationale behind this realization:

> Because originally with chemical engineering, what I wanted to do was I wanted to go into fuels and work on a sustainable ... possibly like not like ... synthetic fuel source that could be ... it's renewable, it's healthy for the environment. All that kind of stuff. So, I was like, "That's what I'm doing. I'm so excited." And then I didn't want to spend the rest of my life in the lab by myself. Clearly I'm very talkative.

While she enjoyed the content of the chemical engineering discipline, her perceived lack of social interactions in the chemical engineering workplace discouraged Macy from pursuing that career. Macy, who defined herself as talkative and social, identified a conflict with her definition of chemical engineering as an isolating profession. As her prior career aspirations in renewable fuels had diminished into a lonely laboratory scientist, her career foundation disintegrated, leaving her feeling lost and unable to negotiate through her imbalance. As related to the emergent grounded theory, Macy experienced an identity crisis that almost propelled her out of engineering entirely. To overcome this crisis, Macy redefined her career aspirations, seeking out a profession that could be defined by her two guiding criteria: personal happiness and helping others. As Macy researched other engineering disciplines, she found that civil engineering

aligned with her criteria and thus provided a base definition for which she could balance her sense of self. Therefore, Macy essentially demolished and reconstructed her negotiation structure. At the time Macy entered into the civil engineering program, she then embarked on the iterative negotiation as described by the model and experienced by her peers.

### *4.3.4 Examining the AOI Model through Participant Vignettes*

While the participant vignettes presented in this section can be used to demonstrate various components of the AOI Model, they also highlight a deeper meaning regarding the various pathways experienced by students as they negotiate and develop their professional identities. Each participant experienced a different level of definition balance within the model that depicted their unique pathway of advancing from outsider to insider. Craig, for instance, achieved balanced definitions through his sense of self and coursework. Amy coped with her definition imbalance by altering traditional definitions of civil engineering and applying them to her own life. Meanwhile, Macy underscored the importance of career aspirations as she used them to re-establish a foundation on which to create her civil engineering identity after she left chemical engineering. While these experiences are diverse, they also converge on students' similar career aspirations of becoming civil engineers, which lends to the flexibility of the AOI Model and its ability to capture participant identity negotiation across a variety of local contexts (i.e., specific circumstances in which a negotiation occurred for a single participant). As all of these participants intended to pursue a career in civil engineering, these vignettes show us that while identity formation is not the same for everyone, all of these pathways are relevant and valid as students construct professional identities.

## 4.4 Capturing Changing Disciplinary Perceptions using Grounded Theory

The purpose of the AOI Model is to capture and further explicate the ways in which participants negotiate disciplinary perceptions to form professional identities. While this model demonstrates the process of definition negotiation, it has also revealed the varied nature of participants' perceptions of the civil engineering discipline and their intimate connections to an individual's everyday interactions with others, perceptions of self, and evolving career goals. To further explore the nuance of this process, I asked four research questions to guide my inquiry, as presented in Section 4.1. In this section, I map my research questions to the corresponding

grounded theory components by which they are answered, as shown in Figure 4.9, and provide a brief discussion for each.

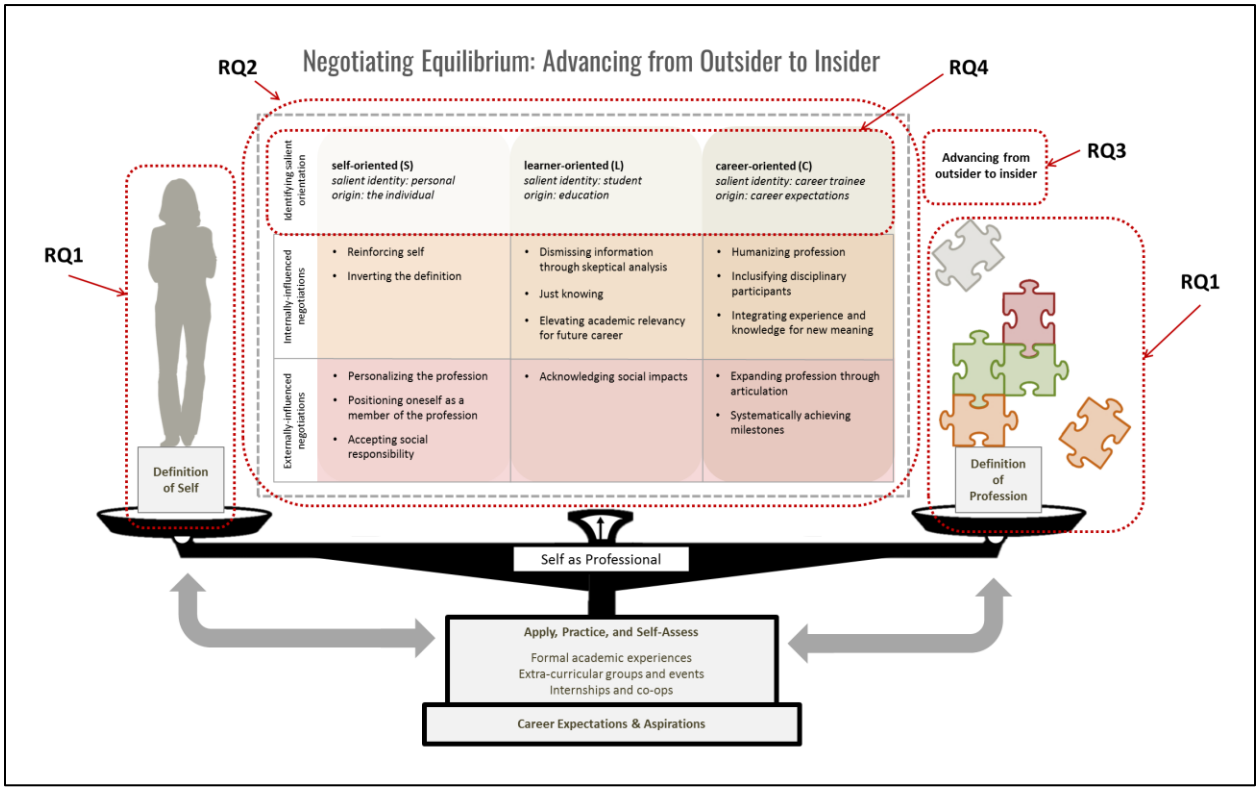



Figure 4.9: Grounded Theory Map of Research Questions

In RQ1 I asked, What are students' initial perceptions of the civil engineering profession? As participants entered college, they possessed a basic definition of engineering or civil engineering based on their experiences prior to college. As shown in Figure 4.3, most participants utilized task-based skills (e.g., math and science) or observed characteristics from their environment (e.g., buildings and bridges). Within the AOI Model, this initial perception is represented through the existing definition of self and definition of profession at the start of a participants' college career, as shown in Figure 4.9. Because participants are choosing to enter or have interest in entering the field of civil engineering based on pre-established career aspirations, it may also be determined that their definition of self is fairly balanced with their definition of profession as they enter into the civil engineering major. Some exceptions to this concept are those students who did not choose civil engineering on their own volition or did not plan on pursuing civil

engineering as a future career path; however, none of the participants in this study exhibited those characteristics.

In RQ2 I asked, How do students' perceptions of the civil engineering discipline change as they enter college and navigate their undergraduate experiences? This research question may be answered in two ways. First, drawing from comparisons of participants definitions of profession prior to college to those during college, it was clear that participants gained a more nuanced and abstract perspective of the civil engineering discipline (e.g., shifting descriptors from "math" to "problem-solving"). These shifts in definition allowed participants to better articulate career goals and make more informed definition negotiations. Second, considering this model in its entirety captures the process by which participants' perceptions of the civil engineering discipline change throughout their educational experiences. As participants entered into college, they learned about the valued behaviors, symbols, language, skills, and knowledge of the civil engineering discipline. This learning took place in many forms and contexts, ranging from learning structural design in a formal academic classroom to more informal contexts such as educating elementary school children about the basics of concrete. Regardless of the specific contexts in which learning occurs, all of these learning experiences influenced participants' perceptions of themselves, of the civil engineering discipline, and how they perceive their future selves in the civil engineering field.

In RQ3 I asked, What are the outcomes resulting from these changes in perception? Unlike the other questions posed in this study, the outcome of the grounded theory model, *advancing from outsider to insider*, is the outcome from participants' changes in disciplinary perceptions, as shown in Figure 4.9. As participants gained more knowledge about the civil engineering discipline, they employed multiple identity negotiations that allowed them to accumulate knowledge useful to their future career aspirations and take command of that information. In this study, participants showed early signs of this advancement as they shifted from being an individual who solely received disciplinary information (i.e., an outsider) to someone who could also provide a more articulate explanation about the discipline (i.e., an insider).

In RQ4 I asked, How do these perceptions intersect with their personal identities or sense of self? Upon examining participants' definition negotiations, it became clear that they did not completely change their sense of self throughout their undergraduate careers. Rather, participants

identified a relevant salient orientation by which to manage and negotiate different aspects of their lives. As captured in the model as salient identity orientations (Figure 4.9), participants chose one of three identity orientations when enacting a definition negotiation: 1) self-oriented, 2) learner-oriented, and 3) career-oriented. While specific orientation-related negotiations may happen simultaneously, future work would need to investigate single negotiations enacted via multiple orientations to further explore more complex intersections of identity.

### 4.5 Chapter 4 Summary

The purpose of my study was to answer the following research question: How do undergraduate civil engineering students negotiate disciplinary perceptions to form identities as professional engineers? The emergent grounded theory model, *Negotiating Equilibrium: Advancing from Outsider to Insider*, captures the process by which undergraduate civil engineering students negotiate definitions of self and profession as they shift from an *outsider* (i.e., an individual who does not belong to the civil engineering profession) to an *insider* (i.e., an individual who belongs to the civil engineering profession) and develop a professional identity. Within this chapter, I reviewed each component of this grounded theory including context (i.e., undergraduate civil engineering), core phenomenon (i.e., self as professional: living the definition), causal conditions (i.e., learning new, unanticipated, or conflicting information), intervening conditions (i.e., apply, practice, and self-assess gained knowledge through formal classroom settings, extra-curricular activities, and internships and co-ops), strategies (i.e., internally- and externally-influenced definition negotiations), and outcomes (i.e., advancing from outsider to insider) that create a model of professional identity formation that is relevant to multiple contexts. Results of this study demonstrated the intimate and nuanced connections between participants' definition of self and profession as related to their evolving career goals. This theory positions career aspirations and expectations as the foundation upon which this definition negotiation and identity formation occurs, thus yielding a variety of implications for engineering educators, as discussed in Chapter 5.

# CHAPTER 5: DISCUSSION AND CONCLUSIONS

## 5.1 Introduction

The purpose of this study was to further understand and explore the processes by which civil engineering students negotiate disciplinary perceptions to form professional identities. I addressed this purpose by designing and conducting a grounded theory study in which I interviewed 31 undergraduate civil engineering students to explore their formation as professional engineers. By conducting this inquiry, I was able to construct a grounded theory model titled *Negotiating Equilibrium: Advancing from Outsider to Insider* (also referred to as the *AOI Model*) that contributes to existing research on identity and the retention of students and professionals in civil engineering. Inspired by multiple identity frameworks and emergent analyses, this model captures the dynamic process by which individuals iteratively integrate definitions of self and profession during their undergraduate civil engineering education experiences. In this chapter, I interpret this model in relation to the literature and provide implications of my contributions for both the engineering education research and practice community and the broader identity research community. Finally, I suggest areas for future work and summarize my overall conclusions from this study.

## 5.2 Discussion of Results

From this study, I created the AOI Model of professional identity construction and negotiation. The fundamental premise of the AOI Model is that students begin to perceive and position themselves as professionals within the civil engineering discipline through a process of definition negotiation. During this process, students negotiate their constructed definitions of self with those of the profession. As this process continues, they form a professional identity and advance from an outsider (i.e., one not belonging to the civil engineering profession) to an insider (i.e., an individual belonging to the civil engineering profession). The grounded theory process I used to develop this model yielded theoretical implications regarding our understanding of the development of professional identities.

As described in Chapter 4, each component of this model captures the dynamic process of construction as individuals develop their professional identities. Throughout this study, existing frameworks within the identity literature served as inspiration throughout the theoretical coding

and model visualization phases. Aligning with the characteristic of constructivist grounded theory that allows the researcher to embrace prior knowledge of the topic under study (Charmaz, 2014), these frameworks were not inductively applied to the data or the model. Rather, they provided thought-provoking ideas that challenged and expanded my thinking throughout theory construction. In this section, I review the primary frameworks that inspired the development of the AOI Model, examine its alignment with existing theory, and identify ways in which it expands on current literature. In particular, I focus this discussion on three primary components that constitute the AOI Model: 1) constructing definitions of self and profession; 2) advancing from outsider to insider; and 3) identity negotiation and orientation. I then discuss overall contributions of this work to the broader identity and engineering education research communities.

