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The Ideal Mentor: A Qualitative Study on Underrepresented Students' Perspectives on Mentoring Relationships in Engineering

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THE IDEAL MENTOR: A QUALITATIVE STUDY ON UNDERREPRESENTED STUDENT'S PERSPECTIVES ON MENTORING RELATIONSHIPS IN ENGINEERING

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Dedication

I dedicate this thesis to my grandmother, Luz Olga Molina Herrera, who unfortunately passed away on June, 2017. Abuelita, thank you for your guidance, support, and unconditional love. I hope I am making you proud. Thank you to my parents, Irma Siboney Quintero and Sergio Armendariz Molina. Your advice, your love, and your support, both moral and financial, has been fundamental to my development as a student, and as human being. To my mentor, Dr. Aurelia Lorena Murga, thank you for your lectures, your advice, and the opportunities you have provided me. You are the reason I chose sociology as a career. You are my biggest source of inspiration, and I hope to replicate the impact you had on me to my own students and mentees in the future. To my friends, my peers, and the students who graciously participated in this project, thank you, from the bottom of my heart.

THE IDEAL MENTOR: A QUALITATIVE STUDY ON UNDERREPRESENTED STUDENTS' PERSPECTIVES ON MENTORING RELATIONSHIPS IN ENGINEERING

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Abstract

Engineering stands as one of the disciplines with the highest rates of student attrition, which is exacerbated by the misrepresentation of women and racial/ethnic minorities (Roy 2019). As a response, multiple universities have launched successful initiatives to recruit women and racial/ethnic minorities into engineering degrees, but have continued to fail in retaining that same student demographic. Mentoring relationships have been regarded as an efficient strategy to mitigate the rates of attrition in engineering degrees (Wilson et al. 2012). However, mentorship in engineering is likewise lacking in diversity, and positive outcomes of mentorship are not universal. Nonetheless, successful mentoring relationships do play a key factor in the retainment and development of future engineers, but literature on mentoring relationships in engineering rarely includes the voices of underrepresented students, let alone their thoughts on what makes a mentoring relationship successful. This thesis seeks to address this issue; provide a phenomenological understanding of what underrepresented engineering students consider their ideal mentor to be like. A total of 10 students were given semi-structured interviews where themes of engineering experiences and identity, gender and ethnic diversity, mentorship, and the COVID-19 pandemic were addressed. Results show that participants value autonomy, occupational experience, and consistent communication as more valuable assets over gender/ethnic homogeneity in mentorship. This is not to say that participants of this study did not see any value in homogeneity, or diversity in engineering education and occupations; participants endorse these traits, but place more value on the practical and occupational essence of engineering. In this sense, the ideal mentor is the one that allows mentees to be engineers.

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1. Introduction

In America, it is estimated that two out three U.S. jobs and nearly 70% of the nation's Gross Domestic Product (GDP) is attributed to science, technology, engineering, and math occupations (STEM). Additionally, STEM occupations generate $2.3 trillion in tax revenues annually (The American Society of Mechanical Engineers 2020). In particular, engineering jobs help develop physical infrastructure that the American population relies on – transport networks, roads, bridges, water and energy supplies, and waste management. Additionally, engineers stay at the forefront of technological innovation, which includes communication and navigation networks, and assemblies of new technologies (Winkles 2016). Due to the positive impact to the economy, and the constant innovations in technology, STEM degrees and professions take precedence over most other fields of study in the country. In fact, development in STEM/Engineering has been a priority for past administration, as billions of federal dollars have been invested on STEM/Engineering education and multiple programs have been implemented to cultivate intrigue on young students toward pursuing STEM/Engineering degrees (Handelsman & Smith 2016; Vincent 2020).

