

# Developing a Grounded Theory of Undergraduate Civil Engineering Professional Identity Formation

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**Abstract**—Prior work in engineering education has shown that individuals who do not identify with engineering groups, maintain a sense of belonging to, or perceive themselves as engineers are more likely to leave the profession. While significant research has been conducted on 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), little is known regarding the ways in which these identities intersect and evolve to form students' professional identities, particularly within a single engineering discipline. In this work in progress paper, we present the preliminary findings of the first phase of a quasi-longitudinal grounded theory study consisting of 20 interviews with sophomore-, junior-, and senior-level undergraduate civil engineering students. By sharing our preliminary findings, we aim to describe and further establish the grounded theory methodology within engineering education research; engage engineering educators in a scholarly discussion regarding the value of this topic; and gain further insights for advancing this work.

**Keywords**— *professional identity formation; identity; grounded theory; civil engineering*

## I. INTRODUCTION

Prior work in engineering education has established that individuals who do not identify with engineering groups, maintain a sense of belonging to, or perceive themselves as engineers are more likely to leave the profession. Drawing from frameworks in sociology, social psychology, and educational psychology, a number of researchers have identified multiple factors that impact identity development related to both internal and external perspectives of identity. Internal factors such as gender, sexual orientation, and race and religion consist of personal characteristics and are often protected from others [1-6]. External factors such as institutional structure, the nature of engineering work, and discourse and communication practices are shaped by an individual's interactions with social contexts and societal structures [7-11]. While significant research has been conducted on these various factors, little is known about the ways in which students construct or develop professional identities in tandem with disciplinary values, behaviors, and practices that are learned during the undergraduate education

experience, particularly within the context of a single engineering discipline.

To further deepen the understanding of engineering education, far more studies investigating identity construction within these contexts are necessary [12]. To enhance the professional formation of civil engineering students, we must first begin to identify the activities, experiences, and relationships that influence the development of students' identities. As we begin to learn how these promote or inhibit identity formation, we can then make necessary pedagogical, course, and curricular changes to increase students' identification with engineering, influence the ways in which they perceive themselves as engineers, and promote their successes both as students and as emerging professionals.

Within the current study, we seek to understand the process by which undergraduate civil engineering students create and form professional identities by utilizing the Constructivist Grounded Theory methodology [13]. By gaining an understanding of the ways in which these students construct professional identities, we may understand the impacts of engineering education on our students both inside and outside the classroom as they prepare for their future careers. Employing Constructivist Grounded Theory (GT) as a methodological framework for this study allows us to capture the dynamic and complex nature of the identity formation process in an unbounded investigation that allows for unanticipated findings to emerge, as well as promotes GT as a relevant methodological framework within engineering education research.

In addressing the purpose of this study, we ask the following research questions to guide our emergent inquiry:

- How do students form initial conceptions of the civil engineering profession?
- How do students' perceptions of the civil engineering profession change as they navigate their undergraduate experiences?
- How do students' perceptions intersect with their personal identities or sense of self?
- What strategies do students employ that influence professional identity formation?

To answer these research questions, a quasi-longitudinal GT study has been designed to conduct informal, semi-structured interviews with sophomore-, junior-, and senior-level undergraduate students over the course of two semesters: Spring 2016 (Phase 1), and Fall 2016 (Phase 2). This research design was developed to incorporate a temporal component within the data collection and analysis procedures and will allow us to “follow” students as they embark on multiple developmental and transitional periods throughout their undergraduate careers. In this paper, we delineate and define our meaning of *identity* and present the proposed methods for the overall study. We conclude our discussion by presenting our preliminary findings from an initial Phase 1 analysis as well as next steps and the anticipated timeline for study completion.

## II. DEFINING IDENTITY

### A. A General Definition of Identity

Multiple definitions of identity exist throughout the literature. Hence, to scope our study, we draw from the work of Holland, Skinner, Lachiotte, and Cain who state that, “Identity is a concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations” [14]. Using this definition, we focus our study of identity on the ways in which an individual forms an identity as he or she interprets and internalizes the experiences, incidents, and relationships of the world in which they live. This definition is highly applicable to engineering education as explained further in the next section.