### *5.2.1 Constructing Definitions of Self and Profession*

At the core of the AOI Model are the constructions of definition of self and definition of profession. Within the model, definition of self is represented as a woman's silhouette; the definition of profession is represented as a partial puzzle that is being constructed. These visualizations within the AOI Model were intentionally developed to illustrate the continuous evolution of self and career perceptions and were inspired by existing literature in constructivism (Berger, 1966; Berger & Luckmann, 1967; Charmaz, 2014; Guba & Lincoln, 1994; Jonassen, 1991; von Glasersfeld, 1995) and the body of work discussed in Chapter 2. Researchers drawing from constructivist perspectives position knowing as a process of active meaning-making and interpretation of the interactions and actions of others (Charmaz, 2014; Collins, 2015; Guba & Lincoln, 1994; von Glasersfeld, 1995). This paradigm aligns with multiple bodies of research that explore the agentic construction of personal identity in which multiple aspects or dimensions (Abes et al., 2007; Jones & McEwen, 2000) of self-definition are interpreted and assembled (Vignoles et al., 2011; Waterman, 2011). Some of these aspects include personal characteristics such as sexual orientation (Abes & Jones, 2004; Cech & Waidzunas, 2011), religion (Abes & Jones, 2004; MacDonald, 2000, 2009), gender (Hatmaker, 2013; Settles, 2004), and values (Hitlin, 2003).

While the interview protocol in the present study was designed to prompt discussion regarding perceptions of civil engineering and their origins, participants also discussed other aspects of

their lives that painted a broader picture of who they are. For example, Macy described herself to be a "girly-girl," Neil exhibited a strong work ethic in which he committed "110 percent" on coursework and activities, and Corey discussed his love for music and the ways in which he managed being an engineer and a musician. However, while participants provided these descriptions of who they were, they also connected these characteristics to the civil engineering discipline as they constructed a more nuanced definition of the profession and became a member of the profession.

### *5.2.2 Advancing from Outsider to Insider*

The outcome of the process depicted by the AOI Model, advancing from outsider to insider, aligned with multiple areas of research including social identity theory (Tajfel, 1974; Tajfel & Turner, 1979), self-categorization (Abrams & Hogg, 1990), discourse identity (Bamberg et al., 2011; Gee, 2011), and occupational identity (Skorikov & Vondracek, 2011). Notably, this outcome cannot be holistically compared to a single body of work. Rather, these areas of work provide pre-existing evidence of the presence of indicators that, when combined, exhibit individual advancement from an outsider to insider, shown in Figure 5.1. In this section, I review various components of the AOI outcome according to the prior research areas mentioned above.

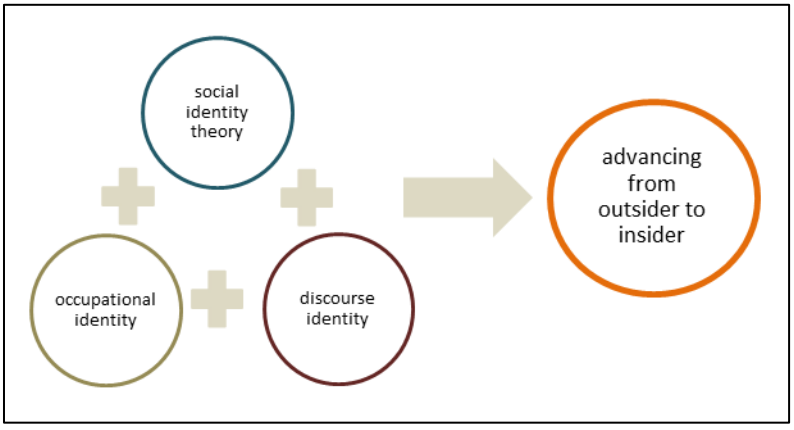



Figure 5.1: Components Underpinning AOI Outcome

Advancing from outsider to insider was first identified as participants ascribed to the civil engineering discipline by aligning definitions of self and profession. For example, Cecilia described her childhood as growing up in a family of engineers which inherently afforded her the skills to "think like an engineer". Cecilia's ability to identify congruence between her definition

of self and profession demonstrated an act of self-categorization (Abrams, 2015; Hogg & Terry, 2000; Spears, 2011), a process by which an individual maintains a personal identity while positioning themselves within a pre-established social group (Tajfel & Turner, 1979). Because Cecilia perceived herself as innately possessing a specific way of thinking that aligned with her perception of the civil engineering profession, she was able to ascribe to the profession as she entered college. Similar demonstrations relating to self-categorization were also reflected by participants who described themselves as individuals who enjoyed and exceled in math while simultaneously defining civil engineering as a math-oriented profession. However, Cecilia further utilized her ability to think like an engineer as a means to differentiate herself from her non-civil engineering roommates during college. In her interview, Cecilia described her ability to solve problems, which positioned her as the roommate responsible for general maintenance around the apartment:

> [My roommates] couldn't get the dishwasher out, and they're just yanking on it, and I was like, 'Okay, well let's stop. Let's look at what isn't working. This pot handle is at the upper rack, let's tilt it. This wheel's off a little bit, let's pick it up and pull it out.' Five seconds later, it's fine. […] So I think it's like the ability to look at a problem and say, 'Okay what's causing this? Okay, now how do we fix this? And then fix it instead of just yanking on something that's not [working].

In this role, Cecilia positioned herself as an engineer in contrast to her roommates, thus establishing an in-group/out-group comparison that is characteristic of social identity theory (Abrams, 2015; Spears, 2011; Tajfel, 1974). However, this is not to say that participants only mapped definitions of self to those of the profession. To demonstrate the reciprocal relationship between the individual and the group (Abrams, 2015), participants also integrated perceived characteristics of the civil engineering profession into who they are. For example, Amy developed a sense of discipline and dedication to the profession while managing an intense, time-consuming course load and a non-engineering friend group. She explained that due to her major, she had to prioritize her out-of-classroom activities, some of which were related to civil engineering (e.g., concrete canoe), rather than taking time to go to a movie or lay out in the sun on a warm afternoon with her friends. From this perspective, Amy positioned herself as someone dedicated to her major in comparison to others outside of engineering.

Throughout the duration of the interviews, participants also discursively enacted their advancement from outsider to insider. Using a combination of discursive indicators that included use of terminology related to the field, tone, and pronoun usage, I was able to examine linguistic moves as related to enactments of participants' definitions of the profession. As participants continued through their undergraduate careers, they began to accumulate language practices associated with the civil engineering discipline, most obviously identified through technical terminology. This was observed in participants of the present study as they began to use acronyms (e.g., V2V, V2I, ACI, ASCE, etc.) and technical jargon (e.g., green buildings, sustainable land development) to communicate aspects of their daily lives and future plans. They also discussed the variety of tools that they use such as "Civil 3D", a short name for a type of computer-aided design software used for civil engineering design. However, when observed in isolation, this use of terminology does not directly link to an identity enactment. Therefore, vocal tone and discursive positioning via pronouns provided context in which civil engineering terms were used. Using this approach, it was observed that participants began to take ownership and command of civil engineering terminology as they engaged in and learned about the profession. These discursive enactments reflect outcomes of situated cognition and learning that situate knowledge as a product of the context and culture in which it is created (Brown, Collins, & Duguid, 1989; Johri, Olds, & O'Connor, 2014). Education constructs within the purview of situated learning such as cognitive apprenticeship (Collins, 2006) and communities of practice (Eckert, 2006; Wenger, 1998) identify learning as a contextualized, social practice of interpersonal engagement. As individuals are provided the opportunities to observe and practice the behavior of a culture or group, they begin to pick up relevant jargon and behaviors and act in accordance with those norms (Brown et al., 1989, p. 34). Eckert (2006) echoes a similar sentiment from a linguistic perspective. She explains that as individuals engage with members of a significant group, they develop an identity aligning with that group and the linguistic practices to articulate it (Eckert, 2006). Therefore, in order to examine a genuine integration of language and identity, broader contexts and meaning must be considered.

For the purposes of this study, these discursive enactments served only as indicators of advancement from outsider to insider, thus contributing a partial explanation of the outcome of the AOI Model. To further articulate the integration and implementation practices of each participant, an in-depth discourse analysis this data would need to be conducted.

Another area of research that supports the outcome of the AOI Model is further supported by work exploring occupational identity. Occupational identity refers to "the conscious awareness of oneself as a worker" (Skorikov & Vondracek, 2011, p. 693). Every participant within the present study held at least some form of career aspiration prior to entering college and could identify ways in which that goal had changed. However, this is not to say that every participant could articulate the changes in those goals. Some participants such as Sid and Macy could identify specific areas of research and projects they would like to work on in the future. Other participants maintained less articulated goals. Brandon, for example, simply stated that he "wanted to be a civil engineer somewhere", and while Madison expressed that she wanted to pursue a career in civil engineering, she was unable to explicate a specific career path. Participants' ability to identify a general career aspiration during childhood and ascribe to that occupational identity is not uncommon and is often inspired by adults within the child's life (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Kalil, Ziol-Guest, & Coley, 2005; Skorikov & Vondracek, 2011). However, prior research has also shown that individuals moving into adulthood, such as college students, may maintain a lack of clear career expectations and role models, and thus experience difficulties formulating and committing to specific occupational practices or cultures (Mortimer, Zimmer-Gembeck, Holmes, & Shanahan, 2002; Skorikov, 2007; Skorikov & Vondracek, 2011). However, in contrast to the findings of Skorikov and Vondracek (2011), a lack of established goals as observed in this study was not necessarily a negative outcome as demonstrated by the *expanding profession through articulation* negotiation. Many students, such as Layla and Lizzy, actually maintained more generic career goals because they were still learning about the profession and had not yet decided on a civil engineering sub-discipline to pursue. From this perspective, participants were able to acknowledge that their definition of profession was still under construction while remaining happy with the current status of their lives. By positioning the profession of civil engineering as an iteratively-revised career trajectory, participants afforded themselves the freedom to explore the discipline while working toward an evolving goal while still maintaining identification with the profession. This exploration was conducted using a number of orientations and a series of identity negotiations, as further discussed in the next section.

### *5.2.3 Identity Negotiations and Orientations*

Lastly, literature exploring multiple identities and identity saliency (Abes et al., 2007; Jones & McEwen, 2000) inspired the representation of the scale that balanced definitions of self and profession. This balance was further conceptualized using the negotiation matrix that captured the actions performed by participants to maintain that balance and their orientations. Within the present study, participants enacted or negotiated different identity dimensions corresponding to a specific orientation based on the context in which the negotiation was occurring. Abes and colleagues' (2007) reconceptualization of Jones and McEwen's (2000) model of *Multiple Dimensions of Identity* also captures this dynamic and the orientations by which specific identities become more salient. In the reconceptualized model, Abes and colleagues added a meaning-making filter that influenced identity saliency based on context and perceptions of identity. For example, Corey was concerned about getting high enough grades to choose his major by his own volition. Therefore, during his freshman year, he positioned himself as a student and focused primarily on getting high grades in his courses. Other studies conducted in engineering education have identified similar behaviors in students. Dannels (2000) conducted an ethnography in which she qualitatively explored student communication practices within a mechanical engineering senior design course. She found that despite the instructor's attempts to simulate a professional industry setting within the course, participants still positioned themselves as students who were completing a project for a grade (Dannels, 2000). Douglas and colleagues (2012) reported similar findings. Upon conducting a discourse analysis of eight interviews with materials science and engineering students, they reported that these students did not connect academic problem solving activities to those within industry. While these studies pose interesting implications for engineering education practice, they also highlight the student orientation by which their participants approached learning within academic settings. However, in the present study, not all students approached their coursework from such a disconnected perspective. Meg, for example, spent extra time checking her homework to ensure its correctness prior to submission. While she wanted to achieve high grades as a student, this was not a sole motivator for her self-discipline. Rather than simply "getting [homework] done" to receive a grade, Meg described her coursework as training for her future career, as captured by the *elevating academic relevancy for future career* negotiation. In contrast to the prior works of Dannels (2000) and Douglas et al. (2012), however, this study also enabled me to reveal another aspect of student

orientations. While Corey and Meg assigned value to the content they were learning to get into the civil engineering program and train for a career, respectively, Maynard dismissed specific content in his courses. He described his first-year engineering project as "dumb", "not real engineering", and as lacking relevancy toward his future career goals, indicated by the *dismissing information through skeptical analysis* negotiation. Because he did not perceive this knowledge as relevant to his future career, he did not consider it to be pertinent knowledge that should be retained. While Maynard was similar to the students in Dannels (2000), his case was used to distinguish shifts in participants' identities as they learned or rejected new knowledge in relation to their developing identities.