Despite federal efforts to improve STEM/Engineering education, the United States is facing a major shortage of qualified STEM/Engineering candidates. The shortage of STEM/Engineering skilled workers is exacerbated by the underrepresentation of women and racial/ethnic minorities, which drastically reduces the pool of potential workers for STEM occupations, particularly engineering ones. Furthermore, engineering is among the top disciplines with the highest rates of attrition, wherein dropout rates have consistently hovered around 50% over the last 60 years (Geisinger & Raman 2013). In an effort to address attrition and lack of diversity in STEM/Engineering education, multiple higher education institutions have launched successful initiatives to recruit more women and racial/ethnic minorities into STEM/Engineering degrees. However, whereas higher education institutions have been successful in their recruitment efforts, they have been less successful in retaining those students they sought to recruit in the first place. Tough grading and extensive coursework, insufficient preparation as a high school student, loss of interest in the field, prevalence of gender and racial stereotypes, and lack of faculty diversity are noted as some of the most common factors that contribute to women and racial/ethnic minority students to drop out of their STEM degrees, particularly in engineering.

In spite of the daunting aura of engineering degrees for prospective underrepresented students, women and racial/ethnic minorities still desire to gain inclusion into the discipline. Motivation to study engineering in undergraduate study is very important to underrepresented students, as it encourages students to enroll in an engineering program and continue their studies without dropping out. Research indicates that most students that select an engineering major do so because of its positive impact on the community and its role in improving the way of life (i.e., water and energy supplies, waste management, technology, etc.). Underrepresented students in particular view engineering as an opportunity climb the social ladder, and hope to afford a better lifestyle for themselves and their families. Furthermore, students, no matter their background, fall in love with STEM related subjects in basic and secondary education, which leads them to pursue their dreams of becoming – in this case – engineers no matter the obstacles (Labib et al. 2021). As noted, however, despite underrepresented student's motivation to pursue an engineering degree, issues of attrition and diversity persist.

Nonetheless, successful mentoring relationships do play a crucial role in the recruitment, retainment, and development of potential STEM workers – including women and racial/ethnic minorities. Thus, if we want to address the shortage of STEM/Engineering workers, address the lack of diversity in STEM, and potentially increase the pool of skilled candidates, we ought to examine mentoring practices taking place in STEM/Engineering education. Most importantly, we must listen to underrepresented students' input on what makes a productive and satisfactory mentoring relationship. Thus, the topic of my thesis revolves around the mentoring experiences of racial/ethnic minority men and women engineering students at a Hispanic Serving Institution (HSI). In this study, I seek to analyze underrepresented engineering student's perspectives on their current mentorship relationships, assess whether homogeneous relationships matter to underrepresented students in creating good mentorship, explore what traits underrepresented engineering students value most in their mentors, and see to what degree my participants identified themselves as engineers.

In the next section, I introduce the literature background of the shortage of workers and students in STEM/Engineering education, issues of diversity and attrition in STEM/Engineering, engineering students' motivations, and mentoring within STEM/Engineering. I use these four literature themes to inform my analysis of participants' experience in my study of mentorship in the field of engineering.

2. Literature Review

2.1 The Importance of STEM/Engineering and the current worker shortage

The monumental strides in technological innovation over the years is the result of talented STEM/Engineering graduates' hard work. Not only are STEM/Engineering graduates at the vanguard of technological innovation, but STEM occupations in general play an important role in boosting the American economy. The American Society of Mechanical Engineers (2020) reports that 2 out of 3 U.S. jobs and about 70% of the nation's Gross Domestic Product (GDP) is attributed to STEM occupations. Given Western society's infatuation with high profits and the beneficial innovations that come from STEM fields (i.e., medicine, ambulatory assistance devices, phones), it makes sense that STEM education has been a priority for past administrations. For example, in 2016, the Obama administration secured more than $1 billion in private investment for improving STEM education; incorporated STEM education into the priorities of the Department of Education; and approve $3 billion across 14 federal agencies for dedicated STEM education programs (Handelsman & Smith 2016). In comparison, former President Trump signed the bicameral, bipartisan Building Blocks of STEM act. The bill's overarching goal was to increase efforts by the National Science Foundation to increase the participation of underrepresented populations in STEM fields, particularly women (Vincent 2020). Despite federal funding to STEM education, the United States is facing a shortage of qualified STEM graduates, and a shrinking proportion of students majoring in STEM fields (National Science Foundation 2019; Wladis, Hachey & Conway 2014). Despite a national targeted focus on STEM fields and education, The National Association of Manufacturing and Deloitte predicts that the United States will have to fill 3.5 million STEM jobs by 2025, with more than 2 million of them going unfilled due to a shortage of highly skilled candidates in demand (Emerson 2018). In addition, Bullhorn's (2018) North American Staffing and Recruiting Trends Report found that 73% of firms serving manufacturing industries, and 65% percent of firms in information technology and accounting, finance, and insurance fields listed skill shortages as one of their top challenges. To remedy the worker shortage, companies have offered higher salary packages to attract – and retain – skilled workers and invest in automation technology. However, these measures have been ineffective as the shortage has continued to increase. If the shortage of qualified STEM candidates continues to increase, it is estimated that by 2028, there will be a potential loss of $454 billion in economic output, which equates to 17% of the forecasted manufacturing GDP in the U.S. (Brightwing 2019).

