An Autoethnographic Account of a Female Undergraduate Engineering Student

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Abstract

This work explores formative experiences and various aspects of one female undergraduate student's Kayla's time in university, from her first to last year of school. Studies have shown that normative engineering culture can make women feel "visible as a woman, yet invisible as engineers" [1]. Some women who persist in the field of engineering have been shown to have an "engineering identity" [2]. This study focuses on how various aspects of one student's lived experiences formed her engineering identity and assisted in her ability to feel authentic in the field of engineering.

The work presented in this paper examined Kayla's experiences with multiple internships, the importance of peer relationships, and the role of extracurricular activities in identity development. The concept of in/authenticity by Faulkner [3] and the engineering identity framework by Godwin & Lee [2] were used to explore her experiences. This autoethnographic account used a co-constructed approach [4] between the student Kayla and her mentor Gretchen and followed autoethnographic steps outlined by Chang [5]. This work demonstrated how various aspects of a female undergraduate student's experiences, including internships, involvement on campus, and peer relationships, can build an engineering identity and create a feeling of authenticity in the field.

Introduction and Literature Review

The benefits of engineering internships to students have been well established in literature [6], [7]. Internships provide opportunities for professional development (such as the improvement of technical and communication skills) as well as a look into what a career in engineering entails [8], [9], [10]. Literature has also established the positive influence of quality mentorship on students and how these relationships can help retain students in their respective fields [11], [12]. It has also been found that internships can impact the persistence of underrepresented groups in engineering [13], [14]. Engineering workplace cultures are frequently male dominated [15] which can marginalize interns working at these companies. Existing literature documents primarily negative internship experiences, but positive internship experiences have been proven to improve motivation and persistence of students [6], [7].

Along with internships, undergraduate students are often involved in clubs and activities outside of their studies. Engineering extracurricular involvement has been proven to be beneficial for students in achieving ABET outcomes [16]. Regardless of whether or not extracurricular involvement is specifically engineering related, students are able to benefit from it [16]. However, while all types of extracurricular involvement are beneficial, it has been shown that engineering related extracurriculars are especially beneficial for the retention of women because it builds a support network of other engineers [17]. These extracurricular activities have been shown to assist students in their professional development, application of knowledge, and provide hands-on learning experiences [18]. In comparison to other types of undergraduate majors, engineering majors' extracurricular activities have been shown to be more strongly

associated with persistence and belonging [19]. Involvement in engineering activities can help build communication and presentation skills which can increase students' confidence [18]. This is significant because some female engineering students have reported that they feel a lack of confidence as a significant barrier that they have had to overcome [20]. Female engineers tend to be more involved in such activities, and this involvement increases throughout their education [21].

Social bonding, fitting into the group, and the ability to develop meaningful relationships is important to many people [22]. People are especially sensitive to the quality of their social bonds when they enter "a domain of achievement" [22] such as engineering. People that belong to a marginalized group can be "more uncertain of the quality of their social bond and thus more sensitive to issues of social belonging" [22]. The male dominated climate of engineering can make women feel unwelcome [23]. Literature has also demonstrated that same-sex friendships positively influence students both socially and academically [24], [25]. These relationships can provide validation and a safe space for women to express ideas and concerns to each other [24]. Women have found same-sex peer and mentor relationships more supportive than those they had with men [26], [25]. The literature did not specifically examine relationships of women within engineering and how these relationships positively impacted their persistence.

In this study, we expand on the existing literature by documenting the positive effects of an internship on engineering identity and authenticity. This study also documented Kayla's multiple types of extracurricular involvement and how it helped her persist in engineering as well as build her identity and authenticity in the field. Lastly, we present what aspects of the same-sex peer and mentor relationships Kayla found to be the most beneficial, and how these relationships contributed to her authenticity and identity in engineering.

Theoretical Frameworks

In this work, multiple experiences and aspects of a student's (Kayla) undergraduate career were explored. Two frameworks were used to explore these experiences: Faulkner's concepts of in/authenticity [1], [3], [27] and the engineering identity framework presented by Godwin and Lee [2].