Negotiations such as this also allowed individuals to retain certain definitions while shifting others to maintain identification with the civil engineering profession. For example, Maggie, who is dyslexic, was often told that she could not be a civil engineer because of her disability. Despite receiving negative feedback from others, Maggie has persisted through the civil engineering discipline while simultaneously managing student accommodations, scheduling exams, and completing coursework. She described herself as hardworking and self-advocating by explaining, "…there's a certain point where it's like, 'It's your life. You're going to have to be able to stand up for yourself'…" While Maggie saw herself as pursuing some form of career in civil engineering, she was unable to articulate specific plans and positioned her definition of the profession as something she was still working toward. Her adaptable definition of the profession allowed her to reinforce herself while maintaining her overall goals of becoming a civil engineer. The presence of participants' abilities to approach negotiations from multiple perspectives aligns with research exploring identity orientations (Cheek, 1989; Cheek, Smith, & Tropp, 2002; Flynn, 2005). Cheek and colleagues (2002) define identity orientations as "the relative importance that individuals place on various identity attributes or characteristics when constructing their self-definitions" (p. 1). Flynn (2005) further explicates identity orientation as a tool that helps individuals relate multiple identity dimensions by situating them within particular contexts. This further explains why Corey approached many of his courses during his freshman year from a learner orientation as a student; however, he was still able to express interest from a career perspective when he could relate what he was learning to his future goals of becoming a civil engineer:

> And the intro to engineering class, I was like, 'Why is this class necessary? Like, why am I doing this?' But then I would go to [my instructor's] lecture …and I would love it […] from day one he was like, 'I am a civil engineer by background so I'm going to teach it with a slight civil sway,' and I'm like, 'Yes.' Like, going in off the bat, I get to do civil stuff. *(Corey)*

While not explicitly related to work exploring identity negotiations, prior work by Settles (2004) examined the role of identity centrality as women scientists navigated conflict within the workplace. In her study, she refers to identity centrality as placing importance on specific identity dimensions within a given context. Settles then examined the ways in which identity centrality influenced strategies by which women negotiated non-ascribed identities (e.g., being a woman) and ascribed identities (e.g., being a scientist) upon experiencing an identity conflict (e.g., existing as a woman in a masculine climate of science). Her findings revealed an existing power dynamic that existed between ascribed and non-ascribed identities. Overall, she found that negative outcomes, such as increases in depression and decreases in self-esteem and life satisfaction, were more prevalent in women who maintained high levels of woman and scientist centrality as identity conflicts increased. However, women with low levels of woman and scientist centrality experienced relatively no change in outcomes as identity conflicts increased. Her results further revealed a complex relationship between these identities and explicated much of the nuance by examining participants' abilities to disidentify or exit a particular identity. Ascribed identities are much easier to exit than non-ascribed ones, thus convoluting identity management within individuals. Aligning with Settles' work, the AOI Model does examine the negotiation of ascribed (e.g., career or major choice) and non-ascribed (e.g., gender, race, and family history) identities as they simultaneously contribute to the development of professional identity. However, the AOI Model does not consider the power conflict that may arise as students negotiate ascribed and non-ascribed identities as examined in Settles' study. Including the weighted influences of ascribed and non-ascribed identities on professional identity negotiation would be a beneficial expansion of the model. More specifically, when are ascribed or non-ascribed identities more influential on the professional identity negotiation process and in what contexts? This expansion could be particularly useful for examining the negotiations of participants who struggle to maintain or do not maintain identification with the profession due to ascribed identities such as those discussed in Foor et al. (2007). This inquiry could also further

capture the experiences of those who do maintain identification with the profession, such as Jimmy who experienced feelings of depression during his sophomore year of college but slowly gained confidence as he continued in the civil engineering program.

### *5.2.4 Aligning with and Contributing to Broader Conversations of Identity*

While the components presented above align with multiple aspects of identity literature, the AOI Model, in its entirety, also aligns with and contributes to broader conversations throughout identity and related literature. These broader conversations include defining identity throughout the research community (Vignoles et al., 2011); longitudinal identity formation via possible selves (Markus & Nurius, 1986; Oyserman & James, 2011; Tanti, Stukas, Halloran, & Foddy, 2011); and using identity research as a means to subvert traditional engineering stereotypes (Crenshaw, 1989; Dannels, 2000; Murzi et al., 2014; Paretti & McNair, 2012; Steele, 2011).

The first conversation to which the AOI Model contributes is examining the definitions of identity and the approaches by which it is investigated. As one of the most commonly studied constructs in the social sciences, the topic of identity has been defined, theorized, and explored in a variety of ways that have created multiple debates throughout the research community (Brubaker & Cooper, 2000; Côté, 2006; Vignoles et al., 2011). In their introductory chapter of the *Handbook of Identity Theory and Research*, Vignoles and colleagues (2011) address this debate by positing four questions (shown in Table 5.1) that delineate existing research areas within identity literature. To preface their review, Vignoles et al. (2011) position these demarcations as "artificial distinctions" (p. 8) and present identity as a construct that simultaneously encompasses all conceptualizations set forth by researchers. The AOI Model developed from this grounded theory study aligns with these multiple aspects of identity research, as shown in Table 5.1.

Table 5.1: Summary of Divisive Research in Identity as Addressed by the AOI Model

| Divisive questions in identity research (Vignoles et al., 2011) | Examples addressing each question (AOI Model) |
|---|---|
| 1) Is identity viewed primarily as a personal, relational, or collective phenomenon? | Situates professional identity as an integration of definitions of self (i.e., personal identity created by the self) with those of the profession (i.e., collective identity created by the profession). |
| 2) Is identity viewed as relatively stable, or as fluid and constantly changing? | Includes identity negotiations and outcomes that acknowledge some aspects of an individual remain constant while others change (e.g., reinforcing self, advancing from outsider to insider) |

Table 5.1 (continued)

| Divisive questions in identity research (Vignoles et al., 2011) | Examples addressing each question (AOI Model) |
|---|---|
| 3) Is identity viewed as discovered, personally constructed, or socially constructed? | Considers the source of identity formation both internally (e.g., self-identified) and externally (e.g., presented by a colleague or imposed by course content) |
| 4) Should identity be researched using quantitative or qualitative methods? | The AOI Model was developed using qualitative methods; however, future work includes plans to quantitatively investigate and apply multiple components of the AOI Model to examine students' progression of professional identity formation throughout their undergraduate careers. |

Because the AOI Model was framed from the constructivist approach of individual interpretation, it does not directly address each question posed by Vignoles and colleagues in Table 5.1. However, multiple identity variations, as loosely captured by Vignoles and colleagues' inquiry, were considered throughout model development and were inherently integrated into its creation. Figure 5.2 highlights various aspects of the AOI Model as they correspond to multiple identity constructs and concepts.

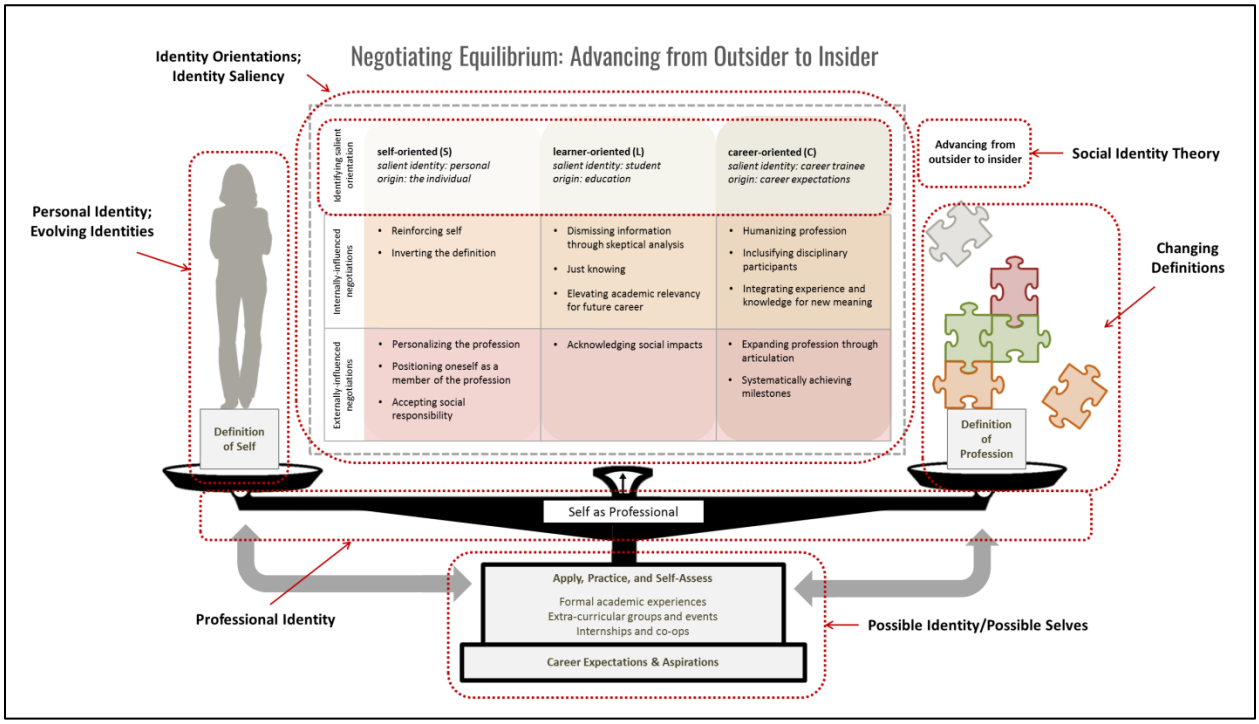



Figure 5.2: Inherent Identity Constructs of the AOI Model

As shown in Figure 5.2, multiple identity frameworks including social identity, identity saliency, identity orientation, and professional identity were combined to create a dynamic model that incorporates perceptions of identity from a variety of research arenas. Therefore, this work aims to further operationalize models such as those developed by Abes et al. (2007) that begin to explore identity in a more encompassing manner, and bolsters research that positions identity as a dynamic process of continuous evolution. From this perspective, the AOI Model aligns with calls from researchers such as Hitlin (2003) and Stets and Burke (2000) to advance identity research through the interrelations of multiple identity theories.

The second conversation to which the present study contributes is longitudinal identity development and theories of expectancy-value (Wigfield & Eccles, 2000), theories of possible selves (Markus & Nurius, 1986), and possible identities (Oyserman & James, 2011). Upon conducting the iterative analysis in the present study, a motivation-related component was repeatedly identified throughout participants' lives that guided their life decisions and informed who they wanted to become. For example, multiple participants chose to enter into engineering and civil engineering prior to college because they excelled at math, science, and physics in high school. These findings reflect the core tenets of expectancy-value theory, introduced by Eccles and colleagues in 1983 (Wigfield & Eccles, 2000). Expectancy-value theory argues that "individuals' choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity" (Wigfield & Eccles, 2000, p. 68). That is, individuals will make choices that align with expectations of high performance on valued activities. Influences of expectancies and values include ability beliefs, personal goals, and affective memories (Wigfield & Eccles, 2000). While many of the participants in the present study entered into engineering because they perceived themselves as high performers in math and science (i.e., ability beliefs), other participants entered into civil engineering because of positive experiences with an adult who was an engineer (i.e., affective memory), because they wanted to help people (i.e., personal goal), or because they wanted to make a decent living to support a future family (i.e., personal goal). Throughout college, participants would also develop multiple paths by which they could navigate their educational experiences, as Corey illustrates in his comment below:

> There was always that hint of doubt in my mind like, 'What if you don't get civil?' So, um, I did like, put down my second and third choices. I pretty much knew that I was going to get civil, but in case like, I really needed to do research on other things. *(Corey)*

While Corey valued civil engineering and wanted to be admitted into the program, he was also researching his second and third major choices in the event that he did not meet the GPA requirements that allowed him to choose his major. If he was unable to get into civil engineering, then he could at least enroll in some form of engineering. In her statement below, Meg actually draws from her prior life experiences to lower her expectations and value for achieving her future plans, recognizing that they will probably change over time:

> Life has taught me not to plan too far in advance because your plans will change, and so I spend time stressing over something that's a couple of years away when there's a lot of time for things to change between now and then. I'm planning to a point. Yes, I want to get a job. Yes I want to maybe do grad school. Yes, I'll figure that out later… *(Meg)*

Events such as these were captured by initial codes that included *mitigating pigeonholes, positioning college as trial and error,* and *testing career paths in civil*. Aligning with Wigfield and Eccles (2000), these participants worked to mitigate failure or other negative outcomes by placing varying levels of value on tasks that they anticipated would either bolster or hinder anticipated future successes.

One's ability to perform well on tasks and anticipate future successes (Wigfield & Eccles, 2000) also aligns with other processes of identity-based motivation, such as possible selves and possible identities (Markus & Nurius, 1986; Oyserman & James, 2011). Positive feelings of success motivate individuals to work toward futures that they believe they can attain, thus leading to feelings of identity congruency (Oyserman & James, 2011). From this perspective, the future self provides an interpretive lens that enables individuals to examine what they would like to become, who they would like to become, and what they are afraid of becoming (Markus & Nurius, 1986; Oyserman & James, 2011). Within the AOI model, the possible identity or possible self that many participants were attempting to achieve was driven by their career

aspirations and expectations, as indicated by the placement of this component as the foundation of the model. As participants identified who or what they would like to become, they would then adjust their definition of profession to align with their career aspirations. For example, Jack, a participant interested in the civil engineering sub-discipline of structures, placed less value on his prior internship experiences working in transportation. This mismatch in prior experience and career aspirations was further emphasized to him during the career fair in which a job recruiter lamented the fact that Jack wanted to work in their structures department rather than in transportation:

> …I was just like talking at career fairs to people, so I go, 'I've done [transportation] before.' They're like, 'It's kind of unfortunate you don't want to do transportation.' I'm like, 'I know.' This summer I'll still do it because for structural I don't have the coursework yet in order to be able to get a structural internship I found. *(Jack)*

Since Jack had not yet acquired the necessary coursework to intern as a structural engineer, he later described his potential summer transportation internship as a means to gather experience in the field, rather than something that he wanted to become. Other participants also utilized this tactic to explore and assess potential career options during college. Yvonne also demonstrated this trial-and-error approach stating, "So, I feel like internships are just three months. If you like it, you have a better chance of getting in with the company. [If you don't,] you can just go to another company and try some other stuff out or go… so I guess, yeah." This method for adaptability inspired the supporting block of *application, practice, and self-assessment*. As participants developed their career aspirations, they could establish more informed definitions of profession that were then applied and practiced within academic courses, co-op experiences, internships, and extra-curricular activities. Upon participating in these events, individuals then received feedback on their decisions from their experiences, thus prompting reflection and self-assessment that influenced participants' definition negotiations of self and profession. This iterative feedback system afforded participants the freedom to define, adjust, and readjust their career aspirations that aligned with both their definitions of self and profession. That is, the AOI Model maintains the capability to capture identity goals that shift throughout individuals' lives (Oyserman & James, 2011). In contrast, it also captures instances in which participants

essentially lose their sense of future self, as in Macy's case. Because she had no concept of who she wanted to be after her initial realization that she did not want to be a chemical engineer, her vision of professional identity disintegrated and was only re-established once Macy had identified a new potential future self within a specific career.