The shortage of STEM workers likewise affects engineering jobs, and this issue has concerned the American government for a while. In 1999, for instance, there were estimates that 300,000 software engineering positions would go unfilled (Jones 1999). By 2005, it was reported that universities graduated 76,000 engineering students, and 11% decrease from the graduating class of 1985. Further, attrition was a pressing issue in 2005, where approximately 17% of all engineers obtained advanced or secondary degrees in fields other than engineering, which made them marketable in business and other sectors (Carroll 2007). Two years later, in 2008, the U.S. Bureau of Labor Statistics projected that due to the aging trend of the American society, by 2018 the demand for engineers would increase by 20%. Yet, proportionate increases in enrollment in engineering programs had not taken place (Chang 2008). Shortages of skilled engineers required to complete large-scale investments of local, national and international importance (i.e., airports, hospitals, dams) are reported around the world (Mannan 2021). In the UK, for example, 1 in 2 engineering firms are concerned that a shortage of engineers is a threat to their business. In addition, there is a serious concern for a lack of experienced engineers. About 73% of employers experienced problems with candidates who had academic knowledge but not the required workplace skills. Although 81% of the engineering firms in the UK agreed to the responsibility of supporting the transition from education to training into the workplace, only 23% of all employers were going into schools or career events to recruit young, potential candidates (Education Journal 2019). Moreover, Russia, where STEM occupations are likewise tied with economic development, faces a mechanical engineering personnel shortage, as more than two thirds of employers report a lack of qualified engineers (Suzdalova, Politsinskaya & Sushko 2015). Currently, the American Society for Engineering Education (2019) notes that the engineering workforce requires highly skilled and trained individuals to meet the needs of the global workforce. However, many of the skills gained through postsecondary engineering programs are transferrable and desired within other areas of STEM, which reduces the pool of potential engineering candidates. Further, the American Society for Engineering Education predicts a 5% increase within engineering occupations. As important as it is to expand the pool of qualified STEM workers, engineering occupations are likewise considered a critical human resource for modern technological innovation. Unsurprisingly, lack of engineers is not only a problem for highly industrialized nations: engineers are desperately needed in many developing countries, since about 20% of the world's population lives without clean water, 40% lacks adequate sanitation, and 20% is homeless. One estimate suggests that over 2.5 million engineers are needed in Africa to ensure the achievement of basic human needs, which include infrastructure, sanitation, and potable water (Geisinger & Raman 2013).

2.2 Lack of diversity and attrition

The shortage of STEM graduates and skilled candidates is exacerbated by the underrepresentation of women and racial/ethnic minorities (National Science Foundation 2019).

Although the representation of women in STEM occupations has increased since the 1970's, women make up only 25% of STEM occupations, and remain significantly underrepresented in engineering and computer science occupations, occupations that represent 80% of all STEM employment. Furthermore, among science and engineering graduates, men are employed in a STEM occupation at twice the rate of women. Nearly 1 in 5 female science and engineering graduates are out of the labor force, compared with less than 1 in 10 male science and engineering students. Additionally, reports indicate a shrinkage of STEM employment among younger women. Indeed, racial/ethnic minorities fair only slightly better than women in the workforce, making up 33% of the overall and engineering occupations. Nonetheless, the inclusion of racial/ethnic minorities into the STEM workforce has seen limited progress. For instance, in 2011, only 6% of STEM workers were Black, which meant a 2% increase of Black candidates to STEM occupations since 1970. Hispanic inclusion into the STEM workforce has seen a higher increase than Black candidates, going from 3% in 1970 to 15% in 2011. However, Hispanics represent 7% of the STEM workforce (National Science Foundation 2019; Jensen & Deemer 2019; Landivar 2013). In terms of engineering occupations, as of 2014, just 24% of the overall engineering workforce in the U.S. was women, which is a slight decrease from the previous three years. Black and Hispanic engineers amount to roughly 12% of the overall engineering workforce. Unsurprisingly, white men occupy most engineering jobs, representing 73.6% of the overall engineering workforce (Walker 2014).