### B. Learning as a Site of Identity Formation

When considering the undergraduate civil engineering education context, students generally enter college as “ordinary [members] of society” [15] and generally have unclear expectations of professional engineering work [16]; therefore, as students learn the values, knowledge, and skills inherent within undergraduate civil engineering education, they also begin to form a professional identity resulting from the subjective application of the civil engineering disciplinary identity to their own personal identity throughout various learning contexts. From this perspective, civil engineering education serves as a site for professional identity formation.

## III. METHODS

As previously discussed, we have utilized a quasi-longitudinal GT study to explore professional identity formation in undergraduate civil engineering students. As an emerging research method within the field of engineering education, the application and use of the GT methodology “shows promise” [17,18] but is not well represented in engineering education research at this time. To further explain the tradition of GT research and its affordances, we present a brief background the GT framework and provide rationale for its use. We will then present the overall research design for this study including data collection and analytical methods.

### A. Overview of Grounded Theory

Initially developed by Glaser and Strauss in 1967, grounded theory is a research methodology that merges 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 within data [13,18,19]. GT is typically used when a theory is not available to understand or explain a process [20]. However, in the event that a model applicable to the process under study exists, a researcher will use GT to further develop the theory for a particular sample population that potentially possesses valuable variables and characteristics of interest. Rather than inquiring about a phenomenon as a single concept or idea, GT allows researchers to generate a general explanation of a process containing identifiable markers over a specific period of time [13,20]. From this perspective, GT researchers seek to reveal potential explanations and underlying mechanisms that influence the occurrence and development of a phenomenon.

As previously discussed, theories of identity formation have been developed and applied to multiple professions such as nursing and engineering in general; however, these theories do not acknowledge nuanced characteristics of groups that constitute these professions, particularly within the disciplinary contexts of engineering. For this reason, we have chosen to develop a GT of undergraduate civil engineering professional identity formation that considers disciplinary practices, values, and beliefs that constitute the civil engineering profession as well as students’ personal and academic-related relationships, interactions, and activities.

### B. Sensitizing Concepts: Gee’s Four Ways to View Identity

Established throughout prior engineering education literature, students may perceive a variety of factors and experiences as contributors to their professional identity formation. However, these factors may be interrelated and include multiple aspects of students’ lives such as family, friends, engineering courses, and extra- and co-curricular activities. For this reason, we did not restrict our inquiry to include only predetermined factors already established in the literature via a theoretical framework. Unlike other research traditions that utilize theoretical frameworks, GT utilizes inductive logic to drive the method once a research topic has been identified. Rather than deductively applying a theoretical framework to answer proposed research questions, grounded theorists identify *sensitizing concepts* that serve as starting points or tentative ideas that are used to guide the initial phases of the research process [13,21].

To examine multiple aspects of students’ lives and how they interact, interpret, and communicate them as they form professional engineering identities, we have chosen Gee’s four identity constructs as sensitizing concepts to guide our initial inquiry. His four identity constructs include: nature identity, institutional identity, affinity identity, and discourse identity [22]. Each of these construct within Gee’s framework is briefly defined and described below:

- *Nature Identity* – an identity that is developed from forces of nature such as gender, race, and sexual

orientation. However, in order for a force of nature to be considered as a meaningful constituent of one's identity, its relevancy must be recognized by that individual within a specific context.

- *Institutional Identity* – an identity that is bestowed upon an individual by certain authorities through laws, principles, rules, and traditions within a given context. Institutional identity may establish itself in multiple ways such as students' entry into and navigation through a desired engineering program, graduation from an engineering department, and passing professional engineering licensure exams.
- *Discourse Identity* – an identity that draws its power from dialogue occurring between rational individuals. From this perspective, identity is not only a characteristic or trait that is to be possessed by an individual, but can be constructed by speaking subjects in which identity is created, managed, and negotiated through everyday discursive activities that are engaged in and recognized by others.
- *Affinity Identity* – an identity that draws its power from distinctive practices and experiences of which members of a particular group share. Members of an affinity group primarily focus their allegiances to a set of common practices and experiences and place a secondary focus on shared culture or traits.