The third conversation to which the AOI Model contributes are those related to diminishing stereotypes within civil engineering and engineering more broadly. Research studies investigating stereotypes, stereotype threat, work expectations, and communication practices have contributed to broadening convers surrounding socially-constructed perceptions of STEM fields (Faulkner, 2007; McCord, 2013; Paretti & McNair, 2012; Steele, 2011). While Faulkner (2000, 2007) and McCord (2013) have examined the technical, masculine perception of engineering and engineering work and culture, Steele (2011) has identified various ways in which race and gender can lead to decreased student performance and stereotype threat, thus prompting individuals to potentially leave the STEM fields. However, work from individuals such as Crenshaw (1989) have identified ways to combat this issue. Initially, Crenshaw's (1989) model of intersectionality was conceived as a social justice framework used to draw connections between the ideas of interlocking oppressions, community organizations, coalitional politics, and identity politics (Collins, 2015; Crenshaw, 1989). However, this framework has since evolved to provide identity researchers with a lens that is used to explore the interrelations among various aspects of a single individual's identity (Abes et al., 2007; Cross & Paretti, 2012; Steele, 2011). Aligning with this prior body of research, the AOI Model further illustrates that our students are multi-dimensional, complete with their own unique backgrounds, obstacles, and talents. While not explicitly reflected in this model, the participant stories from which this grounded theory was abstracted serves as a testament to diminishing stereotypes throughout engineering and the complex nature of our students' lives.

To summarize this discussion, the AOI Model aligns with and contributes to multiple areas of identity work at both the local level of individual components (e.g., balance of definition of self and profession) and at a broader level of the holistic model. More specifically, this model adds to research that aims to understand the dynamic processes of identity formation in such a way that maintains the capability to understand multiple dimensions of individuals as they experience their lives. The AOI Model in itself is an expansion of identity research as it synthesizes multiple

frameworks and their interrelations to capture the dynamic processes by which individuals evolve throughout their college careers.

### 5.3 The AOI Model: A Grounded Theory that "Travels"

The primary outcome of this study was the development of a theory that captured and explained civil engineering students' professional identity formation during their undergraduate careers. By employing grounded theory approaches, the AOI Model was developed and included essential components fundamental to emergent grounded theories. Each grounded theory component, as outlined in Charmaz (2014), is presented in Table 5.2 with corresponding portions of the AOI Model. These components are tightly linked and, as introduced in Chapter 4, explain the process by which students negotiate or adjust existing definitions of self and profession as they learn about civil engineering during their undergraduate careers. Through this learning process, students advance from outsider to insider as they take command of civil engineering behaviors, values, skills, and discourse as they apply, practice, and assess their evolving definitions. This advancement is achieved as students maintain a balance among existing and developing definitions of self and profession. Therefore, the grounded theory components presented in Table 5.2 are scoped by the context from which the grounded theory emerged.

Table 5.2: Mapping of Grounded Theory Components to AOI Model

| GT Component | AOI Model Component |
|---|---|
| Context | Undergraduate civil engineering education |
| Core Phenomenon | Perceiving self as professional; living the definition |
| Strategies | Negotiating definitions of self, of definition of civil engineering, and of career aspirations and expectations |
| Causal Conditions | Learning new or unanticipated information |
| Intervening Conditions | Self-assessment, practice, and application of perspectives inside and outside of the classroom |
| Outcome | Advancing from outsider to insider |

As identified in Table 5.2, the AOI Model was initially developed as a theory situated within the context of undergraduate civil engineering education. However, through the multiple iterations of grounded theory analysis and development, a final, abstracted version of the AOI Model was generated that allowed for its transferability and application to other contexts. This enables the model to "travel" past the initial context in which it was created and proposes a plausible

theoretical explanation for professional identity formation beyond civil engineering education. To further demonstrate the abstraction of traditional grounded theory components within the AOI Model, Figure 5.3 illustrates the ways in which the AOI Model expands the initial, contextualized grounded theory shown in Figure 5.3.

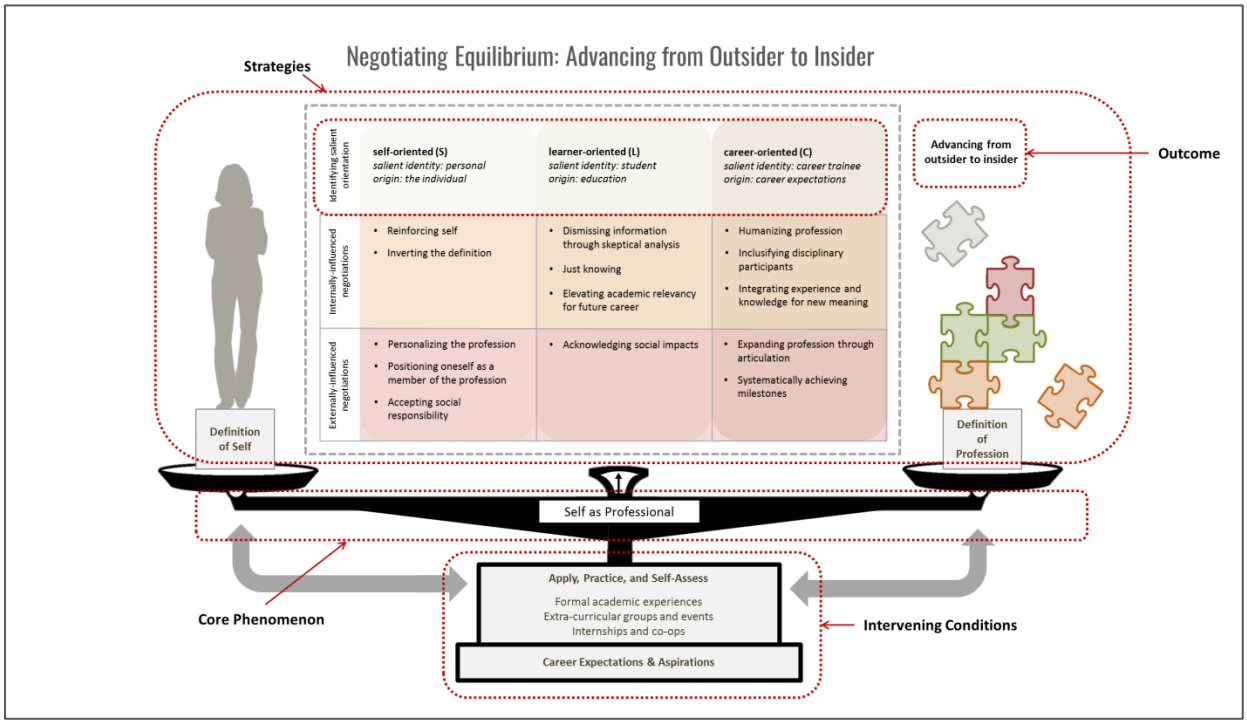



Figure 5.3: Inherent Grounded Theory Components of the AOI Model

Notably, a single grounded theory component, causal conditions, is missing from Figure 5.3. Future depictions of the AOI Model will need to explicitly include causal conditions, as this grounded theory component prompts the individual to negotiate various aspects of their definitions of self and profession (i.e., strategies). The transferability of the travelling version of the AOI Model is further discussed in the following section.

### *5.3.1 Transferability of the Model: A Consideration of Causality*

While many qualitative traditions do not attempt to determine causality (Creswell, 2014), Maxwell (2004) presents an argument that aligns with scientific aims of causality through a constructivist perspective of qualitative research. From this perspective, causal conditions are seen as contextualized and contingent (Maxwell, 2004); therefore, resulting grounded theories are sophisticated explanations of the phenomena under study (Charmaz, 2014; Creswell, 2013).

Rather than assuming that casual mechanisms transcend time, they are only relevant provided a given context. All of these components are then integrated to create a model of a grounded theory that maintains the ability to explain *how* and *why* a phenomenon is occurring. From this perspective, the AOI Model may be applied to other contexts within education and across majors; however, the orientations and negotiations completed by participants may vary based on context- and time-dependent characteristics. For example, acknowledgement and acceptance of social impacts were prevalent among the civil engineering students participating in this study. However, these particular negotiations may be less common when applying the AOI Model to other engineering disciplines such as computer engineering or the engineering sciences. While all engineering disciplines ultimately serve the public, these majors tend to possess applications that are less focused on the public as direct stakeholders. For example, computer engineers work to develop hardware for computing systems whereas engineering sciences are more mathematical and theory-based. Therefore, as researchers apply the AOI Model to other contexts, nuances among the type of negotiations and the duration by which they are enacted by students may vary.

## 5.4 Implications

The development of the AOI Model has yielded multiple implications for researchers, educators, and students throughout academia. While the AOI Model was developed from interviews conducted with civil engineering undergraduate students, the AOI Model has been abstracted in such a way that it may be applied to multiple contexts (e.g., other engineering majors). However, due to its emergence from experiences of students within a civil engineering program, I situate my discussion of the implications from this study within the contexts of civil engineering and engineering education.

### *5.4.1 Implications for Researchers*

Multiple implications were revealed for engineering education researchers and methodologists interested in studying professional identity formation and/or utilizing the grounded theory methodology (Groen et al., forthcoming). While prior work primarily explores identity-influencing factors in a phenomenological sense, this research contributed a theoretical framework that can be used to further understand the dynamic nature of students' identity

formation and negotiation as they experience their undergraduate careers. More specifically, the emergent grounded theory model developed from this study serves as a framework by which researchers can integrate multiple constructs of identity to gain a more nuanced understanding of identity development and evolution (Groen, forthcoming; Groen & McNair, 2016; Groen, Simmons, & McNair, 2016).

The methodological strategies utilized within this study also advance the use of the Grounded Theory Methodology within engineering education research. As an emerging research method within the field of engineering education (Case & Light, 2011; Charmaz, 2008), the application and use of the methodology "shows promise" (p. 190) but is not currently well represented in engineering education research. While some researchers grapple with the flexible, yet systematic, framework of grounded theory methods (Charmaz, 2014), this study may serve as a useful guideline that provides emerging grounded theorists with a more operationalized view of the grounded theory methodology. I welcome researchers wishing to integrate these methods to draw inspiration and processes from this work.

Lastly, this study prompts an interesting question regarding students' identifications with their college majors and the ways in which this identification is communicated to students. As instructors, we often push our students to pursue a career that they are passionate about. However, participants in this study, such as Amy and Neil, have demonstrated that their motivations for going into civil engineering were based on creating a stable financial foundation to support their future families. While they maintained identification with the civil engineering discipline throughout college, they also perceived the profession as a job that will provide them the means to achieve a happy and healthy family life, rather than a reflection of who they are. While maintaining an identity with a profession has been repeatedly shown to enhance retention within the engineering field (Jones et al., 2013; Lichtenstein et al., 2009; Seymour & Hewitt, 1997), further studies exploring students' identification with their majors should be conducted. These investigations could further contribute to overarching conversations relating to the variations of identifications and their implications for retention (Jones et al., 2014; Jones et al., 2013; Osborne & Jones, 2011; Oyserman & James, 2011; Pierrakos et al., 2009).

### *5.4.2 Implications for Instructors*

Prior work examining professional identity formation suggests that the very experiences educators provide to students greatly impact their engagement and retention within engineering (Atman et al., 2008; Loui, 2005; Lutz & Paretti, forthcoming; Paretti & McNair, 2012; Pembridge, 2011; Pierrakos et al., 2009). Therefore, a number of implications were identified for engineering educators and instructors as a result of this study. As indicated by the AOI Model, participants performed identity negotiations and constructed profession definitions based on learned knowledge, behaviors, and values that related to their overarching career aspirations. The importance of this career foundation was emphasized by Macy, who had experienced an identity crisis in which she lost sight of her future career goals. Only upon identifying a new career path was Macy able to redefine her chosen profession and continue the process of identity negotiation and development. Cases such as Macy's, highlight the importance of reflective practice in engineering. This work aligns with prior research calling for the integration of classroom activities that prompt student reflection and career planning (Eliot & Turns, 2011; Ibarra, 2004; Stevens, Johri, & O'Connor, 2014). These may be operationalized as e-portfolios in which students develop a professional online presence that enables them to reflect on their own growth and their accumulating knowledge of the civil engineering profession (Eliot & Turns, 2011; McNair & Garrison, 2013; McNair, Paretti, & Gewirtz, 2017). Students may also use these portfolios as resume materials when seeking out jobs, internships, and co-ops.

While reflective practice serves as a tool for promoting the transfer of knowledge from the classroom to other aspects of students' lives, instructors also need to explicitly encourage this practice. Prior work within professional identity formation suggests that the very experiences educators provide to students greatly impact their engagement and retention in engineering (Atman et al., 2008; Loui, 2005; Lutz & Paretti, forthcoming; Pembridge, 2011; Pierrakos et al., 2009). The findings within this study also corroborate this prior work, as many participants could specifically name a particular instructor who had influenced their perceptions of the civil engineering profession and their career aspirations. During these instances, students reflected on ways in which their instructors inspired them and encouraged creative applications of technical content. Providing opportunities for students, such as course projects in which they receive genuine feedback on creative applications, will greatly influence the development of their

identities as they emerge as professionals. However, further work will need to be conducted in order to provide specific recommendations of course modules and activities to be implemented in civil engineering classrooms that achieve this aim.