Although there is a low numerical representation of women in STEM occupations, gender inequalities in school are not as glaring. For instance, women account for roughly half of all STEM bachelor's degrees, 44.7% of master's degrees, and 41.2% of doctoral degrees. However, computer sciences and engineering possess the lowest degrees shares of women

(National Science Foundation 2019). Indeed, the high rate of women graduates and low rate of women workers is indicative of a gender bias in hiring practices for STEM occupations. Concerning engineering degrees in specific, however, gender disparity is once again an issue. In 2018, women earned only 21.9% of all engineering bachelor's degrees, 26.7% of engineering of master's degrees and 23.6% of doctoral degrees (Roy 2019). In contrast, racial/ethnic minorities make up 24% of all awarded STEM bachelor's degrees, 22.1% of master's degrees, and 13% of all awarded doctorate degrees. The low numbers of degree completions among Black and Hispanic students are also reflected in engineering. In 2018, Black students earned 4.2% of bachelor's degrees, 4.8% of master's degrees, and 4.2% of doctoral degrees in engineering. In contrast, Hispanic students earned 11.4% of bachelor's degrees, 8.8% of master's degrees, and 65 of doctoral degrees in engineering (Roy 2019). Similarly to women, research indicates that Black and Hispanic male college matriculants are as likely as their white male peers to enter STEM majors, and Black male youth in particular are substantially more likely to declare a physical science or engineering major than white males (Riegle-Crumb & King 2010).

In light of the occupational and educational STEM shortages, multiple universities across the country have launched initiatives to recruit more racial/ethnic minorities and women into STEM degrees. Recruitment initiatives have resulted in a steady increase of minority and female students choosing STEM degrees (Feldman, 2019). However, minority and women students do not complete STEM degrees at the same rates as their white male counterparts, which complicates racial/ethnic minorities and women's entry into the workforce (Wladis, Hachey & Conway 2014). Additionally, whereas universities have successfully implemented recruitment initiatives such as scholarships, internships, and summer undergraduate research experiences (SUREs), they lack the same focus on retention of STEM minority and female students (Reyes, 2011). In fact, a National Center for Education Statistics (NCES) report showed that 48% of bachelor's degree students and 69% of associate's degree students who entered STEM fields between 2003 and 2009 had left these fields by Spring 2009. About half of the students switched their major to a non-STEM field and the rest of them dropped out of college before earning a degree. Similar studies suggest that fewer than 40% of students enrolled in STEM actually receive their degree in STEM. Indeed, women and racial/ethnic minority students are more likely to drop out of their STEM degree than their white male peers (Chen & Soldner 2013; Chen, Johri & Rangwala 2018). Multiple factors influence women and minority students to drop out of their STEM degrees, including tough grading and extensive coursework, insufficient preparation as a high school student, loss of interest in the field, prevalence of gender and racial stereotypes in STEM, and lack of faculty diversity (Lowery 2010; Chen & Soldner 2013; Shapiro & Williams 2012; Espinosa 2011). Unsurprisingly, attrition in STEM is reflected in engineering, which holds some of the highest attrition rates of all majors. Over the last 60 years, U.S. engineering graduation rates have consistently hovered around 50%, suggesting that nearly half of the students entering engineering degree programs in the U.S. leave prior to graduation (Geisinger & Raman 2013).

