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Experiencing Disability in Undergraduate Civil Engineering Education: An Initial Examination of the Intersection of Disability and Professional Identities

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Abstract

While recent calls throughout the engineering education community have focused on increasing diversity and broadening participation in STEM, these conversations typically center on race and gender with little to no work addressing disability. But research in higher education broadly suggests that cognitive, physical, and learning disabilities can markedly impact the ways in which students perceive and experience school, develop professional identities, and move into the engineering workforce. To address this gap, we build on emerging conversations that explore the ways in which students experience disability within the context of engineering education. In particular, we conducted an initial grounded theory analysis of interviews examining professional identity formation in undergraduate civil engineering students who experience disabilities. From our analysis, we observed three themes that begin to highlight ways in which the experience of students with disabilities may contribute to their development as emerging civil engineers.

Introduction & Background

While recent calls throughout the engineering education community have focused on increasing diversity and broadening participation in STEM [1, 2], these conversations typically center on race and gender, with little to no work addressing disability [3-6]. But research in higher education broadly suggests that cognitive, physical, and learning disabilities can markedly impact the ways in which students perceive and experience school, develop professional identities, and move into the engineering workforce [7]. Therefore, to promote diversity and broaden participation in engineering, it is imperative that we gain a deeper understanding of the development of these populations within engineering education – more specifically regarding the ways in which they perceive, interpret, internalize, and engage in the engineering field.

As evidenced throughout engineering education research, identification with the profession is crucial for persistence among engineering students and professionals [8-11]. Those who do not maintain a sense of belonging to – or identification with – engineering groups, or fail to perceive themselves as engineers, are more likely to leave the profession. This identification can be particularly difficult for individuals with disabilities. Students with disabilities face a unique set of challenges in navigating the “physical, social, and intellectual structures” [7, p. 96] of the university that are typically designed for those without disabilities [12]. In their review of the literature, Pearson Weatheron and colleagues [4] further examine systemic and personal barriers, identifying that they can discourage students’ self-efficacy, persistence, and sense of belonging in undergraduate engineering programs and hinder engineering identity development.

To continue to bring disability more fully into discussions of diversity in engineering, this paper builds upon emerging conversations initiated by several engineering education researchers (e.g., [3-5]) at the intersections of disability and professional identity. We explore the ways in which three students experience disabilities while enrolled in an undergraduate civil engineering program as they become civil engineers. Our work addresses the following research question: How do students' experiences with disability influence their professional identity in engineering and vice versa? In the following sections, we review key sensitizing concepts that inform our inquiry, outline our methods, and describe preliminary themes as articulated through participant experience. We close with a discussion of conclusions and directions for future work.

Sensitizing Frameworks

Intersectionality

We begin our exploration with the concept of intersectionality. Initially conceived as a social justice framework used to draw connections between the ideas of interlocking oppressions, community organizations, coalitional politics, and identity politics [13, 14]; intersectionality has since evolved to provide researchers with a lens for exploring interrelations among various aspects of a single individual's identity [15-17]. This framework maintains that factors such as gender, race, sexuality, and ethnicity are not isolated and distinct, but rather reciprocally and simultaneously interact to contribute to identity construction [13, 14]. In this study, particularly in our preliminary analysis, we focus on the interactions between two such factors: disability and professional identity. We thus focus our discussion on the ways in which experiences with disability influence and are influenced by the ways in which students engage in, internalize, and interpret the civil engineering profession as they move through their undergraduate careers.

Professional Identity and the AOI Model

Our work is also informed by prior research on professional identity construction. Typically, *professional identity* is described using a variety of research lenses that capture a dimension of identity that forms as individuals learn and internalize the values, behavioral norms, and symbols of a profession through career training (e.g., undergraduate engineering education) [18-20]. However, existing research also emphasizes the influence of personal identity dimensions on professional identity formation. Gender, race, and sexual orientation have each been shown to impact the ways in which students experience engineering culture, belonging, self-efficacy, and other factors related to identity development [17, 21-25]. More recently, studies have expanded conceptions of identity development to include the interactions among multiple identity dimensions and their relationships, particularly within the disciplinary contexts of engineering [26-28]. In one such study focused on civil engineering, Groen [27] used grounded theory to develop the Advancing from Outsider to Insider Grounded Theory of Professional Identity Negotiation (the AOI Model).