In/Authenticity

Faulkner developed in/authenticity to study gender roles in engineering workplaces [1], [3]. The idea of "inauthenticity" is used to describe the dualities of the technical and social realms of engineering. The technical realm traditionally being "real" engineering, where men dominate, and the social realm being where women in engineering are more commonly found. Faulkner studied various firms and discovered that there were gendered expectations in the workplace that stereotypically led men to be expected to do more technical work than women. Both men and women felt "inauthentic" in the workplace if they did not fit into their prescribed gender roles due to the gendered expectations. Cech [28] made similar findings in a study of engineering undergraduates; women in the study had lower confidence than their male counterparts in their professional abilities. This lack of confidence resulted in lower persistence in engineering degrees and less intention to enter the field of engineering after graduation.

Engineering Identity

Engineering identity has been studied expansively specifically regarding women in engineering [29]–[32]. Engineering identity is built due to a combination of recognition, interest, and perceived confidence [33]. Identity development is important for the persistence of women in engineering [34]. Studies have also shown that engineering identity helps create a feeling of belonging in workplaces [31]. Developing an engineering identity is linked to feeling authentic in engineering, as shown by Hatmaker [31].

Methodology

The methodology used for this autoethnography follows ideas and steps outlined by Chang [5]. Data was primarily collected from self-observation and recent memory. Self-observational data was collected at the time of the experience, while data from recent memory usually came sometime after the event from reflection by Kayla. When there was any notable experience or event in her life that could potentially relate to the work, a journal entry would be recorded using the date, title, theme, narrative, and analysis. Data from recent memory was recorded the same way, the only difference being the time between the event and the entry.

We used a co-constructed approach in this work, similar to our previous work [35] as well as Martin and Garza [4]. Kayla recorded her experiences in a journal and self-analyzed them. Then, Gretchen would read the entries which helped to raise new questions and probe deeper into emerging themes. Kayla and Gretchen have been meeting regularly for the past 3 years to discuss the entries both casually and in longer interviews. The co-constructed approach minimizes the "researcher-participant hierarchy" [4]. This paper focuses on exploring Kayla's professional internship experiences, peer relationships, and extracurricular as well as academic involvement.

The frameworks of in/authenticity as well as engineering identity were chosen to explore a gain in cultural understanding as suggested by Chang [5]. An important part of the methodology of autoethnography is to relate someone's lived experiences to a broader picture. These frameworks helped guide the analysis so that the work provided information about the culture of engineering as a whole and not just an account of her college experience.

Another crucial aspect of autoethnography is quality monitoring. Data validation and quality control was conducted using the Q^3 framework outlined by Walther et. al [36]. Frequent references to the framework helped to ensure that experiences were recorded in an unbiased manner, and that only relevant data were used. Every time the framework was referenced, Kayla would briefly overview the whole outline, then delve deeper into one specific section (such as ethical validation or pragmatic validation). These check-ins with the framework allowed Kayla to foresee and avoid potential biases in the data as well as ensure that the data presented was relevant.

Findings

Kayla is a fourth-year white female undergraduate student in Civil Engineering at the University of Florida. Her narrative provides a brief account of the aspects of her time at university that she felt were the most critical aspects in building her engineering identity and authenticity within

engineering. These experiences included two internships, peer and mentor relationships, and design teams. We built upon our previous paper [35] in which we examined her engineering identity and in/authenticity, and their roles within her decision to stay within engineering. Names within Kayla's narratives were pseudonymized for anonymity.

Kayla is a cis-gender, white woman in engineering. Although Kayla is a gender minority in engineering, we recognize that she does not experience the marginalization that comes with intersectional identities such as race. She holds privileges through her race and gender identity; therefore, we are explicitly addressing these privileges to emphasize that she experiences discrimination based on gender alone.

Kayla's Narrative

I decided to pursue engineering in college due to a combination of encouragement from math and science teachers in high school, as well as a pre-college engineering summer program I attended at a university my junior year of high school. When I first started university, I immediately tried to get involved in engineering activities outside of the classroom because I wanted to meet other aspiring engineers.