### *5.4.3 Implications for Students*

A number of implications were identified for civil engineering students as a result of this study. *Career aspirations and expectations* serves as the foundational component of the AOI Model, thus demonstrating the importance for individuals to identify career expectations. Aligning with prior work in identity-based motivation such as possible selves and possible identities (Markus & Nurius, 1986; Oyserman & James, 2011), it is important for students to identify who they want to be. These career aspirations may be very articulate (e.g., I want to be a joist design engineer at a steel company in Nebraska) or vague (e.g., I want to be a civil engineer). However, without these goals, students are unable to make necessary identity negotiations and relate learned content to their future lives. To prompt their thinking about this topic, I encourage students to create e-portfolios or utilize journaling techniques

To promote identity development and enhance learning, students should also attempt to connect what they are course content to out-of-classroom experiences and vice versa. Getting involved in civil engineering-related extra-curricular activities, working at internships and co-ops, and identifying impacts of civil engineering on everyday life were activities in which participants practiced and applied their civil engineering knowledge outside of the classroom. This kept them more engaged in their courses and also informed the development of their career aspirations.

### *5.4.4 Implications for the Discipline of Civil Engineering*

Also emerging from this work were implications for the discipline of civil engineering. While the AOI Model of professional identity negotiation provided insight into the ways in which students' professional identities evolve throughout their undergraduate careers, it also reinforced the connections between disciplinary histories and its evolution through our students. As introduced by Groen et al. (2016) and discussed in Chapter 2, the discipline of civil engineering maintains a culture that consists of hundreds of years of technological and social advancements that dictate what civil engineers do and who civil engineers are. Within the current civil engineering education curriculum, these advancements serve as guidelines for what and how we

prepare the next generation of civil engineers for the workforce (Groen et al., 2016). Therefore, understanding how students internalize and enact this information serves as a roadmap that allows the civil engineering profession to track the evolution of the discipline from its past, to its present, and into the future through the voices, stories, values, and actions of its members. As we determine potential directions for the discipline, we can begin to instill necessary characteristics in our students who will shape the future of civil engineering.

### 5.5 Future Work

While my dissertation introduces a new framework for exploring identity negotiation and formation, it is imperative that future work be conducted to further expand and articulate the AOI Model in various contexts. In this section, I offer six areas of future work within the engineering education community and the identity research community more broadly. I discuss each area of future work below.

My first proposed area of future research is the expansion of the AOI Model to include more identity dimensions. The AOI Model was developed from the experiences of 31 undergraduate civil engineering students at LLG and examined their definitions of self that included multiple identity constructs as gender, race, first-generation college student, social class, and work ethic, to name a few. However, this model needs to be expanded to include experiences of students with other identity dimensions, such as disability. Participants maintaining this dimension were not explicitly or intentionally recruited to be interviewed; however, those participants who identified as disabled revealed drastic identity negotiations not experienced by their peers. Further studies integrating the nuanced negotiations of these less-prominent identity dimensions into the model are necessary.

My second proposed area for future research is a study that longitudinally captures the growth and development of students' professional identities as they enter into the move throughout their academic and post-graduation endeavors. During the study, I had conducted follow-up interviews with the participants for research quality purposes. However, I also used this opportunity to receive participant updates on their degree progress or perceptions of their new job in the event that the participant graduated. Over a short period of 8 months, it was observed that each participant had experienced major changes in their lives and professional identity

formation for a variety of reasons. Future work following these students for a longer period of time and across contexts and life experiences would provide more significant identity negotiations as participants transitioned out of college and into the workforce.

The third area of future research area inspired by this work would be to examine identity negotiations of students who leave civil engineering or the engineering field, in general. The participants within the present study maintained identification with civil engineering and anticipated pursuing a career related to the civil engineering field. But what happens when an individual does not maintain identifications with a discipline? While the model captures Macy's identity crisis and ability to establish a new career aspiration of becoming a civil engineer, it does not currently explain approaches she used to negotiate her identity prior to leaving chemical engineering nor does it reveal any indicators of her decisions to leave. Including participants ready to leave the field either during or after college may provide more insight into course modules and activities that may keep students engaged in the field during college and beyond.

A fourth research area proposed for future research is to conduct further qualitative and quantitative studies to refine and establish the AOI Model as a broader framework that could be used in identity research. While the model captures multiple relationships among various aspects of identity dimensions, the model needs to be applied to other data sets, particularly those outside of engineering, to enhance its usability as a research tool. Further, utilizing quantitative approaches such as those used in Settles (2004) may potentially reveal a hierarchy among identity negotiations based on context.

The fifth future research area inspired by this work is to revisit participant experiences prior to college. Throughout the course of the interviews, participants in this study talked in detail about their childhoods and inspirations and motivations for entering into the civil engineering program. While not explicitly demonstrated within the model, many of these stories maintain specific contexts and narratives throughout the participant's life that influence how they perceive themselves and the civil engineering discipline. This could potentially be used to add more nuanced negotiations to the current AOI Model and be used to capture identity shifts across multiple phases of life as individuals change (Oyserman & James, 2011).

A final area of future work would be to develop course modules for civil engineering instructors to use in their classrooms that enhance students' professional identity formation and promote reflective practice. While I provide implications for practice in the previous section, further work would need to be conducted to design civil engineering class modules to fully implement this framework into civil engineering courses. The goal would be for these types of modules or interventions to be easily-implementable and would serve as a useful course assessment tools for instructors (Suskie, 2008). The development of these course modules may also be used to bridge the gap between civil engineering education and practice. Industry and academic leaders can work together to further shape the future identity of the civil engineering discipline and develop approaches as to how that new disciplinary identity is to be communicated to our students.

The work suggested in this section could expand the development and the use of the AOI Model through confirmation and revision, broadening the scope of the emergent theory, and addressing the limitations discussed in Chapter 3. Essentially, this work introduces a new research trajectory that can further our understanding of professional identity formation and explore the interrelations of existing identity constructs and theories.

### 5.6 Conclusions

To further understand the approaches by which undergraduate civil engineering students negotiate professional identities, I conducted a qualitative study that employed constructivist grounded theory (Charmaz, 2014) to develop the AOI Model, an emergent model grounded in student experiences. In particular, I chose to explore the experiences of undergraduate civil engineers due to the direct, pervasive, and potentially life-altering influence that civil engineers maintain on the culture and societies in which they live and work. For this reason, professional identity formation is vital to the effective preparation of the next generations of civil engineers, and thus serves as a rich context in which to explore the development of students' professional identities.

To construct a grounded theory model of identity formation, I interviewed 32 undergraduate civil engineering students and embarked on an iterative, constant comparative procedure in which data collection and analysis were simultaneously conducted. Through this iterative process, I began to abstract meaning from participant interviews to create an emergent model consisting of

six grounded theory components: 1) context – undergraduate civil engineering education; 2) core phenomenon – perceiving self as professional; 3) strategies – negotiating definitions of self and the civil engineering discipline, negotiating career aspirations and expectations; 4) causal conditions – identifying conflicting information, questioning, reflection; 5) intervening conditions – self-assessment, practice, and application of definitions inside and outside the classroom; and 6) outcomes – advancing from outsider to insider.

The overall premise of the AOI Model is that individuals attempt to balance their definition of self and definition of profession to maintain identifications with the civil engineering discipline and achieve their career goals. This balance is conducted as students learn new or conflicting information during their undergraduate careers and negotiate various aspects of these definitions. Assessments of balance are also iteratively conducted as individuals apply, practice, and self-assess their knowledge in their courses, extra-curricular activities, and internships. Definitions of self and profession are considered to be balanced when the individual is able to live or simultaneously enact both definitions and advance from an outsider to an insider. While the AOI Model illustrates and captures professional identity negotiations of students within the civil engineering discipline, it may also be transferred to other contexts and has sparked additional research trajectories for myself and other engineering educators.

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## APPENDIX A: ASCE VISION OF 2025 AND THE BODY OF KNOWLEDGE

ASCE Vision of 2025 Outcomes (ASCE, 2007)
Entrusted by society to created a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master:

1. planners, designers, constructors, and operators of society's economic and social engineer – the built environment;
2. stewards of the natural environment and its resources;
3. innovators and integrators of ideas and technology across the public, private, and academic sectors;
4. managers of risk and uncertainty caused by natural events, accidents, and other threats;
5. leaders in discussions and decisions shaping public environmental and infrastructure policy.

ASCE Body of Knowledge (Adapted from ASCE, 2008)

| Outcome Number & Title | Bloom's Taxonomy Levels of Achievement* | | | | | |
|---|---|---|---|---|---|---|
| | Knowledge | Comprehension | Application | Analysis | Synthesis | Evaluation |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Foundational | | | | | | |
| 1. Mathematics | | | | | | |
| 2. Natural Sciences | | | | | | |
| 3. Humanities | | | | | | |
| 4. Social Sciences | | | | | | |
| Technical | | | | | | |
| 5. Materials Sciences | | | | | | |
| 6. Mechanics | | | | | | |
| 7. Experiments | | | | | | |
| 8. Problem Recognition & Solving | | | | | | |
| 9. Design | | | | | | |
| 10. Sustainability | | | | | | |
| 11. Cont. Issues & Hist. Perspectives | | | | | | |
| 12. Risk & Uncertainty | | | | | | |
| 13. Project Management | | | | | | |
| 14. Breadth in Civil Engineering Areas | | | | | | |
| 15. Technical Specialization | | | | | | |
| Professional | | | | | | |
| 16. Communication | | | | | | |
| 17. Public Policy | | | | | | |
| 18. Business & Public Administration | | | | | | |
| 19. Globalization | | | | | | |
| 20. Leadership | | | | | | |
| 21. Teamwork | | | | | | |
| 22. Attitudes | | | | | | |
| 23. Lifelong Learning | | | | | | |
| 24. Prof. & Ethical Responsibility | | | | | | |

*Colored boxes indicate level of achievement acquired during a typical Civil Engineering Bachelor's Degree

## APPENDIX B: CIVIL ENGINEERING DESIGN MANUALS, EXPERIMENTS, AND EXAMS

### Design Manuals:

1. ASCE/SEI 7: Minimum Design Loads for Buildings and other Structures

   Published by the American Society for Civil Engineers and the Structural Engineering Institute, this manual provides requirements for general structural design and includes means for determining dead, live, soil, flood, wind, snow, rain, atmospheric ice, and earthquake loads, as well as their combinations, which are suitable for inclusion in building codes and other documents. With this manual, engineers may tailor loading conditions based on location and weather conditions. *(ASCE, 2015)*

2. AISC Steel Construction Manual

   Published by the American Institute of Steel Construction, this design manual provides engineers and engineering educators the specifications, guidelines, and design loads necessary for designing steel structures. As the best known and most widely-used design manual, the Steel Construction Manual holds a highly respected position in engineering literature. *(AISC Steel Construction Manual, 2010)*

### Experiments:

3. Liquid Limit of Fine Grained Soil: Atterberg Limits

   Also known as the *Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Limit of Soils* (ASTM D 4138), this test is used to establish limits of consistency to classify fine-grained soils to be used in the construction of geotechnical structures and foundations. Within civil engineering curricula, this test is often used as a laboratory activity. *(ASTM, 2015)*

### Exams:

4. PCI Certification: ACI Concrete Field Testing Technician – Grade 1

   Created by the Precast/Prestressed Concrete Institute (PCI) and the American Concrete Institute (ACI), this certification program consists of two portions: a one hour written exam and a performance exam. Individuals wishing to become ACI certified must demonstrate knowledge and ability to conduct six required concrete materials tests that are used in the field to ensure quality construction. *(ACI, 2015)*

## APPENDIX C: RECRUITMENT QUESTIONNAIRE

Please check the appropriate box to indicate your level of interest in participating in this study:

☐ Yes! I would like to participate in this study.

☐ No thanks. I don't really want to participate in this study.

☐ Ummmm. I need more time to think about this. I'll email you at cgroen@vt.edu if I would like to volunteer at another time.

If you checked the "Yes!" box above, please provide the following information to schedule an interview:

Name: _____

Contact Email: _____

## APPENDIX D: INTERVIEW PROTOCOL

Introduction:

Hello, my name is Cassandra Groen [continue participant/interviewer introductions and informal small talk].

Did you have an opportunity to read the consent form?

- if no: Please take a few moments to review the consent form, and let me know when you are finished.
- if yes: [Continue to next question.]

Do you have any questions regarding the consent form?

- if no: [Continue to next prompt.]
- if yes: [Review participant's questions and answer appropriately.]

If you acknowledge that you have read and understood the informed consent and the conditions of this study and give your voluntary consent for participation in this project, please sign your name on the consent form on the appropriate line.

I want to remind you that you may end the interview at any time without penalty. I will be taking some notes while we talk, but to make sure I accurately capture what you are saying, I would like to record our conversation. Do I have your permission to start recording?

[Start recording devices]

Question Protocol:

First of all, I would like to thank you for taking the time to come speak with me today. As outlined in the consent form, the purpose of this study is to further understand how undergraduate civil engineering students form professional identities. Essentially, we want to understand how your skills, activities, and values have contributed to your overall career goals and how they have shifted over time. Keep in mind that there are no right or wrong answers; this interview is about understanding you and your opinions. If you have any questions at any time, please do not hesitate to ask.