The AOI Model [27] captures the complex, dynamic nature of professional identity formation – influenced by multiple identity dimensions – as civil engineering students advance from an outsider (i.e., an individual not belonging to the civil engineering profession) to an insider (i.e., an individual belonging to the civil engineering profession). The overall premise of the AOI Model is that individuals undertake a variety of negotiations in an attempt to balance their definitions of self and profession to maintain identification with civil engineering and achieve their career goals. As students learn new or conflicting information (both academic and non-academic) during their undergraduate careers, they 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, internships, and interpersonal relationships. According to the AOI Model, definitions of self and profession are balanced when the individual is able to “live as” or simultaneously enact aspects of both definitions of self and profession and advance from an outsider to an insider.

From the AOI Model, professional identity formation is not separated from the individuals in whom it is occurring nor is it constrained to students’ experiences in academia. Rather, the AOI model considers multiple dimensions of a single individual and the experiences that influence those dimensions as they enter into, navigate through, and professionally develop during their civil engineering undergraduate career. In this paper, we use this model as a lens to focus on negotiations linked to disability, which became particularly salient for our participants prior to or early on in their enrollment in the civil engineering program and continued to shape how they navigated the program and moved toward their future careers in civil engineering.

Methods

To better understand civil engineering students’ experiences with disabilities, we focus here on interviews conducted as part of a larger grounded theory study of professional identity formation. Semi-structured interviews, each lasting between 60 and 90 minutes, were conducted with participants using intensive interviewing approaches [29] as framed by constructive interviewing [29] and critical incident techniques (e.g., [31, 32]). Combining these techniques enabled the research team to tailor interviews to participants’ unique responses and achieve an in-depth exploration of each individual’s perspectives, meaning, and experiences. For this analysis, we focus on the subset of participants who discussed their experiences with disability, summarized in Table 1. Personal background for each participant is discussed in the following sections. These students voluntarily disclosed their disabilities during the interview, not prompted by any specific interview question; these disclosures in turn prompted conversations that were framed by or – in one case – focused on students’ experiences with disability during their undergraduate experience.

Table 1: Summary of Participants

Pseudonym	Gender	Academic Level	Disability	Diagnosed
Maggie	Woman	Junior	Dyslexia	Prior to College
Madison	Woman	Sophomore	Lyme Disease	Entering College
Anthony	Man	Senior	Attention Deficit Disorder	During College

All interviews were transcribed and field notes were taken to preserve the context and subtle implications of topics discussed by participants. Analysis was conducted using the constant comparative approaches of grounded theory as outlined by Charmaz [29]. While grounded theory analysis includes five phases (1) open/initial coding, 2) focused coding, 3) axial coding, 4) theoretical categories, and 5) theoretical saturation) we have only completed initial coding of this particular group within this context. Therefore, the results discussed in this paper are preliminary salient themes identified by the research team. Subsequent analyses will examine these themes in greater detail through continued grounded theory analysis and data collection. Aligning with grounded theory methods, this first phase of analysis was supplemented by interview field notes captured in the form of researcher memos.

Researcher Reflexivity

Due to the personalized nature of the grounded theory interviews, the interviewer was able to create social bonds with study participants. This increase in rapport was also due to the identity of the interviewer, who also experiences a disability, as do most members of the full research team. While the interviews in the initial grounded theory study were not focused on examining student experiences with disability in civil engineering, the interviewer’s sensitivity to these experiences was also attuned during the analytical phases of the study. Identity-altering experiences with disability emerged as a salient theme during the initial analysis, particularly as participants discussed periods of transition such as undergoing the process of being diagnosed with a disability, while members of the research team were also undergoing on-going diagnoses at the time interviews were conducted and analyzed.