In the GT tradition, it is important to establish that Gee's constructs do not dictate our data collection and analysis; rather they are used to initiate multiple research phases. Other defining GT characteristics incorporated into our research design are *constant comparative methods* and *memo writing*. The constant comparative method consists of the continuous comparison of codes and categories from previously collected data to those of recently collected data as supported by memo writing [13,20,21]. Memo writing occurs throughout the entire research process in which the researcher writes preliminary analytical notes to oneself to further analysis and theory development (*for more information on the types of memos used in GT research, see [13]*). While data collection and analysis are discussed as a linear process in this paper, they are actually being conducted in tandem and influence one another.

### C. Participant Selection and Recruitment

Aligning with traditional qualitative methods, participants were purposely chosen to best answer our research questions from a large research-intensive university in the southeastern United States [13,20,21,23]. To capture the temporal component of GT research and phases of student development throughout their undergraduate experiences, we have chosen three groups of civil engineering students to participate in this study: sophomores, juniors, and seniors. The primary criteria for student participation in this study is that they must be at least 18 of age or older, enrolled in a 2000 or 3000 level engineering mechanics or civil engineering course, and intend to graduate with a bachelor's of science degree in civil engineering.

These groups of students were chosen to participate in this study for three reasons: 1) their first-hand experience of substantial identity shifts as their exposure to disciplinary work becomes increasingly focused; 2) the transient positions of these students within the curriculum (i.e. sophomore students are emerging as "engineering students" within the curriculum, junior students are emerging as "civil engineering" students within the curriculum, and seniors are emerging as entry-level engineers within the profession); and 3) sophomore- and junior-level students are traditionally understudied in the field of engineering education research.

Maintaining these recruitment criteria enable us to consider students who may possess wider varieties of identity-influencing experiences that include *negative cases*. Negative cases are data that sharply contrast the emerging themes that are accounted for in the majority of the data [13]. 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.

Participant recruitment for both phases of this study are designed to be conducted using a brief, 10-minute, in-person classroom visit in which the first author would describe the research study and pass out an interest survey to each student. Students wishing to participate in the study provide their contact information to schedule an interview with the first author. Instructors who grant access to their classrooms will be compensated with a summary of our study's findings and strategies for enhancing professional identity formation within their classrooms.

For Phase 1 recruitment, we contacted 15 instructors for permission to visit their classrooms for sophomore-level courses such as Statics and Measurements in Civil Engineering and from junior- and senior-level courses such as Structural Analysis, Introduction to Environmental Engineering, and Introduction to Reinforced Concrete Structures. These courses were chosen due to the nature of their content that introduces students to the fundamental concepts of the engineering field, the discipline of civil engineering, and the engineering profession. Nine instructors responded to the recruitment permission email and granted access to 10 classes. The research networks created through this communication and recruitment process during the first phase will also be utilized in Phase 2, which will be conducted during the Fall 2016 semester.

### D. Data Collection

Students wishing to participate in the study are asked to complete two primary duties throughout the duration of the study: 1) conduct up to four, 60-90 minute interviews, and 2) complete a Minute Follow-Up questionnaire after each interview. In the following, we describe the semi-structured interview as well as the follow-up questionnaire.

During each interview, the participant is asked to complete a worksheet that prompts them to reflect on the skills, activities, and values that they would use to describe civil engineering during different periods of their lives. In particular, we ask that students position themselves as individuals prior to college, during college, and after graduation. As students write

down their responses on the worksheet, we ask them questions regarding the origin and experience from which that response came using an interviewing technique called the *critical incident technique*. A critical incident is defined as an activity that makes a significant contribution, whether positively or negatively, to a phenomenon [24-27]. For the purpose of the present study, a critical incident would be defined as any incident, relationship, activity, event, or experience that a student perceives as influencing, either positively or negatively, their professional identity formation.

