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Paper ID #15019

Disciplinary Influences on the Professional Identity of Civil Engineering Students: Starting the Conversation

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Abstract

As the discipline of civil engineering has evolved from an apprentice-based trade to a socially-engaged profession, the role of the civil engineer has responded to shifts within the ever-changing culture of society. These shifts and historical events have directly influenced what is considered to be valued civil engineering knowledge, behaviors, and practices that we teach to students during their undergraduate careers.

As part of a larger grounded theory study that is currently being conducted by the authors, the purpose of this paper is two-fold. First, we present the topic of professional identity formation as heavily influenced by unique historical events that shape the civil engineering discipline. . To establish the connection between identity formation and the history of civil engineering, we interpret historical events as constituents that create a disciplinary identity that is communicated to and subjectively applied by students during their undergraduate careers. Second, we hope to promote and invoke conversations surrounding the relevancy of civil engineering professional identity formation in engineering education among our colleagues within the technical disciplines.

Through this paper, we add to ongoing research exploring the professional formation of engineering identities and promote discussions surround this topic at the disciplinary level. While most research conducted on identity formation has been generalized to include all or most engineering disciplines, we focus our discussion solely on professional identity formation within the civil engineering discipline. To reinforce the relationship between the history of the civil engineering profession and students' professional identity formation, we review the literature on these two areas of inquiry. In particular, we will frame our paper using the following key discussion points: 1) providing a brief overview of key historical events of civil engineering in the United States; 2) discussing the influence of this history on instructor pedagogies and student learning within civil engineering education; and 3) conceptualizing this learning process as a means of professional identity formation.

From this work, we will begin to understand how major historical shifts within our discipline maintain the potential to impact its future as we educate the next generation of civil engineering students. To conclude this paper, we will introduce current research that is being conducted by the authors to further understand the nuances of professional identity formation in undergraduate civil engineering students and how instructors may help or hinder that development.

Introduction

Civil engineering is credited as the second oldest engineering discipline behind military engineering [1, 2]. The earliest civil engineers in ancient civilizations were responsible for building shelter, water systems, and protection for their people [1]. These emergent engineers did not receive the specialized, theoretically-structured education that we currently utilize and were primarily known as peacetime builders who relied on an apprentice-based, hands-on, tinkering model of training up until the late 18th Century [2, 3]. While present-day civil engineers are still responsible for such socially-responsible domains, civil engineering now exists as a profession that is acquired through a formal education process that is deeply rooted in and influenced by the historical advancements of the discipline [3-10].

Today, the education of undergraduate civil engineering students is largely shaped by the behaviors, practices, and knowledge that have been established and are valued by the discipline's governing professional societies. Topics such as ethics [11, 12]; design regulations for city, state, and federal public works [13, 14]; and communication [12, 15] have all been incorporated into civil engineering curricula across the US. As we teach these topics to our students, we inherently communicate what civil engineers do, who civil engineers are, and how civil engineers interact with the public. In essence, we as instructors are introducing a *professional civil engineering identity* to our students. As students learn about the civil engineering profession, they transition from "ordinary [members] of society" [4] to members of a profession and learn how to "become" civil engineers [16-19]. In this context, learning is perceived as a site for professional identity formation in which students subjectively merge the identity of the discipline with their own personal identities during their undergraduate education experience [4, 18-21]. From this perspective, civil engineering education serves as the nexus that links students' individual identities to those of the profession.

As part of a larger grounded theory study that is currently being conducted by the authors, the purpose of this paper is two-fold. First, we present the topic of professional identity formation as heavily influenced by the unique history of the civil engineering discipline. Second, we hope to promote and invoke conversations surrounding the relevancy of civil engineering professional identity formation in engineering education among our colleagues within the technical disciplines. Drawing from the work of Tonso [22] and Gee [23], we define key identity concepts and review current research on professional identity formation in engineering contexts. Next, we emphasize two primary underlying concepts to guide the remainder of our discussion: 1) the learning process perceived as a means of identity development [4, 18, 22]; and 2) the influences of the civil engineering profession on the environments in which this learning takes place. Upon linking professional identity formation and learning to the professionally-influenced education of civil engineering students, we review three key events that have greatly impacted the identity of the civil engineering profession: 1) the establishment of professional credentialing systems, 2) the development of the American Society for Civil Engineers Body of Knowledge, and 3) the