During my freshmen and sophomore years, I was primarily involved in ASCE (American Society of Civil Engineers) and design teams through ASCE. I went to some social events, but mostly I just attended meetings and participated in the design teams. My junior year, I was accepted into Engineering Without Borders design team (EWB) and I was thrilled. Even though my entire junior year I never met another member in person due to COVID, I still felt remarkably close to the team and really found a group of likeminded engineers.

Most of – if not all of – the relationships I made with my peers happened outside of the classroom, either from ASCE, EWB, design teams, or the study abroad program I participated in. While I never joined one of the women-centered engineering organizations on campus, I did find myself gravitating towards friendships primarily with women. Being involved in engineering organizations was a huge benefit to me, because the friends I made from these organizations are always the first people I go to when I have a question. Having peers to turn to with jokes, complaints, and anything else is a huge source of comfort and support to me. These relationships made the workload and intensity of my major seem more manageable. Additionally, through these organizations I was free to join design teams I was truly interested in. Much of my coursework was required, and there was not a lot of freedom of choice in regard to classes. However, I could join a design team purely out of interest. One of the first teams I joined was called "Sustainable Solutions" through ASCE where we designed a bus stop using sustainable materials and methods. I joined EWB my Junior year because of my interest in water resource engineering and sustainability, things I was not exposed to in my required coursework until the end of my junior year. On the team we worked together to help design improvements to an irrigation reservoir, which to me was a much more interesting project than the one I have to design for my capstone course.

Nonetheless, not all of my experiences with my peers have been positive. On design teams that I joined I sometimes felt as though some of the men on the team never seemed to listen to me.

Working on a team where I did not feel valued was extremely frustrating. In classes, I almost never ask my male friends for help or support if I can avoid it. If I do ask for help, they tend not to understand my constant worries and anxieties about the coursework as much as my female peers do.

Most of my professors were male. I never felt discouraged by this, male faculty I have worked with or taken classes with have always been very supportive and encouraging. However, I never saw many people who looked like me teaching classes, which I believe could have been beneficial for my authenticity in engineering. From my peers and professors, I learned just how important it was for me to participate in summer internships. I had two internships during my time at university. The first internship was as a stormwater engineer and took place the summer after my sophomore year. It was almost completely virtual due to COVID. This internship was a particularly important experience in my development as a female engineer [15].

I had two supervisors, both of whom were female. From the beginning, they placed trust and confidence in my work. The tasks I was given were real engineering work and I felt as though I was actually contributing. I felt visible as an engineer, not just a woman, because of all the other women in the office; I did not feel as though I was sticking out. The women I worked for were what engineers should be in my eyes – organized, professional, intelligent, and hardworking. I remember, one of the few days I was able to go to the office, my boss was wearing a pink sweater and pink skirt. I had a preconceived notion in my head that to be professional you had to downplay your femineity. It seems like such a small unimportant occurrence, but when I saw her wearing that outfit, I realized that you could be feminine and still be a "real" engineer. Overall, I had a great experience at this internship.

After my first internship I decided to try for another. Although I really enjoyed my internship experience, I wanted to try working in a new area of civil engineering field. I was still interested in stormwater, but I wanted to try out other types of work such as utilities or surface water. Additionally, I wanted to gain experience at a larger company to see if I would prefer one working environment over the other.

The second internship I had was as a hydrology/hydraulics intern that took place after my junior year at a much larger company than the first. This firm had some similarities to the first company I worked for. The company itself seemed to place value on keeping women in the workplace, similar to my last firm. In this experience as well as my last, I felt as though I did not have to hide my femininity or dress a certain way in order to be taken seriously. Before I started interning, I was under the impression that I would need to look or act a certain way to fit into the company culture. I am not entirely sure why I felt this way, but I thought I might need to be more masculine to fit in. However, once I got to the company, I realized that I could be my authentic self and still fit in and make valuable relationships. I think this realization really helped me to enjoy the experience more, because I could just work and learn without worrying about sticking out. Having multiple female supervisors in this role also helped me to feel more comfortable in the workplace. I felt as though my female supervisors understood my working style better and how to facilitate my learning better than male counterparts did. It was not as if having female supervisors and being myself in the workplace eliminated all worries and anxieties I had (I still

got nervous attending meetings, lunches, happy hours, etc.) but it did lower them at least a little bit.