Participants

Maggie, a civil engineering junior, was diagnosed with dyslexia at an early age. She disclosed her disability within the first few minutes of her interview by stating, “The only thing I can also think of is that I’m dyslexic, and that has played a major role in my academics and stuff.” From this disclosure, her interview primarily consisted of conversations in which she further articulated the impacts of her disability through accounts of critical events that ultimately influenced her pathway into civil engineering.

Madison is a sophomore civil engineering student who grew up in a family of engineers and scientists. Her transition into college life was particularly complex; during her senior year of high school and into her freshman year of college, she underwent the long process of being

diagnosed with Lyme Disease, which prompted many visits to her doctor and multiple stays in the hospital. Unlike Maggie, Madison did not disclose her disease from the outset of the interview; however, she made a number of comments that made it apparent that her disease is unpredictable and has had significant impacts on her academic progress. In the months following her diagnosis, Madison became very ill and, as a result, had to medically withdraw from her first semester in her civil engineering program. During the interview, Madison discussed ways in which she could manage her disease while maintaining energy and focus to keep progressing through her program.

Anthony is a senior who had experienced a much different pathway into civil engineering than other students. While investing his first two years of college in a mechanical engineering degree, he felt disinterested in the material and struggled with focusing on his coursework. After multiple attempts and reassurances of just “sticking it out” with no improvement in his academic performance, Anthony was diagnosed with Attention Deficit Disorder (ADD). Upon his diagnosis, he medically withdrew from his second-semester mechanical engineering courses, worked a part time job, and researched other engineering disciplines. He then decided to go into civil engineering, a program in which he found himself more interested, engaged, and focused – characteristics he attributed in-part to finally finding medication to appropriately manage his symptoms of ADD. Despite experiencing a winding journey into civil engineering, Anthony discussed at length the alignment between his interests and skills with those of the civil engineering profession.

Results & Discussion

As a result of the initial grounded theory analysis, three primary themes were identified regarding the ways in which experiences with disability influenced students’ professional identity formation in civil engineering: 1) developing a sense of self-advocacy, 2) seeking out and utilizing accommodations, and 3) negotiating intermediate expectations. However, based on each student’s time of diagnosis, their experiences related to each theme influenced their professional identity to varying degrees. The themes as well as the variations in how they were experienced by each student are discussed in the following sections.

Theme 1: Developing a sense of self-advocacy

The theme of *developing a sense self-advocacy* captured the variations by which students granted, or refused to grant, authority to other entities (i.e., people or systems) regarding their perceptions of skill or physical and mental well-being. For Maggie, developing a sense of self-advocacy was a dimension that began during middle and high school through multiple requests to be placed into more advanced math courses. She further articulated the growing pains of learning how to self-advocate as she grew older and more independent from her parents:

When I was younger and dyslexic, it was a lot of my parents standing up for me, and 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.” So that’s when I started to want to switch [to advanced] math classes [in high school]. It wasn’t directly like, “these are the accommodations I need,” it’s more like kind of what I want - being able to stand up for myself. And then to be shut down the first time was really traumatic almost. I can remember being taken into a classroom and crying, because I was like, “No, no, no, I know I’m good enough, I know I can do this” and it was just... shut down and it affected me from that point on.

In this instance, Maggie was learning how to negotiate interactions with her math teachers while simultaneously learning to advocate for herself. Even though Maggie felt that she could – and should – be placed in more advanced math courses to align with her interests and perceived academic strengths, she experienced pushback from her teachers. Such experiences can be particularly difficult for students experiencing disabilities who are simultaneously learning what accommodations they need and how to request them as well as managing instances in which requests are not met [4, 7, 12]. While Maggie stated that experiencing an initial rejection on an academic request made her feel “shut down,” she utilized this experience and her skills and knowledge of self-advocacy to identify, obtain, and – in some instances – fight for her accommodations during her undergraduate experience, as further discussed in the next section.