creation of the ASCE Code of Ethics. Upon presenting each event and their impacts on the professionalization of the civil engineering discipline, we discuss potential implications for civil engineering education and student professional identity formation. Drawing from this discussion, we conclude this paper by introducing current work seeking to understand the nuances of civil engineering students' professional identity formation and the ways in which instructors can promote or hinder that development.

Developing a Theoretical Foundation: Defining Identity

Identity is a complex, dynamic, and contextually-dependent phenomenon that hinges on individual and group positioning [19, 24]. Similarly, the study of identity is also complex and contextually-dependent, relying on the contexts in and the theoretical lenses through which it is investigated. To understand how professional identity formation occurs, we adopt an overall definition of identity as presented in Tonso [22] and posed by Holland, Lachicotte, Skinner, and Cain [25]: "Identity is a concept that figuratively combines the intimate or personal world with the collective space of cultural forms and social relations." This definition primarily focuses on the ways in which an individual forms an identity as he or she interprets, is influenced by, and internalizes the experiences, incidents, and relationships of the world in which they live.

Gee's Four Ways to View Identity

Acknowledging that a single person's identity may take on many forms, Gee created a foundational research structure for other researchers studying identity [16, 26-29], Gee's [23] framework consists of four views of identity that encourages researchers to understand how a "certain 'kind of person,' . . . [is recognized] in a given context" [23]. These four views of identity, presented in Table 1, provide an analytic tool for studying the myriad of identity dimensions possessed by or granted to a single individual as he or she encounters, negotiates, and performs within a variety of contexts. This framework reinforces a complex and double-sided perspective of identity by acknowledging the interrelated processes, power shifts, and varied levels of agency by which individuals construct an identity [19, 23].

Table 1: Four Ways to View Identity [23]

Construct	Process	Power	Source of Power
Nature Identity *(a state)*	developed from	forces	in nature
Institution Identity *(a position)*	authorized by	authorities	within institutions
Discourse Identity *(an individual trait)*	recognized in	discourse/dialogue	of/with "rational" individuals
Affinity Identity *(experiences)*	shared in	the practice	of "affinity groups"

The four views of identity are: 1) nature identity, 2) institutional identity, 3) discourse identity, and 4) affinity identity [23]. Nature identities are determined due to a state developed by a force outside of an individual's control [23]. 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. One distinguishing attribute of nature identities is that they must be recognized by the individual as a meaningful constituent an individual's identity. Institution identities are bestowed to an individual by certain authorities through laws, principles, rules, and traditions within a given context [23]. Once an individual obtains an authority, they maintain the rights and responsibilities that accompany the position of which the authority entails. Discourse identity draws its power from dialogue occurring between rational individuals. 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 [23, 30]. However, while discourse identity is enacted through language, it must also be engaged in and recognized by others [23]. Unlike nature and institutional identities, discourse identities allow individuals some sense of agency in maintaining an identity while still relying on perceptions of others. Affinity identities draw their power from distinctive practices and experiences of which members of that 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 a shared culture or trait [23]. By using this framework to explore the professional formation of civil engineers, we acknowledge that multiple identity perspectives exist simultaneously and are influenced through a variety of complex ways.

Developing the Civil Engineering Profession and Identity

Throughout history, the field of engineering, as well as the discipline of civil engineering, has evolved into an organized profession, requiring members to possess a large amount of disciplinary knowledge and adhere to a regulatory code of ethics [4, 6, 8, 9]. To gain membership into a profession, one must learn its valued knowledge, behaviors, and symbols [4] . These disciplinary characteristics that define the civil engineering discipline are continuously responding to cultural, economic, and societal shifts through a process of code-switching. *Code-switching* refers to a process through which "engineers build legitimacy for themselves and their knowledge simultaneously in professional and popular terms" [31]. Hence, as a result of historical events, the discipline defines its own identity to which an individual wishing to become a member must align.