In my second internship experience I got to meet some of the other interns, one of whom was a female in a similar role as me. I often turned to her with questions or anxieties, similar to my friends at school, and she was a major source of comfort and reassurance to me. I used to message her over Microsoft Teams before meetings so we could walk down together or eat lunch together. I think she found a similar source of comfort with me; she seemed to only attend after work happy hours if I was able to go, and we also left at the same time. Being able to have someone my age, who I was comfortable showing my nervousness around, really helped me to feel more authentic, because I knew I was not alone in what I was going through and that I had someone who understood exactly what I was going through. The other male interns did not seem to understand my anxieties about walking into meetings alone or attending company events and lunches like she did. We both worried about these things together, which made them less worrisome to me. Outside of my office, there were many people from my school who interned at the company and because of our shared experience we stayed in touch when school started again, and we likely would not have met if it were not for this internship.

I felt authentic as an engineer during my second internship experience as well. There were many aspects of this internship that helped build my identity and create a feeling of authenticity. One of the ways I began to feel more authentic was through feedback. My female supervisors often provided me with feedback. Whether this was positive or negative the effect was the same, the guidance helped me to feel as though I was growing. If I knew what I was doing wrong or right, I knew what to fix or continue doing and over time this provided me with the ability to produce work more confidently. By the end of the summer, I felt that my female bosses in particular valued my opinions because I had so much feedback from them and knew I had improved. Towards the end of the internship, my primary female boss asked me to do a task even though I was busy because she "did not trust the other interns as much" which, although maybe a tad insulting to the other interns, made me feel as though my engineering abilities had something unique and valuable to offer the group. Working with so many female coworkers and supervisors and just being able to see them every day also allowed me to feel more authentic in engineering. When you are the one of the only women in your group or class, which does happen at school, it can feel like you are sticking out and I become more aware of my gender. It feels as though this difference is more important than it actually is. However, seeing and working with women made me feel less "other" and my gender did not really matter, I was just working as an engineer like everyone else around me.

After the summer was over, this company (my second internship) extended a full time offer to me and gave me the opportunity to keep working for the office remotely for about 10-15 hours a week once I went back to school. I accepted both offers. Although I did prefer the summer internship to the fall (the stress of school hindered my ability to be as fully committed to projects as I was in the summer) I still really enjoyed being able to keep in touch with my bosses during the year. Additionally, I took the FE exam in the semester of my fall internship. My boss went out of her way to get the company to pay for my exam and even sent me a Starbucks gift card to

"help me study." It was nice to know that I still had that support system there even though I was no longer in the office.

Discussion

Engineering identity and authenticity are often interrelated. As Kayla's engineering identity developed, her authenticity in the field did as well. While working with her peers on design teams or homework she began to develop an engineering identity from the validation that success in these tasks brought. Her internships also allowed her to build her engineering identity due to the confidence her supervisors showed in her. Because she began to gain confidence in her work and identity, she consequently felt more authentic as an engineer.

In/Authenticity

Kayla had many experiences over her time at university that contributed to her authenticity as an engineer. However, although her extracurriculars and peer relationships were invaluable to her engineering identity, her internships were really what developed a feeling of authenticity in the field. Her internship experiences were critical because they made her feel "visible as an engineer" which created an authentic sense of belonging.

The feeling of authenticity was first formed in Kayla's remote internship. Her female supervisors created a positive image of what it is like to be a female professional engineer. This was her first job at an engineering company and removed her preconceived notion of needing "to be masculine" or downplay her femininity to be taken seriously in the workplace. She noted that having female mentors "contributed to why she enjoyed the internship so much" because her supervisors seemed "more likely to understand her." Contrary to Faulkner's participants [1], [3], Kayla felt authentic in the workplace because of the women within it. Kayla had similar positive experiences in her next internship; her mostly female supervisors helped her feel authentic as an engineer. Both her supervisors at this internship and the previous one "provided her with feedback" which was crucial, in her opinion, to her growth and authenticity in the workplace because it provided her with guidance. By the end of her internships, she felt as though her "supervisors really valued her opinion" and that she was "capable" of doing the work assigned.