First, we are going to fill out this table on the worksheet together. [The worksheet is located on the next page]..

1. To get started, picture yourself at any time before you came to college. What were the skills, events, activities, interests, and people that helped you determine why you wanted to go into engineering? Please list these skills and activities in the "Prior to College" column.
2. So think about yourself in the present day. What skills, events, activities, events, and people do you feel are important while you are in college, specifically within civil engineering? Please list these skills and activities in the "Now" column.
3. Now I'm going to ask you to speculate a little bit. Think about yourself after graduation. What skills, events, activities, interests, and people do you feel you will need to have and

do in your pictured role? Please list these skills and activities in the “After Graduation” column.

4. Where do your insights come from?
5. As you review what you’ve entered into the table, how are the items you listed in the “After Graduation” column consistent or inconsistent with how you see yourself?
6. Would you be willing to participate in another interview at a later date?

Within a day, I will be sending you a very short follow-up, online questionnaire to your email to see if there is anything that we missed during our conversation.

Thank you for your time. This will conclude the interview. I will turn off the recording devices now.

[Turn off recording devices]

**APPENDIX E: PARTICIPANT WORKSHEET**

Name: _____

| Prior to College | Now | After Graduation |
|---|---|---|
| | | |

## APPENDIX F: MINUTE-SURVEY PROTOCOL

Body of Email:

Dear [Insert Participant Name]:

Thank you for participating in the interview on [Insert Interview Date]. It was a pleasure talking with you and learning about your experiences.

To capture any topics that we may have missed or to provide comments from your interview, please visit the link, below, to complete a short follow-up questionnaire. This questionnaire should take less than 5 minutes for you to complete.

Link to questionnaire: [Insert Qualtrics Questionnaire Link]

Thank you for your time!

Sincerely,

Cassandra

II. Sample of Minute Survey in Qualtrics

A screen-shot of the entire questionnaire is shown below to illustrate how the Minute-Survey will appear to participants.


**Directions:** In the following questionnaire, I will ask you a series of questions regarding two topics: 1) your demographic information, and 2) any other topics or ideas that you may have forgotten to talk about or were not comfortable discussing during our interview session.

In the following section, I will ask you questions about your demographic information and enrollment status.

Question 1: Please indicate your enrollment status (select one).

- ○ Sophomore (1st semester)
- ○ Sophomore (2nd semester)
- ○ Junior (1st semester)
- ○ Junior (2nd semester)
- ○ Other (please specify)
- ○ Prefer not to say

Question 2: Please describe your gender (e.g. male, female, etc.). If you do not wish to disclose your gender, type "Prefer not to say."

Question 3: Please indicate your ethnicity (select one).

- ○ Hispanic or Latino
- ○ Non-Hispanic or Latino
- ○ Prefer not to say

Question 4: Please indicate your race (check all that apply).

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White
- ☐ Prefer not to say

Question 5: Are you a domestic student or an international student (please select one).

- ○ International
- ○ Domestic
- ○ Prefer not to say

In the following section, I will ask you questions about your interview and any topics that you may have forgotten to talk about or were not comfortable discussing during our session. If you do not have any questions, you may also use this time to provide any feedback for the interviewer.

Please answer the following questions as appropriate to you as honestly and accurately as you can.

Question 6: Please insert the time and date of your last interview (e.g. 4:00pm 03/15/16).

Question 7: Are there any topics that you did not bring up or forgot to talk about during your interview (please select one)?

- ○ Yes
- ○ No

Question 8. If you answered "Yes" to Question 7, please describe the incident or topic that you would like Cassandra to know.

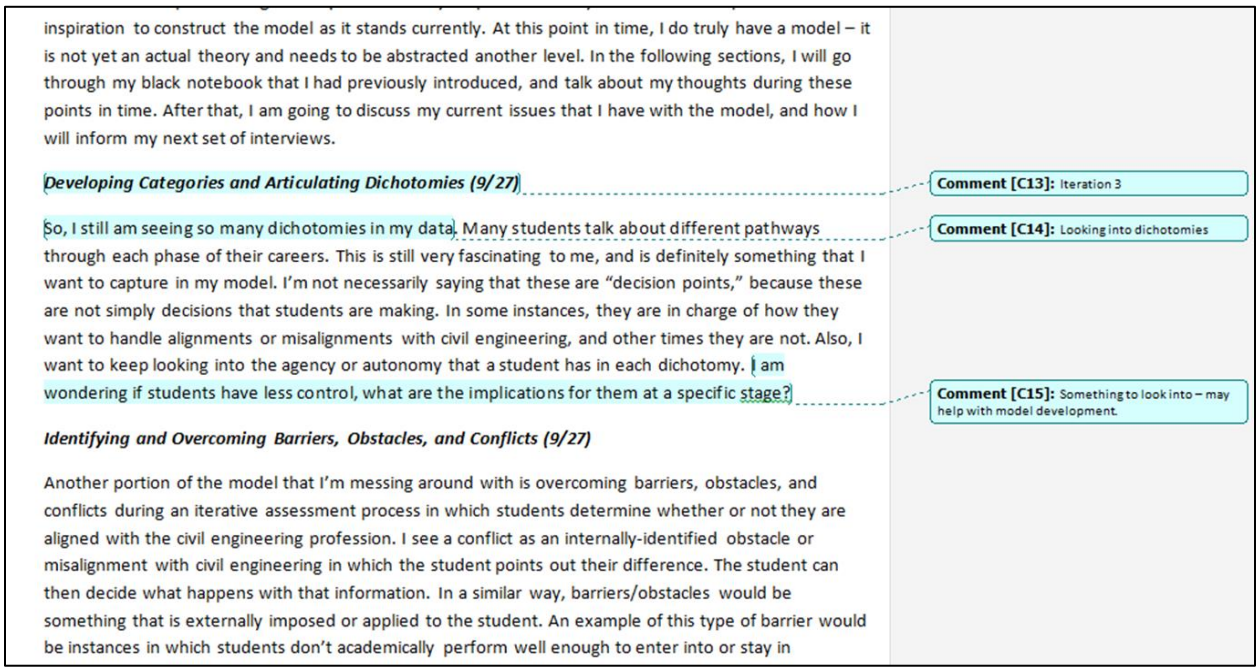
Question 9. Is there any other feedback that you would like to provide to Cassandra regarding your interview?

- ○ Yes
- ○ No

Question 10. If you answered "Yes" to Question 9, please provide any feedback that you would like Cassandra to know.

>>

# APPENDIX G: EXAMPLE OF ADVANCED MEMO



inspiration to construct the model as it stands currently. At this point in time, I do truly have a model – it is not yet an actual theory and needs to be abstracted another level. In the following sections, I will go through my black notebook that I had previously introduced, and talk about my thoughts during these points in time. After that, I am going to discuss my current issues that I have with the model, and how I will inform my next set of interviews.

***Developing Categories and Articulating Dichotomies (9/27)***

Comment [C13]: Iteration 3

So, I still am seeing so many dichotomies in my data. Many students talk about different pathways through each phase of their careers. This is still very fascinating to me, and is definitely something that I want to capture in my model. I'm not necessarily saying that these are "decision points," because these are not simply decisions that students are making. In some instances, they are in charge of how they want to handle alignments or misalignments with civil engineering, and other times they are not. Also, I want to keep looking into the agency or autonomy that a student has in each dichotomy. I am wondering if students have less control, what are the implications for them at a specific stage?

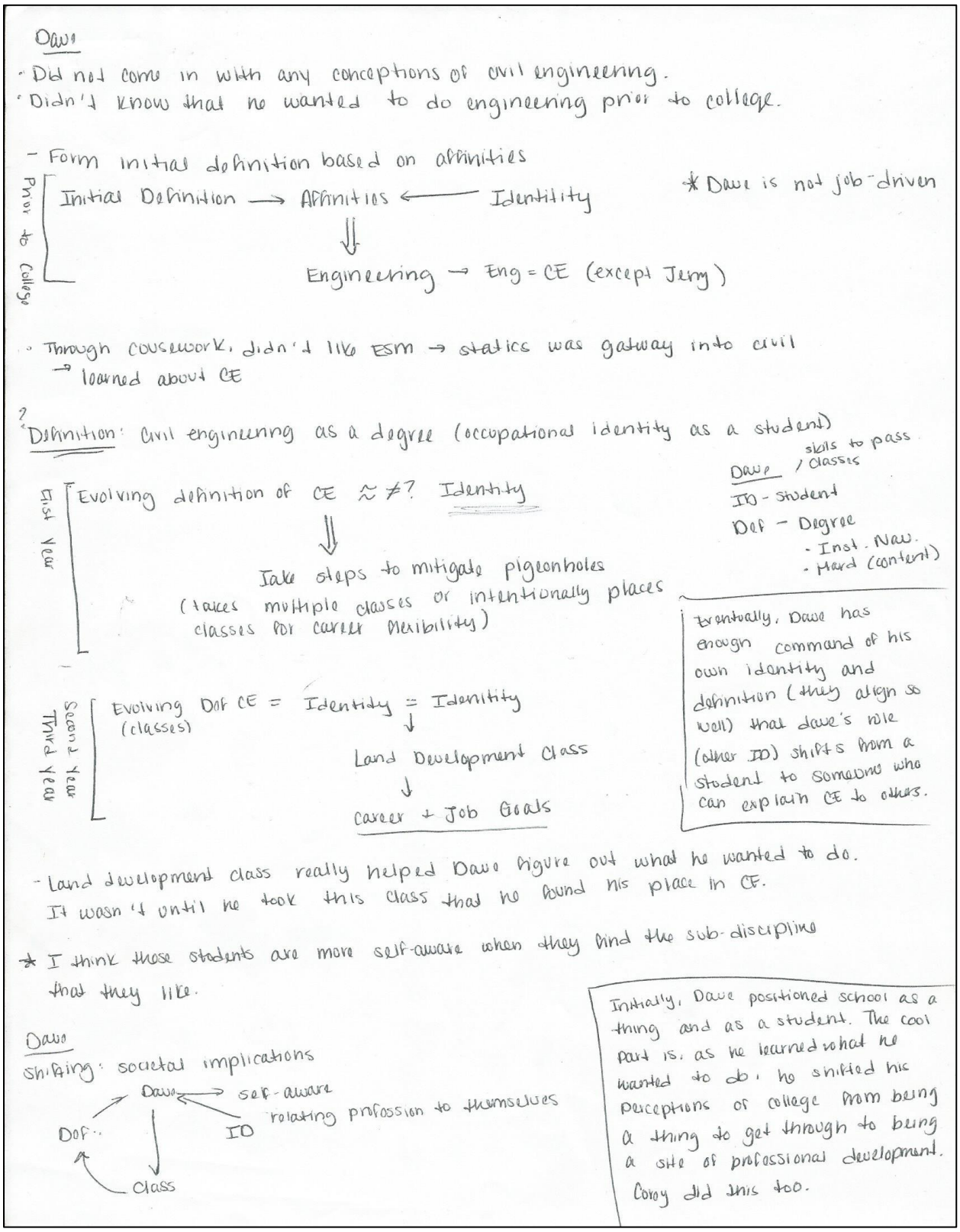
Comment [C14]: Looking into dichotomies

Comment [C15]: Something to look into – may help with model development.

***Identifying and Overcoming Barriers, Obstacles, and Conflicts (9/27)***

Another portion of the model that I'm messing around with is overcoming barriers, obstacles, and conflicts during an iterative assessment process in which students determine whether or not they are aligned with the civil engineering profession. I see a conflict as an internally-identified obstacle or misalignment with civil engineering in which the student points out their difference. The student can then decide what happens with that information. In a similar way, barriers/obstacles would be something that is externally imposed or applied to the student. An example of this type of barrier would be instances in which students don't academically perform well enough to enter into or stay in

## APPENDIX H: EXAMPLE OF INTEGRATED MEMO



## APPENDIX I: EMERGENT CODEBOOK FROM ITERATION 4 ANALYSIS

### Theme 1: Prior to College

| | **Category**<br>Gaining interest in civil engineering | This category includes codes that capture students' for going into engineering or civil engineering. |
|---|---|---|
| Intrapersonal Comparisons to CE | **Strategy**<br>Using abilities to the fullest (in vivo) | The student describes their decision to go into civil engineering or engineering based on their abilities to apply their skills at a level that is considered appropriate to the students' expectations. |
| | **Strategy**<br>Operationalizing and applying interests and skills | The student describes civil engineering, or engineering in general, as a means of "doing" something with their science and math knowledge; putting their knowledge into action. |
| | **Strategy**<br>Gaining interest due to Civil Engineering content knowledge | The student discusses an increased interest in civil engineering due to CE domain knowledge. |
| | **Strategy**<br>Synonymizing technical skill to other characteristics | The student synonymizes technical skill to intelligence, money, and talent. This may also be used to help students make decisions about where to go to college, who they should become friends with, etc. |
| | **Strategy**<br>Realizing future goals | When the student describes a realization in which he or she wants to pursue a certain career or make a career decision. |
| Interpersonal Influence | **Strategy**<br>Carrying on family institution | The student talks about how multiple family members have gone to a single university, so college choices were not options they considered. |
| | **Strategy**<br>Modeling/unmodeling other engineers | The student is attracted to or interested in engineering or civil engineering because a friend or family is an engineer, and they want to "be like them". This can also be the inverse where a student doesn't want to go into engineering or civil engineering because a friend or someone in their family is in engineering. |
| | **Strategy**<br>Developing interest through others | The student's interest in civil engineering grows based on interactions with family and friends that the student connects to civil engineering. |
| Unique | **Strategy**<br>Being thrown into STEM (in vivo) **(UNIQUE)** | The student talks about being somewhat pressured or strongly encouraged by their parents or other individuals to go into STEM, engineering, or civil engineering. |