For students such as Madison and Anthony who were diagnosed with their disabilities during college, this learning came much later in life. At the time of her interview, Madison was in the early phases of self-advocacy development after being diagnosed with Lyme Disease during her freshman year. Despite her desire to attend football games and fear of “falling too far behind” in her program, Madison heeded her doctor’s advice to withdraw from courses during the fall of what would have been the first semester of her sophomore year:

Madison: [The treatment] was the beginning of August, and then by the beginning of the [fall] semester, I still wasn't 100 percent [...].

Interviewer: So then you decided to just sit back and take that semester off?

Madison: Yeah. I didn't really have a choice. My doctor was basically like, "Yeah, you're not going [to school]." And I was like [sighs], "I already bought my season [football] tickets." "Well, refund them."

Her doctor had a similar reaction when she discussed with him a summer internship opportunity:

I had [an internship] that I was offered with [a company], which I really really wanted to do, but it's the [type of] internship that you're going out into the field all of the time, doing actual maintenance work on the tracks. It's long hours, and it was [...] really far [from home], and my doctor was like, "Um, that does not sound like a good idea," and I was like, "Okay."

Because Madison was in the early phases of understanding her Lyme Disease and her assessments of her own physical and mental well-being aligned with those from her doctor, she was willing to develop other approaches for achieving her goals. For example, to minimize the number of courses she would miss during her first semester of sophomore year, Madison enrolled in two courses at a community college close to her hometown. To find an internship, she utilized alternative resources (i.e., her friend's father who owned a construction company) to find more amenable internships that were available for the summer.

Anthony, who had only been diagnosed with ADD for a little over a year at the time of his interview, was still determining what his disorder was and its implications for his academics. While he knew that he wasn't enjoying his courses in mechanical engineering prior to his diagnosis, he maintained a "stick it out" attitude to push through his coursework until he was diagnosed with ADD:

Once I finally got into mechanical engineering, I was struggling a lot with the course material. My grades were starting to slip and I just wasn't enjoying it. But I tried to just stick it out, and I did that for two years [...] and I ended up withdrawing from two semesters worth of classes just because my grades were bad and I just wasn't enjoying it. I knew I wanted to do something different. [...] For one of them I was able to medically resign for the semester, and I know that sounds terrible, and I don't mind sharing this, but I found out that I had ADD, and apparently I've had it my whole life.

Receiving a diagnosis enabled Anthony to take a step back from his education, find a medication to manage his symptoms, and research other types of engineering that would be better suited for his interests. During this time, Anthony took agency in his situation and was, in a way, advocating for himself against a tough and demanding university curriculum. Rather than perceiving himself as not smart enough or not belonging to engineering, Anthony took control of his academic career and his disability to continue in an engineering program in which he is genuinely interested.

From the experiences presented here, participants developed self-advocacy in multiple ways, to varying degrees, to help them continue on their path toward becoming a civil engineer. Maggie utilized lessons learned from middle and high school to advocate for her accommodations once she entered college. For Madison, self-advocacy was slowly emerging as she began to learn more about the physical limitations of her disability and to find ways to achieve her academic and professional goals using alternative resources. Like Madison, Anthony also gained a sense of self-advocacy as he began to learn about his disability; however, he used this knowledge to advocate against traditional engineering stereotypes that tend to favor technical content as an indicator of belonging [23].