Authenticity was also built when she connected to another intern in her second internship. Kayla was able to form a bond that made her comfortable and authentic in the workplace. She stated,

> Being able to have someone my age, who I was comfortable showing my nervousness around really helped me to feel more authentic, because I knew I was not alone in what I was going through and that I had someone who understood exactly what I was going through.

Kayla did experience feelings of inauthenticity in her college career, primarily when she compared herself to or interacted with male peers in school. She described inauthenticity when she stated that on some design teams she felt as though men on the design team "never seemed to listen" to her. She also stated that she "avoided" asking her male friends for help because they "did not understand" her like her female peers did. In school, she did not have very many female professors. While the male faculty she has worked with have "never discouraged her" and quite

the contrary, all faculty have seemed to really support her it would have also been nice to "see someone like me" teaching a course. Similar experiences were noted within her internship with male peers. Kayla described that "the other male interns did not seem to understand my anxieties about walking into meetings alone or attending company events and lunches like [my female friend] did."

Engineering Identity Development

Identity development is assisted by recognition in the field, interest, and competence [2]. Kayla's engineering identity was developed due to interactions with peers, work experiences, extracurricular involvement, and growth/maturity. Her narrative suggested that the longer she remained in engineering the more comfortable she became in the field and her abilities; her competence improved with validation from work.

Having multiple internships helped build a strong engineering identity in Kayla. By the end of her second internship, she felt much more confident in her abilities as an engineer than she did before these experiences due to a combination of more time spent in the industry, positive feedback, and a job offer. Internships were also critical in both her authenticity and identity development because not only was she becoming more competent, she was also recognized as an engineer. She explained that feedback was important because it provided her "the ability to produce work more confidently," thus she "knew [she] had improved." Therefore, she built competence to perform engineering tasks.

Peer recognition from work and school friends helped strengthen her identity. Her second internship experience also connected her with other women her age who were navigating similar problems as her. This bolstered her engineering identity as well because her peers recognized and validated doubts she has about the industry and expanded her support network. She stated that "just knowing someone is going through the same experience as me, and that I can be comfortable talking to them about it has made a huge difference for me." Campus involvement and developing peer relationships are linked in her narrative. Many of her relationships were formed outside of the classroom. Although few of these relationships were what she considered "close friendships" and she mostly interacted with her peers in engineering related settings, it was "comforting to recognize people in her courses" and to "have someone to share experiences with."

Involvement in extracurriculars and internships specifically helped bolster Kayla's identity regarding her interest in the field. She had a specific interest in sustainability in engineering, and the design teams she joined helped her explore this and boosted her interest by exposing her to this aspect of the field. In her internships, she could pursue positions in the specific area of engineering she was most interested in to gain more exposure. Thus, her interest within engineering strengthened and her engineering identity developed.

Conclusion

Engineering identity and authenticity are closely related. Having positive experiences in engineering, such as productive internships, strong relationships, and extracurricular involvement

all contribute to identity formation. Strong engineering identity helps some women to feel more authentic in the field [15]. This project has demonstrated how various aspects of a female undergraduate's time in university can bolster identity and authenticity in the field, before they even officially enter it. These findings expand on existing literature by providing an autoethnographic account of many diverse aspects of student life, such as work and classroom experiences. Employers and university faculty can benefit from this work. It can demonstrate to employers what aspects of internships some women find positive, which can enlighten them on how to improve on their own programs. Additionally, school faculty could use this as an example as to why strong relationships and involvement should be promoted in the college, especially for marginalized groups. positive aspects of internship experiences. This work also aimed to display the benefits of these experiences to other students, so that they can seek out similar experiences to help build their own identity and authenticity to help them become more confident as engineers.

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