## Theme 1: Prior to College (Continued)

| | **Category**<br>Actively Preparing for Engineering/Civil Engineering | This category includes codes that capture students' motivations for going into engineering or civil engineering. These codes could be considered as causal conditions for students' choosing to go into college. |
|---|---|---|
| Performance-Related Strategies | **Strategy**<br>Getting a jump-start on the curriculum | The student discusses starting the civil engineering curriculum early in their lives such as taking college credits during high school. |
| | **Strategy**<br>Competing for spots | The student discusses competing to get into academic or extra-curricular programs that would help them along their path into a career in civil engineering. |
| | **Strategy**<br>Performing well in primar and secondary school | The student talks about their ability to perform well in math and science during elementary or high school years. May also include performing well on college entrance exams. |
| Information Gathering | **Strategy**<br>Conducting research/gathering information | The student conducts research to gather information about decisions to go into civil engineering. May also include taking more classes to better understand civil engineering. |
| | **Strategy**<br>Interacting with engineers | The student discusses interacting with individuals who are engineers in either industry or academia. |
| | **Strategy**<br>Seeking out information from others | The student seeks out individuals who know about civil engineering, or are perceived to know about civil engineering to gather more information about the major or profession. |
| | **Strategy**<br>Receiving information from non-engineering others | The student receives information from others outside of engineering or civil engineering. This code is not synonymous to the "gathering information" code. |

## Theme 2: Definitions of Self

| **Category**<br>Perceptions of Self | | This category contains codes that describe how students percieve or initially perceive themselves. |
|---|---|---|
| Personal Attributes | **Causal Condition**<br>Enjoying learning | The student describes themselves as being a person who loves to learn, which helps motivate them to engage in their coursework and other activities. |
| | **Causal Condition**<br>Demonstrating work ethic | The student discusses jobs and experiences that they've had that demonstrate their work ethic and commitment to their education and career. |
| | **Causal Condition**<br>Being okay with flexibility | The student realizes that it is okay if you get knocked off track in your life plans. Not everything has to work out perfectly. |
| | **Causal Condition**<br>Planning for future/Having a plan | The student takes a proactive approach to future plans by discussing the steps it would take to set that plan into action. |
| Family Attributes | **Causal Condition**<br>Coming from a lower economic class | The student expresses coming from an economic class and may even feel somewhat left out due to economic disparities with other students. |
| | **Causal Condition**<br>Perceiving family culture as career influence | The student discusses how the culture of their family greatly influenced how they perceived, became interested in, or chose to pursue a degree or career in civil engineering or engineering. |
| | **Causal Condition**<br>Keeping your roots (in vivo) | The student discusses maintaining ties with their family and where they came from. |
| Unique Cases | **Causal Condition**<br>Diminishing civil engineering **(UNIQUE)** | The student diminishes the civil engineering profession by talking about it in a negative way. |
| | **Causal Condition**<br>Blue-collar engineering (in vivo) **(UNIQUE)** | The student discusses perceptions of civil engineering as a less rigorous or complex than other engineering disciplines. |

## Theme 2: Definitions of Self (Continued)

| | **Category**<br>Decision making processes | This category captures ways in which students approach decisions in throughout their early lives and undergraduate careers. |
|---|---|---|
| Decision Processes | **Strategy**<br>Seeing engineering as an easy decision/option | The student discusses their choice to go into civil engineering or engineering as an "easy" or logical choice based on their own skills, experience, and sense of self-efficacy. |
| | **Strategy**<br>Approaching a crossroads | The student talks about coming to an important decision point in their lives. |
| | **Strategy**<br>Using process of elimination | The student describes a decision-making process in which they use a process of elimination approach to identify what they don't like about that decision and the alternatives. |
| Unique | **Strategy**<br>Placing a secondary priority on civil engineering<br>**(UNIQUE)** | Not having civil engineering as a primary decision point for choosing a major and going to school. |

| | **Category**<br>Defining Engineering and Civil Engineering | This category captures how students initially define engineering or civil engineering. This is not a descriptive code, but rather identifies where student conceptions of civil engineering come from. |
|---|---|---|
| Active Participation | **Intervening Condition**<br>Doing engineering | An incident, event, or activity in which the student participates that further reinforces their perception of engineering or civil engineering work. |
| | **Intervening Condition**<br>Articulating non-engineering characteristics | The student separates an experience, characteristics, interest, skill, activity, etc. from what they perceive as engineering or civil engineering. |
| | **Intervening Condition**<br>Playing as a child | The student describes playing with toys or other objects that they relate to engineering, civil engineering, or their future career decision. |
| Passive Observer | **Intervening Condition**<br>Growing up with engineering or civil engineering | The student indicates that a family member or close friend who demonstrated to them what civil engineering was when they were young. |
| | **Intervening Condition**<br>Seeing engineering in surroundings | The student recalls learning about engineering and civil engineering as inspired by their surroundings and the world in which they live. |

## Theme 3: Life as a College Student

| | **Category**<br>Managing Life as a College Student | These codes capture how students handle themselves within the educational context of college. Codes in this category capture multiple strategies that students employ to be sucessful both academically and professionally. |
|---|---|---|
| Managing Self | **Intervening Condition**<br>Managing school and work | The student discusses strategies for managing having a job and being an undegraduate student. |
| | **Intervening Condition**<br>Adjusting to college life | The student discusses the impacts of transitioning to college life on their academic performance. |
| | **Intervening Condition**<br>Managing time and self | Similar to establishing a working style, this code refers to students explicitly talking about managing their time and planning. I am keeping this code separate from other working styles because it is fairly common across multiple participants. |
| Positive Affect | **Intervening Condition**<br>Gaining balance | The student discusses strategies that they use to gain or find balance in their lives between personal, professional, and academic activities. |
| | **Intervening Condition**<br>Reducing stress | Strategies that students use to reduce their stress levels during their undegraduate careers. |
| | **Intervening Condition**<br>Gaining confidence as a college student | The student discusses their experiences in gaining confidence, generally speaking, as a college student. |
| Negative Affect | **Intervening Condition**<br>Feeling overwhelmed with other aspects of life | The student has discusses other non-academic events outside of their control that may have impacted their learning and/or degree progress. |
| | **Intervening Condition**<br>Realizing the difficulty of college | The student realizes how difficult transitions and aspects of college life can be. |

| | **Category**<br>Institutional Navigation | This category contains codes that describe ways in which students must navigate the institution. |
|---|---|---|
| Navigation | **Intervening Condition**<br>Entering major | The student discusses their process for applying and being granted access into a major. **(Combined 'Entering major' and 'Declaring major' codes.)** |
| | **Intervening Condition**<br>Withdrawing from major | The student discusses an instance of withdrawing from a major that they were in prior to entering civil engineering. |

## Theme 3: Life as a College Student (Continued)

| **Category** Perceptions of College | | This category contains codes that describe how students position their college career when pursuing an undergraduate degree in civil engineering. |
|---|---|---|
| Job Training | **Intervening Condition** Synonymizing school and job training | The student talks about college as training program for a future job or considers entering the job field as an opportunity to learn. **(Combined 'Positioning school as job training' and 'Perceiving job as a learning environment'.)** |
| | **Intervening Condition** Using college for trial and error | The student positions college courses as a trial and error process to determine what the student likes and dislikes. |
| | **Intervening Condition** Testing career paths within civil engineering | When the student positions using an internship or other experience as a way to test or tryout jobs in the civil engineering profession. Could also be applied to instances where students feel safe testing out a career trajectory and life transitions (e.g., living at home, earning a stable income, etc.) |
| "The Fake World of College" | **Intervening Condition** Taking punches and getting through it (in vivo) | The student positions the difficulties associated with obtaining a civil engineering degree as a way to build resiliency and as preparation for life. Also includes descriptions of getting through classes **(also is a combined code of 'Persisting through the Curriculum' and 'Getting through')**. |
| | **Intervening Condition** Staying on track | The student talks about "staying on track" in their curriculum and not falling behind. May also include when students talk about having a jam-packed curriculum, causing them to take high credit hours. |
| | **Intervening Condition** Stifling academic exploration | The student discusses that their course schedule is so packed that they cannot explore other interest areas in the academic context. |
| | **Intervening Condition** Extrinsicly emphasizing GPA | The student discusses the importance of a GPA for a specific reason (e.g., needing a certain GPA to keep a scholarship) |

## Theme 4: Learning and Shifting Perspectives

| | **Category**<br>Learning about Engineering/Civil Engineering | This category includes codes that capture students' motivations for going into engineering or civil engineering. These codes could be considered as causal conditions for students' choosing to go into college. |
|---|---|---|
| Definition Evolution | **Causal Condition**<br>Learning the nuances of civil engineering | The student discusses how they learned about the nuances of civil engineering - not that it just one nebulous field. |
| | **Causal Condition**<br>Realizing the politics of civil engineering | The student discusses the realization of inherent politics within civil engineering and the profession (i.e., you must build experience before you can actually help people). |
| | **Causal Condition**<br>Realizing roles | The student no longer discusses civil engineering as something that one person can do, but rather as an individual with a particular role within the civil engineering field. |
| | **Causal Condition**<br>Articulating knowledge accumulation versus application | The student discusses the difference between learning information and applying it to specific contexts; however, they perceive this learning to be very interconnected. |
| | **Causal Condition**<br>Separating design and doing | The student separates the design and building aspects of civil engineering and perceives them as dichotomous career choices. |
| Experiential Learning Gains | **Causal Condition**<br>Learning from social interactions | The student discusses learning about aspects of civil engineering through social interactions and conversations (e.g., over-hearing a friend's conversation about credentialling). |
| | **Causal Condition**<br>Identifying gaps in coursework | The student identifies topics, skills, or values that would be useful in their future careers but are missing from the course context. This may include tools, communication skills, values, etc. |
| | **Causal Condition**<br>Fostering interest through work experience | The student discusses working in engineering-related fields as something that they enjoy doing and increases their interest in the civil engineering profession. |
| | **Causal Condition**<br>Gaining confidence in problem-solving abilities | The student discusses their increase in confidence regarding problem solving strategies. |

## Theme 4: Learning and Shifting Perspectives (Continued)

| | | |
|---|---|---|
| **Category**<br>Shifting Perspectives | | This category captures the ways in which students' perspectives or conceptions of civil engineering shift as students learn about and engage in the profession. These shifts can occur holistically regarding their perceptions of the field of engineering or be more localized to the student themselves. |
| Shifting from Materialistic to Altruistic | **Intervening Condition**<br>Shifting from materialistic to more altruistic motives | The student shifts their perception of civil engineering as a way to get a job and make money to a way of using civil engineering as something more. |
| | **Intervening Condition**<br>Identifying societal implications | The student sees civil engineering as a way to impact society. This code may be similar to the "globalizing outside of oneself" code, but is more operational in nature. |
| | **Intervening Condition**<br>Screwing up is not an option (in vivo) | The student addresses the responsibility inherent within the civil engineering profession and how mistakes can be costly in money and lives. |
| | **Intervening Condition**<br>Globalizing outside of oneself | The student sees engineering as a global activity with societal impacts and resides outside of themselves. |
| | **Intervening Condition**<br>Learning the importance of ethics and credentials | The student discusses the importance of ethics and credentials in civil engineering. |
| | **Intervening Condition**<br>Inclusifying engineering | The student talks about the capability for anyone to be an engineer or a civil engineer. It's not only intelligence that separates engineers from others. |
| Shifting from Altruistic to Material | **Intervening Condition**<br>Shifting from altruistic to local perspectives | The student initially discusses altruistic motives for helping people with civil engineering, but then shift this perspective to a more localized goal (e.g., getting a job). |
| | **Intervening Condition**<br>Learning/experiencing stereotype | The student identifies characteristics that embody a stereotypical engineer or a stereotypical civil engineer. The student also describes events or incidents in which they realized these charactertistics. |
| | **Intervening Condition**<br>Credentialling | The student discusses credentialling within their undergraduate careers as a means to gain power or prestige in the profession. |