Learning as a Site for Professional Identity Formation: "Becoming" an Engineer

"Becoming" is described as a collective identity that is developed through the iterative negotiation of a group's objective identity for subjective application to one's personal identity [20, 21, 32]. In other words, as individuals begin to experience and become socialized into a group, they begin to recognize their own identities through that group's socially-defined terms. This same

concept may be applied to the education of undergraduate civil engineering students. As these students enter into college as "ordinary [members] of society" [4] they typically have unclear expectations of professional engineering work [33]. Therefore, as students learn about the values, knowledge, and skills inherent within undergraduate civil engineering education, they begin to form a professional identity. This professional identity results from students' subjective application of the civil engineering disciplinary identity to their own personal identities. From this perspective, students are enculturated into the civil engineering profession during their academic, undergraduate experiences and begin to develop their professional identities as civil engineers [16-19].

Historical Influences of the Disciplinary Professionalization on Civil Engineering Education and Professional Identity Formation

The earliest universities were established to prepare students for the professions [5]. Therefore, as the civil engineering discipline grew as a profession, so did the reasons for formally educating future civil engineers. As undergraduate engineering educators, we hope that students obtain the necessary competencies to enter into the engineering workforce; however, it is also important that students begin to align and negotiate their identities with those of the profession to create their own professional identity throughout their educational experiences [22, 34-36]. In this section, we describe three key disciplinary advancements and their influences on civil engineering education: 1) the development of the American Society for Civil Engineers (ASCE) Body of Knowledge, 2) establishment of professional credentialing systems, and 3) the creation of the ASCE Code of Ethics. We then draw from prior identity literature using Gee's framework [23] to map the historical advancements and educational impacts to the various aspects of identity.

ASCE's Code of Ethics: Exploring a Disciplinary Sense of Self and Reputation

Description. As civil engineering work evolved and became more complex, civil engineers wanted to both distinguish themselves from poorly-trained builders and raise their status above military engineers [37]. To gain prominence throughout society despite a lack of documentation to verify competency prior to licensure exams, the ASCE developed one of the first professional practice codes in the United States. Initially used as a means of describing engineering work rather than guiding it, the ASCE utilized this code to identify a specialization within the engineering field and used it to limit the number and type of individuals upon who the civil engineering discipline's reputation depended [37]. While many of these men did not have receive formal education, they used their membership in ASCE as proof of competence [37]. For many years, the code essentially remained the same with one primary message, "Do not do anything to harm the profession, its reputation, or your fellow engineers" [37]. In 1914, an official Code of Ethics (COE) was adopted to ensure the "crucial character of a civil engineer through judicious

membership" [37]. It was at this time that the civil engineering discipline began to define its values, knowledge base, and behaviors to shape its own identity as a profession.

However, maintaining a higher status in society was not enough. As a result of a growing tension in the professionalization of the civil engineering discipline *(*for an in-depth discussion on this topic, see Pfatteicher [38]), civil engineers in the 1960s began to press for "social consciousness" in engineering. This call was further exacerbated by catastrophic engineering failures such as the Hyatt Regency Walkway Collapse and the Challenger Shuttle Explosion in the 1980s [39, 40]. The responsibility for public safety became a paramount value to civil engineers as they began to incorporate this message within defining disciplinary documents to further establish the civil engineering professional identity. 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 [11]: 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 are meant to establish the reputation of the discipline as well as its members. Rather than perceiving the code as a professional guideline, founders of ASCE saw the code as a way to proactively define the identity of the civil engineering discipline and communicate the meaning of their group to others [37].