Theme 2: Seeking out and utilizing accommodations

The theme of *seeking out and utilizing accommodations* captured the extent to which participants sought out and utilized accommodations within the university setting. From her prior experiences of requesting accommodations with her parents, learning about accommodations within the university system, and developing as a self-advocate, Maggie knew what information her instructors needed, when they needed it, and how they processed it. She would arrange her accommodations with her university's Services for Students with Disabilities office (SSD), meet with her instructors to verify receipt of the accommodation, and send emails to schedule exam times. This process went fairly smoothly until Maggie had a negative accommodations experience with an uncooperative and unresponsive instructor. While the incident was resolved by the SSD office, Maggie still reflected on the stresses that these types of incidents can cause:

Maggie: But I was just like these sorts of situations just continually tend to happen – not receiving my accommodations – and I think that affects me a lot in my academics because ... if I know where I'm taking the test and I know when I'm taking a test, I'm normally fine; it's like when it comes up to having to plan out where it is, is where it gets difficult.

Interviewer: It's just added stress that you have to deal with?

Maggie: Yeah, am I going to get my accommodations?

Unfortunately, Maggie's experience is not uncommon. A study conducted by Jensen, McCrary, Krampe, and Cooper [32] revealed faculty members' reluctance to provide accommodations to students with learning disabilities due to perceptions that students may be trying to cheat or get through a class using a less academically rigorous process. Managing these types of perceptions, in addition to the already complex process of requesting and receiving accommodations [7], can create multiple levels of stress and anxiety for disabled students that is unrelated to course content and not experienced by their non-disabled peers [4, 12].

At the time of the interview, the only university accommodation Madison and Anthony had utilized was medically withdrawing from their coursework for a single semester. In both of their interviews, however, they identified other strategies for and individual sources of support in the university system. Madison often described a friend within her civil engineering program with whom she would do homework and study for exams. Once Anthony had identified an engineering discipline that better aligned with his own interests and found a medication to manage his ADD, he continued college without formal accommodations and relied on his professors and well-practiced time management skills for academic support.

Theme 3: Negotiating intermediate expectations

The theme of *negotiating intermediate expectations* captures the ways in which participants had set goals and then altered them based on challenges faced during their undergraduate civil engineering careers. For Maggie, this negotiation occurred as she altered her expectations about the need to participate in an internship prior to graduation. When asked what she saw herself doing after she graduated from college, Maggie responded:

I'm not really sure. [...] I don't have a summer internship lined up or anything like that, so I don't really have any outside the classroom experiences, but [...] I've just had such a difficult time with school that I use my summers to just relax almost. [...] I don't know. I feel like I should apply for all these internships and I've had interviews and stuff like that. But a lot of times it's like, "where's your experience?" I just feel sometimes that I should have applied myself more than that. [...] it's just a lot to deal with within school. So I feel like maybe I haven't set my future up well enough. What am I going to do in a year from now when I'm graduating? Will I have a job or will I just be trying to figure it out? So there's that aspect of it.

Due to the time and energy Maggie spent managing her accommodations and completing school work, which contributed to her lack of internship, Maggie was unsure as to whether or not she would possess the work experience necessary to get a job in civil engineering. However, when asked how she saw herself communicating her prior experience to potential employers, Maggie described shifting her narrative to focus on her strengths gained through study abroad and learning about engineering on a global scale. While she initially perceived internships to be a necessary aspect of the undergraduate civil engineering experience, she realized that she could still demonstrate her skills from other, less-obvious, opportunities.

While Madison also experienced challenges in finding civil engineering internships due to her physical disability, one of her more significant negotiations occurred in changing her academic minor due to her absence during the fall semester of her sophomore year: "Before I had to take off, I was a statistics minor, but that's kind of not possible now, so I'm considering one other minor I might want to add. Because I do need to add a minor, but I just don't know which." When asked why obtaining a minor was important to her, Madison responded:

[...] I feel like having a broader knowledge of different things is better than just focusing all your efforts on one thing. And I was getting a statistics minor because I really do love statistics a lot. I think it's fascinating. It's my favorite class I took in high school. So, that was why I was getting a statistics minor. And then that's not happening, but I was so set in getting a statistics minor that not having a minor is weird. [...]