## Theme 5: Alignment of Self and Profession

| **Category**<br>Connecting to CE profession | | This category captures codes in which the student uses strategies and experiences feelings that connect themselves to civil engineering and vice versa. |
|---|---|---|
| Aligning with CE | **Strategy**<br>Seeing oneself as a civil engineer | The student explicitly describes him or herself as a civil engineer or explicitly states that they can be a civil engineer in the future. |
| | **Strategy**<br>Merging engnineering with the self | This is opposite of "Merging the self with engineering." This code indicates that the student is saying that engineering aligns with who they are and what they like, not vice versa. |
| | **Strategy**<br>Merging the self with engineering | The student merges one's likes, interests, or skills to a desired career. |
| | **Strategy**<br>Valuing civil engineering courses | The student discusses putting more effort into civil engineering courses or placing a higher value on civil engineering courses moreso than their other classes. |
| | **Strategy**<br>Thinking like an engineer (in vivo) | The student identifies that he or she thinks like an engineer or aligns with an engineering way of thinking. |
| | **Strategy**<br>Having an engineering personality (in vivo) | The student self identifies that he or she has an engineering personality, or a personality similar to one of what a civil engineer is or what a civil engineer should be. **(Combined 'Having an engineering personality' and 'Unknowingly isolating self' codes.)** |
| | **Code**<br>Realizing engineering skills through others | The student realizes their engineering skills by recognizing differences between their own behavior and the behaviors they observe in non-engineering majors in their surroundings. |
| Communication | **Strategy**<br>Legitimizing self to others | The student describes instances or feelings in which they must legitimize the civil engineering profession through their own talents, skills, and intelligence. They use these positive characteristics to reinforce positive perceptions of civil engineering. |
| | **Strategy**<br>Exceptionalizing engineering | When students puts engineering up on a pedastal as being above average - or that only engineers are capable of doing things that no one else can. **(Combined 'Exceptionalizing engineering' and 'Being cocky' codes.** |
| | **Strategy**<br>Correcting others' perceptions of civil engineering | The student makes statements that correct what others may think about civil engineering. |
| | **Strategy**<br>Being questionned by others | The student discusses being questionned about aspects of college life or career path by those who do not necessarily know. |
| Aligning with Peers | **Strategy**<br>Struggling together (in vivo) | The student describes struggles that they experience with their civil engineering peers. This code is based off of stereotypical perceptions of engineering education that engineering work is "hard". |
| | **Strategy**<br>Positioning peers as civil engineers | The student explicitly positions peers or other students as civil engineers (e.g., when I went to college, I met a lot of civil engineers). |
| Separating | **Strategy**<br>Separating from non-engineering others | The student talks about strategies they use to maintain relationships with others (e.g., not being friends with non-engineers because they don't understand). **(Combined 'Just don't have time' and 'Maintaining relationships with others' codes.)** |

## Theme 5: Alignment of Self and Profession (Continued)

| | | |
|---|---|---|
| **Category**<br>Separating self from civil engineering | | This category captures the ways in which students separate themselves from civil engineering. |
| Intrapersonal | **Strategy**<br>Pushing away from engineering | The student describes an instance when they felt themselves pushing away from civil engineering or engineering in general. |
| | **Strategy**<br>Separating personal and professional life | The student explicitly discusses their engineering or academic life separate from their personal life. |
| | **Strategy**<br>Rebelling against norms | The student discusses strategies to keep others from perceiving them as an engineer or related to engineering. |
| Interpersonal | **Strategy**<br>Separating the self from engineering others | The studen separates themselves from individuals who are associated with engineering based on the fact that they are associated with engineering. |
| | **Strategy**<br>Working alone | The student talks about doing homework assignments alone. |
| Institutional | **Strategy**<br>Disengaging from courses | The student discusses instances in which they begin to disengage from the engineering or civil engineering course content. |

| | | |
|---|---|---|
| **Category**<br>Presenting yourself (in vivo) | | The student discusses strategies for presenting yourself as a civil engineer or safe civil engineer. |
| Perceptions of others | **Strategy**<br>Being looked-down upon by others | The student discusses incidents when individuals in their environment do not necessarily support a students' decision to go into civil engineering or pursue a degree in civil engineering. This may also include instances when students experience push-back from individuals they work with when completing engineering tasks. |
| | **Strategy**<br>Looking professional (in vivo) | The student discusses activities or strategies that they can use to "look more professional" as a civil engineer. |
| | **Strategy**<br>Saving face | The student describes an embarassing moment that helped them decide to go into civil engineering and how they recovered from it. |
| | **Strategy**<br>Relating to others | The student discusses their ability to relate to others who may differ from them. |
| Credentialing | **Strategy**<br>Gaining power and responsibility through credentials | The student discusses gaining responsibility through acquiring a credential. |
| | **Strategy**<br>Being perceived as safe | The student discusses strategies that help them gain the reputation or identity as being a safe engineer. |

## Theme 5: Alignment of Self and Profession (Continued)

| | **Category**<br>Iterative Self Assessment | This category includes codes that capture students' motivations for going into engineering or civil engineering. These codes could be considered as causal conditions for students' choosing to go into college. |
|---|---|---|
| Family | **Intervening Condition**<br>Feeling pressure for high acheivement | The student discusses instances in which they felt pressured by other individuals to perform well in life endeavors. |
| Institutional | **Intervening Condition**<br>Using grades to measure knowledge gains | The student discusses their perceptions of grades as a reflection of their knowledge gains. |
| Peers | **Intervening Condition**<br>Comparing to peers | The student discusses comparing themselves to the behaviors, skills, characteristics, and values to their peers or colleagues. |

| | **Category**<br>Coping with misalignment | This category captures strategies that students use to cope with their misalignment as embodied in their obstacles and contradictions. |
|---|---|---|
| Personal | **Strategy**<br>Overcoming obstacles | The student discusses obstacles outside of their control that hindered their academic progress and/or made them doubt their participation in the program. |
| | **Strategy**<br>Gaining momentum | The student describes overcoming barriers and feeling good about where they are at a specific point in time. **Move to Establishing Conguence - this is an outcome, not a strategy** |
| Institutional | **Strategy**<br>Managing institutional structure | The student discusses strategies for meeting university requirements to complete specific milestones. |
| | **Strategy**<br>Dismissing courses/identifying weed out courses | Strategies that the student uses to interpret obstacles during their undergraduate career. **(Combined code of 'Dismissing first year courses' and 'Identifying weed out classes'.)** |
| Decreasing Failure Potentia | **Strategy**<br>Going with the flow | The student discusses a "why not?" mentality regarding career and life choices - particularly regarding staying on a path that you are currently on without experiencing much contradiction. |
| | **Strategy**<br>Mitigating pigeonholes | The student discusses a strategy by which they create enough options for themselves so they aren't stuck in a single situation that they can't get out of. |
| | **Strategy**<br>Analyzing alternatives | The student talks through and analyzes their future options regarding job, family, and location. |

## Theme 5: Alignment of Self and Profession (Continued)

| | | |
|---|---|---|
| **Category**<br>Being Stuck | | Tthis category includes negative outcomes that result from a students' failure to cope with a misalignment between themselves and the engineering/civil engineerin identity. |
| Personal **(Changed to Doubting Self)** | **Outcome**<br>Expressing fear | The student explicitly states that they are scared or uncertainty to take the next step in their lives. **(Combined 'Expressing fear' and 'Expressing uncertainty' codes.)** |
| | **Outcome**<br>Doubting major choice | The student expresses doubt or regret regarding their current major choice. |
| | **Outcome**<br>Regretting path | The student admits regret over a career or life decision as part of the reflection process. |
| Institutional **(Change to Delaying Career Decisions)** | **Outcome**<br>Remaining undecided | The student doesn't know what civil engineering concentration they want to go into. |
| | **Outcome**<br>Witholding type | The student could not say that he or she was a type of engineer or in a specific engineering major because he or she was not in a particular major yet. |
| | **Outcome**<br>Being locked in (in vivo) | The student describes being "locked in" to the civil engineering major due to GPA restrictions or having taken so many classes that they did not want to switch to another major. |
| | **Outcome**<br>Feeling trapped in position | The student reflects on engineering undergraduate as being funneled into a job or feeling a loss of agency when making life decisions. **(Combined 'Being funneled into a job' and 'Feeling trapped in position'.)** |

## Theme 5: Alignment of Self and Profession (Continued)

| **Category**<br>Negotiating Perspectives | | Tthis category includes negative outcomes that result from a students' failure to cope with a misalignment between themselves and the engineering/civil engineerin identity. |
|---|---|---|
| Future Goals | **Strategy**<br>Negotiating family and work goals | The student talks about attempting to have a family and a career. |
| | **Strategy**<br>Negotating possible future | The student explains that an initial career choice or profession would not be practical due to a variety of conditions or contexts. |
| | **Strategy**<br>Shifting career goals | The student begins to shift their career goals based on what they've learned or are learning about civil engineering. |
| | **Strategy**<br>Contemplating other future | The student discusses or projects a potential future if they had chosen a different career option. |
| | **Strategy**<br>Predicting the future | The student is projects or speculates what career interests can or cannot help them do or become. Discussing possible selves. |
| Values | **Strategy**<br>Being away from family | The student discusses that their job may take them away from their family, and they don't know if they are okay with that or not. |
| | **Strategy**<br>Comparing desire, interest, and skill | The student discusses their comparisons between desire, interest, and skill (e.g., a student may be skilled in completing math calculations but just does not like completing math calculations). |
| | **Strategy**<br>Negotiating passion and practicality | The student talks about making decisions in such a way that they are compromising passion for practicality and vice versa. |
| Eng. Characterist | **Strategy**<br>Shifting topical focus in civil engineering | The student identified interesting topical concentrations in civil engineering based on courses that they've taken or on internship experiences. |
| | **Strategy**<br>Negotiating engineering work | The student explains variations in characteristics in engineering work such as safety, difficulty, tasks, etc. |

| **Category**<br>Reflection | | Tthis category includes negative outcomes that result from a students' failure to cope with a misalignment between themselves and the engineering/civil engineerin identity. |
|---|---|---|
| Individual Growth | **Intervening Condition**<br>Reflecting on personal growth | The student discusses about general growth of themselves since a self-identified point in time (e.g., levels of maturity, how they handle adverse situations, etc.). **(Combined 'Getting humbled' and 'Reflecting on personal growth'.)** |
| | **Intervening Condition**<br>Reflecting on past and connecting to present | The student reflects on their past experiences to describe how they've changed and to determine potential career choices. May also be used as a way for students to justify why they are interested in or are pursuing a degree in civil engineering. |
| | **Intervening Condition**<br>Reflecting on misconceptions | The student reflects on a previous conception of civil engineering that they deem as incorrect. **(Combined 'Becoming the contradiction' and 'Reflecting on misconceptions' codes.)** |

## Theme 5: Alignment of Self and Profession (Continued)

| **Category**<br>Negative affect | | Tthis category includes codes that describe students' feelings as a result of a misalignment with civil engineering or another aspect of their lives. |
|---|---|---|
| Interpersonal | **Intervening Condition**<br>Feeling bad | The student discusses feeling bad because they anticipate letting someone down, disappointing someone, or hurting someone's feelings. |
| Intrapersonal | **Intervening Condition**<br>Losing hope | The student expresses losing hope for their future at some point during their undergraduate experience. |
| Curriculum | **Intervening Condition**<br>Burning out | Losing interest in major choice due to fatigue caused by overwhelming amounts of course work or other factors. |
| | **Intervening Condition**<br>Losing excitement | The student begins to lose excitement about their major choice based on their experiences of and knowledge tht they are learning other courses. |
| | **Intervening Condition**<br>Feeling like a fish out of water (invivo) | The feeling of discomfort when a student perceives that his or her characteristics do not align with those attributed to engineering or civil engineering. |

## Theme 6: Outcomes

| **Category** Identifying Overall Outcomes and Goals | | The student talks about or identifies their overall outcomes or goals for career or life. |
|---|---|---|
| Obtaining a Sense of Belonging | **Outcome** Appreciating community/finding home | The student discusses enjoying being at their institution and feeling like a family with other students. |
| | **Outcome** Finding your place | The student discusses the need to belong and find your place. |
| | **Outcome** Knowing what to do (in vivo) | The student discusses knowing what to do and working independently as a civil engineer. |
| | **Outcome** Establishing a working style | The student describes or discusses their work strategies to complete homework assignments or other habits used to conduct their work. |
| | **Outcome** Finding oneself | The student talks about finding their identity or finding themselves. |
| | **Outcome** Reconnecting with initial attraction to civil engineering | The student talks about being reminded why they wanted to be civil engineers. |
| Establishing Career & Life Goals | **Outcome** Being happy in career and life | I am using this code to capture students' want to just "be happy" with where they are and what they are doing, regardless of income. This code will typically refer to students who don't necessarily want to make a lot of money, but they want to be comfortable and happy. |
| | **Outcome** Anticipating personal growth | The student discusses ways in which they may potentially grow as a person in the future. |
| | **Outcome** Getting a job | The student discusses, in general, that their overall goal is to get a job. |
| | **Outcome** Living a comfortable lifestyle | The student positions civil engineering, or a career in engineering or civil engineering, as a way to achieve a comfortable lifestyle. |
| | **Outcome** Taking ownership of work | The student takes ownership of their work either literally or figuratively. |

## Theme 7: Guidance and Support

| **Category** Receiving guidance and support from others | | This category captures the variety of ways that students experience support from individuals around them regarding their academic and career decisions. |
|---|---|---|
| Validation | **Intervening Condition** Receiving validation from others | The student received validation or encouragement from another person for career interests and choices. This could be in the form of someone telling the student that "when the student was little, they used to [insert activity here]." **(Combined 'Receiving validation from others' and 'Acquiring passive** |
| | **Intervening Condition** Facilitating Interest | The student discusses receiving encouragement from their family or others regarding their interestest in engineering or civil engineering. |
| Support | **Intervening Condition** Creating a support system/friend group | The student describes who they work with or hang out with as a means of emotional/professional/academic support. This can include the students' group of friends, homework partners, and family. |
| | **Intervening Condition** Obtaining guidance from instructors | The student has received helpful information from course instructors, professors, or academic advisors regarding career decisions or skill development (includes academic support). **(Combines 'Receiving guidance from instructors' and 'Seeking academic support from instructors'.)** |
| Unique Case | **Intervening Condition** Lacking a support system **(UNIQUE)** | The student discusses not having people around them that can give them advice on various aspects of college life or career paths. |