Upon completion of an interview, each student is asked to complete an online, Minute Follow-Up Questionnaire that is designed to capture any demographic data and missing or sensitive information that the student is willing or wishing to provide. These questionnaires should take students less than five minutes to complete and serve as another form of data collection to scope future interview protocols throughout the duration of the study. These surveys will be analyzed in tandem with interview transcripts and field notes to inform further theory development and data collection.

During Phase 1 of this study, 20 interviews – one interview per student – have been conducted to date with 18 of those students returning Minute Follow-Up Questionnaires. It is hoped that by conducting a single, initial interview with each student during Phase 1 that we will establish a broad foundation from which to develop an emerging theory and encourage students to come talk to us again during Phase 2 of the study in the Fall 2016 semester.

#### E. Data Analysis

As previously stated, data collection and analysis are simultaneously performed, during which time the researcher persistently interacts and engages with the data – a practice that is explicitly encouraged within the grounded theory tradition [13]. Within GT research, data analysis shapes and is shaped by the data collection process.

Interviews are transcribed and will be analyzed using methods characteristics of the GT methodology. Primary data analysis within GT are conducted through coding and categorization procedures that consist of five primary phases: 1) initial (i.e. open) coding, 2) focused coding, 3) axial coding, 4) theoretical coding, and 5) theoretical categorization [13,20]. These phases of data analysis are conducted iteratively throughout data collection until theoretical saturation is reached and no new themes emerge. The analytical structure of GT is highly dependent upon the researcher to determine when and how to streamline analytical techniques to inform the emerging theory. Minute Follow-Up surveys and GT field notes will also be incorporated into the analytical process to further identify and explicate emerging codes, categories, and themes.

#### IV. PRELIMINARY FINDINGS

For Phase 1, only an initial, open-coding procedure has been conducted on 3 of the 20 interviews. Therefore, in this section, we will present some common themes as identified through researcher field notes that highlight areas for further inquiry. Example quotes from research participants have been

provided to illustrate some of the trending topics discussed in the interviews, where applicable.

##### A. Initial Interest with Civil Engineering

Students have experienced a variety of paths into civil engineering. Some students have known that they wanted to be a civil engineer since they were fairly young children, such as Calvin. Upon asking him when he first wanted to be a civil engineer, he responded, “I think for my fourth grade career fair, I dressed up as a civil engineer, actually.” Other students, such as Madeline, knew they wanted to go into engineering based on their high school math and science skills, but were not aware of civil engineering until they reached college. When asked the same question regarding her interest in the civil engineering discipline, Madeline responded:

*“So, I just think when I got into the engineering program it became like, ‘Well, what are you doing?’ ‘Engineering.’ ‘Okay, what type of engineer?’ So it’s like, okay, once you are on the inside circle almost, you realize there is more than one type of engineer.”*

##### B. Identification with Civil Engineering

Students also exhibit a vast array of ways in which they identify with civil engineering. Some students, such as Calvin, know right away that they want to be civil engineers due to a family member or friend and plan their future to align with that goal. However, other factors such as institutional structures and medical issues have impacted the ways in which students position themselves within civil engineering. During Adam’s interview, he consistently returned to the institutional structure of the university and the measures he had to take to sign up for extra classes in order to boost his GPA so that he could transfer from General Engineering into Civil Engineering. Other students, such as Madeline, related much of her experience to factors outside of academia as she discussed earning an undergraduate degree while managing her dyslexia.

While these results do not individually provide groundbreaking evidence of students’ formation of professional identity, they do begin to provide some insight regarding the initial conditions and contexts that may impact the ways in which students interpret their identities as they embark on their undergraduate careers. In particular, Madeline’s comment that describes engineering as an “inside circle” warrants further inquiry based on the social culture of civil engineering and how students interact with and within it.

#### V. NEXT STEPS

As discussed in this paper, only the data collection for Phase 1 is completed and has been partially analyzed. Next steps for this study include: 1) to further analyze data over Summer 2016, and 2) use these results to adjust and tailor interview protocols for returning participants in Phase 2 (Fall 2016). As these interviews are iteratively conducted and analyzed, we will theoretically sample returning participants to tailor data collection and analysis toward theory development [13,19]. The proposed completion of this project is May 2017.

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