Unfortunately, due to her semester-long absence, the courses necessary for Madison to obtain a statistics minor no longer aligned with her civil engineering program schedule. Therefore, despite her love for statistics and goal to minor in statistics, she had to modulate her personal academic plan to find a new minor that could both broaden her understanding of topics not typically associated with civil engineering that also fit into her academic schedule. While Madison had not found a new minor at the time of the interview, she was planning to continue her search in hopes of finding a new minor that could help fill her schedule due to her now-expanded graduation timeline.

Anthony also experienced multiple time delays throughout his undergraduate experience as he transferred from university studies, to general engineering, into mechanical engineering, and finally into civil engineering. Due to university GPA requirements, multiple major changes, obtaining a diagnosis, and identifying effective medication for his ADD, Anthony was anticipating graduating approximately two years after his initial date.

Influences on professional identity formation

Participant experiences highlighted in this study demonstrate the dynamics of disability and how a single individual can experience differences in how influential their disabilities are over semesters and even days. While Maggie primarily experienced her disability when communicating or receiving information from others with her learning disability, Madison's experiences were shaped more by the experience of physical disability due to varying levels of energy that impacted her participation in academic and non-academic activities: "I'm still probably not 100 percent. I'm probably 90 percent. [...] It really just depends on the day, though." For Anthony, the influences were more retrospective: he experienced significant challenges managing a learning disability that he had just discovered due to an increase in course workload and content difficulty, which in turn led to receiving a diagnosis he may not have obtained otherwise. Once Anthony's disability was addressed, he continued college and anticipated graduating with his civil engineering degree shortly after the interview was conducted.

Overall, experiencing disability did not alter students' overarching goals to become civil engineers; each of these students anticipated pursuing a career in civil engineering. Rather, their experiences added a dimension of complexity to their professional identity negotiations and the ways in which they engaged in civil engineering academia. In particular, students began to adapt a traditionally rigid engineering curriculum to their shifting life circumstances and vice versa. In particular, they became more creative in their attempts to complete coursework (e.g., Madison) and demonstrate prior, non-internship-related experience (e.g., Maggie), and remained patient in the face of challenge (e.g., Anthony). However, this is not to say that these students' paths through undergraduate civil engineering education are easy. Our observed themes, while not significant enough to force these students out of civil engineering, align with prior research examining inherent physical, social, cognitive, and systemic barriers in the university system [4,

7, 12, 33-35]. If experienced too frequently and on a negative basis, disabled students may choose to leave the profession, causing civil engineering and engineering, more broadly, to miss out on a talented, creative, and adaptive workforce [4]. Experiences described by participants in this study – particularly those describing additional time and resources – can point engineering educators and researchers toward the development of better support programs to support inclusion.

Conclusion & Future Work

In this study, we conducted an initial, grounded theory analysis of three students who experience disability in an undergraduate civil engineering program. From this analysis, we identified three themes that reveal ways in which experiences with disability influence students' education and professional identity formation in civil engineering: 1) developing a sense of self-advocacy, 2) seeking out and utilizing accommodations, and 3) negotiating intermediate expectations. Students' experiences with disability did not alter professional identity formation; rather, they added dimensions of complexity to this formation that often prompted students to seek out non-traditional approaches for gaining professional experience, demonstrating technical knowledge, and persevering through barriers and delays to become civil engineers. Bringing Maggie, Madison, and Anthony's experiences to the fore demonstrates that we as researchers cannot separate disability from professional identity formation; at the time of the interviews, these participants were able to use the processes of managing their experiences with disabilities to enable them to continue to move toward success in their future careers.

The findings presented here are the result of an initial investigation of students' experiences with disability and their impacts on professional identity formation during the undergraduate civil engineering education experience. However, further data collection and more in-depth analyses need to be conducted to determine the myriad of ways in which students experience disability and form professional identities in undergraduate civil engineering programs based on 1) type of disability, 2) time of diagnosis, and 3) plans to remain in the civil engineering field. While each student in this particular study anticipated working in the civil engineering industry, a further understanding is needed regarding factors that may influence students with disabilities to leave civil engineering academia or industry.

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