Identity Impact: Discourse Identity. 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 [30, 41, 42]. When considering the civil engineering COE, we may use discourse to communicate our values and knowledge to others and establish group boundaries through comparison. From a developmental perspective, we can also use discourse identity to determine students' internalization of the discipline's ethical canons and disciplinary identity based on how they discursively position themselves in relation to the values of the profession. For example, research conducted by Dannels [17] and Douglas and colleagues [43] explored the discursive practices utilized by students throughout a variety of academic contexts. They found that students did not perceive themselves as engineers; they perceived themselves as students working for a grade that would lead them to graduate from an engineering program. In these studies, these students utilized discourse to maintain their student identities and separated themselves from engineers. To strengthen the link between student identity and an initially-perceived valueless list of canons, we may educate students on the COE while positioning them as emerging civil engineers who should strive to adhere to those values. The COE maintains a significant influence on civil engineering education because it describes to

student and novice civil engineers the valued behavioral and practical expectations of their careers [44]. 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 [45-48].

While many engineering disciplines have established and currently follow a disciplinary COE, civil engineering was one of the first disciplines to incorporate such a practice. The ASCE COE serves as a "framework for ethical judgement" for its members [37] and communicates to emerging and novice civil engineers and the public the socially-responsible role of the civil engineering discipline within society.

NCEES and the Credentialing Process: Creating an Institutional Identity

Description. One of the first advancements toward the professionalization of the engineering field originated within the civil engineering discipline in the form 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 civil engineers to train for and pass a licensure exam as proof of their practical competence [6]. Today's credentialing exams are regulated by the National Council for the Examiners for Engineering and Surveying (NCEES) and are open to all engineering disciplines [49].

The NCEES currently offers two types of licensure exams for engineers: the Principles and Practice of Engineering exam (PE) and the Fundamentals of Engineering exam (FE). The FE is the first step in licensure process and is designed to test a student's knowledge of disciplinary content acquired throughout his or her undergraduate career [50, 51]. Because the FE exam is designed to asses a uniform knowledge base as established by the discipline's professional societies (e.g., the ASCE Body of Knowledge), the exam is promoted to universities as a robust tool for program assessment [12, 50].

However, not all engineering students are required to pass the FE to graduate with an undergraduate degree in engineering. While educators are encouraged to promote the knowledge of licensure among students [12], it is anecdotally known throughout the engineering community that it is more beneficial for civil engineering students to complete licensure exams due to the public nature of their work. Evidence of this practice is reflected in statistical data collected by NCEES. In 2015, roughly 39% of FE examinees registered and completed the FE Civil Engineering exam [50] and approximately 54% of PE examinees registered and completed the civil construction, civil geotechnical, civil structural, civil transportation, and civil water resources and environmental exams [49]. While this evidence may not directly support anecdotal knowledge among engineering students and engineers, it does illustrate the vast amount of civil

engineers who partake in the licensing process and serves as an indication of the importance of licensure in today's civil engineering contexts.

Identity Impact: Institutional Identity. The primary identity construct associated with licensure in the civil engineering discipline could be conceptualized as a form of institutional identity [19, 23]. As described by Stevens and colleagues, to become an engineer, a student must first be "admitted" to college, "pass" a series of course, and "complete" certain sets of requirements to "graduate" [19]. This first step in the credentialing process can be perceived in such a similar way. A student may or may not consider him or herself to be a civil engineer until they pass that licensure exam, and for those students struggling to develop a civil engineering identity, institutional identity may pose as an external barrier outside of the student's control, potentially hindering the student's retention if they do not pass the exam [19].

While the licensure process has impacted the field of engineering in its entirety, its origins in the civil engineering discipline maintains a significant influence on the ways in which civil engineers perceive their work and prepare for the workplace. From a student's perspective, these credentialing and licensing exams are gateways to "becoming" a civil engineer. From a disciplinary perspective, the credentialing and licensure process solidified the future of the civil engineering profession by setting a standard for its membership. By creating this examination, civil engineers created an avenue to "organize themselves as licensed professionals" [6] and defined themselves from other engineering groups through groups such as the ASCE (founded in 1872) [52].

ASCE's Vision of 2025 and the Body of Knowledge: Establishing a Valued Knowledge-Base

Description. 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 [53]. 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 [15] 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 [12]. Resulting from the 2006 Summit on the Future of Civil Engineering, the BOK 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" [53]. From the creation of the BOK, the civil engineering discipline further delineated a specific set of valued knowledge that expected to be mastered by those wishing to become civil engineers.

Identity Impact: Affinity Identity & Discourse Identity. Members of an affinity group achieve their identities through a set of common practices, experiences, and shared knowledge. For instance, members within an engineering community may share an affinity for mathematically-oriented work [54] or participate in a course because they are interested in learning about topics related to civil engineering. ASCE's BOK establishes the content knowledge and skills that beginning civil engineers must attain. Therefore, as students initially enter into an engineering discipline based purely on topical interest or skill (e.g., are good in math and science), they may begin to internalize the values and practices of that discipline. For this reason, affinity identities may be useful in exploring the initiation and early developmental stages of students' professional identities in contexts such as high school education.

Partaking and actively engaging in disciplinary discourse also serves as a powerful tool for enacting a disciplinary identity and communicating affinity [30, 41, 42]. As students advance throughout their undergraduate career and the ASCE BOK, they begin to learn about the variety of topics valued by the civil engineering discipline and how they may be practically communicated and applied in the field. Through this education, students grow accustomed to key terms, acronyms, and symbols that belong to the civil engineering discipline and may begin to incorporate them into their everyday language.

One defining characteristic of the ASCE BOK is its push for continued higher education and professional development. 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 [53]. While some individuals argue that the BOK and its mandate for continued higher education is outside the purview of ASCE, 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 [2, 9, 12, 53].

The Overarching Impact of Nature Identity

While nature identity is not explicitly mapped within historical advancement discussed herein, it plays an important background role in students' professional identity formation within civil engineering. Nature identity is often recognized due to an identity conflict that the individual experiences with members of the dominant group (e.g., the masculine nature of the engineering profession [55]). In these instances, the individual cannot easily change or negotiate these identities because they exist outside of the individual's control (e.g., race, sexuality, or disability). For this reason, nature identities are a particularly useful construct 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" within a given context (e.g., being a lesbian woman in an engineering discipline, which is typically prescribed through notions of heteronormativity and masculinity [56].). While the civil engineering discipline does not explicitly determine a nature identity for itself, the nature of individuals already belonging to this group communicate the nature by which individuals wishing to become civil engineers must align.

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 disciplinary values. As students are subjected to the multiple behaviors, practices, symbols, and discourse valued by the civil engineering profession throughout their undergraduate careers, 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* [57]. Through this learning process, students begin to internalize and merge their personal identities with those of the profession, thus creating an individualized professional identity for that student.

Limitations and Future Work

In this paper, we introduced the concept of the development of a unique professional identity as influenced by major historical events that have shaped the overall identity of the discipline. Upon the creation of credentialing processes, the ASCE Code of Ethics, and the ASCE Body of Knowledge, the discipline of civil engineering has inherently established varying levels of nature, affinity, discourse, and institutional identities that impact the ways in which students "become" and perceive themselves as "being" civil engineers.
As a second aim of this paper, we strive to invoke conversations among engineers and engineering educators within civil engineering regarding the relevancy of professional identity formation and the impacts that historical events maintain on existing civil engineering culture. We believe that this is a valuable topic of discussion that maintains the potential to aid in and transform retention efforts throughout the civil engineering discipline. Work in this area also may serve as a means to improve and enhance the education of future civil engineering students and eventually, the civil engineering discipline.

It is imperative that more empirical work is conducted to further understand the nuanced and dynamic ways in which students construct their professional identities. Therefore, the authors are currently undertaking a qualitative grounded theory study to explore professional identity formation in undergraduate civil engineering students. In this study, we seek to understand the ways in which civil engineering students form a professional identity and the ways in which it is influenced by students' academic and non-academic relationships, events, and experiences. From this work, we hope to answer many questions that this deep and complex topic invokes. Because

each engineering discipline maintains its own set of valued knowledge, skills, behaviors, and practices [58], we can no longer assume that all engineering students form professional identities in the same way. While current identity research typically generalizes to all engineering disciplines, we believe this empirical gap may leave researchers unable to parse out meaningful findings for application to relevant disciplinary educational contexts, causing them to overlook key ways in which students enter, engage, and thrive within a discipline.

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