2.3. Engineering Students' Motivations

With the current worker shortage of skilled STEM/Engineering candidates, and the issue of attrition and lack of diversity in engineering degrees, the aura of engineering degrees and occupations is understandably daunting for underrepresented students. Nevertheless, despite the clear hurdles present in engineering degrees and occupations, underrepresented students will defy expectations and pursue engineering degrees. Underrepresented student's pursuit of engineering degrees is partly attributed to universities' recruitment efforts to improve diversity in their disciplines. However, a student's motivations are of great importance in encouraging students to enroll in engineering programs and continue their studies without dropping out. In an economic sense, both men and women see potential monetary value in pursuing engineering professions after graduation, which shows to be encouraging for students with low socio-economic status as they desire to move up the social ladder (Labib et al. 2021). For women in particular, a study conducted by the National Society of Professional Engineers (2020) revealed that they see value in the field of engineering, not only monetarily, but also in the sense that engineers work on solving important problems, and that by becoming engineers, women will have the opportunity to help others and contribute to society. The study also revealed that women have a chip on their shoulder of sorts, perpetrated by stereotypes and lack of diversity. Thus, women feel confident and desire to demonstrate that they have the skills and knowledge to do the work of engineers. In fact, research indicates that women show to be more capable in math, physics, computer sciences, and craft better than their male peers (National Society of Professional Engineers 2020; Labib et al. 2021). Having a strong support network is likewise heavily important for women and racial/ethnic minorities alike. The unconditional love and support from family, and the encouragement and advice from peers and role models are strong motivators for underrepresented students to pursue and finish engineering degrees (National Society of Professional Engineers 2020: Fleming 2016).

Unsurprisingly, racial/ethnic minorities (including women) carry a chip on their shoulder, or what Smith and company (2014) denominate the "proving them wrong syndrome." The achievement gap in the United States, that is, the rates at which white and non-white individuals attain academic or professional success is exceedingly disparate. The achievement gap is exacerbated by a history of prejudice and discrimination towards ethnic minorities attaining education. The prejudice has had a two-fold effect: first, the denial of, and complicated access to post-secondary education, and second, a lack of self-efficacy in ethnic minority students regarding educational attainment because of the pervasiveness of negative stereotypes about their achievement (Smith et al. 2014). Of course, the negative stereotypes and continued denial of ethnic minorities into post-secondary education has served as motivation to prove nay-sayers wrong. Unfortunately, however, the desire to prove individuals wrong may actually exact a psychological toll to minority students; an added pressure that may, in fact, affect their self-efficacy and academic achievement, and ultimately lead to students dropping out, which exacerbates attrition (Smith et al. 2014). Interestingly, but perhaps not surprising, one of the key factors for women's and racial/ethnic minorities' motivation are their desire to identify as engineers, and the opportunity to be members of effective engineering programs. Women and racial/ethnic minorities actively seek out programs that provide them with components that provide practical engineering experience, such as projects or problem-based courses, research experience, industry internships, and involvement in MEP programs (Fleming 2016). Many students that pursue engineering programs demonstrate an early passion for math, and other STEM related subjects, thus, they begin forming this identity as an engineer early on, which motivates to seek out good engineering programs and identify as engineers themselves (Fleming 2016). In other words, for women and racial/ethnic minorities, the first and foremost important success factor for them in engineering is exposure to engineering itself. Indeed, their entrance and enjoyment of an engineering degree may be improved by the guidance and support from a mentor.

2.4 Mentoring in STEM/Engineering

Many studies agree that student attrition in STEM can be effectively countered through strategic academic interventions into structured research programs (such as summer undergraduate research programs), and mentoring relationships (Wilson et al. 2012). Mentoring, in fact, has become a popular strategy for addressing STEM degree drop-outs, stimulating interest in STEM, and building STEM skills. Furthermore, having close relationships with mentors while pursuing STEM degrees enhances mentees' self-efficacy for conducting research; contributes to a stronger interest in, and commitment to, having a STEM career; and fosters mentees' identities as scientists (Stelter, Kupersmidt & Stump 2021). Indeed, mentoring through research programs and graduate school pipeline and preparation programs are likewise an effective way of countering student attrition in engineering (Oppliger 2002; Postmore, Rogers, & Pickering 2003; Bubbar et al. 2016). In fact, research indicates that engineering mentorship programs can also indirectly assist in the achievement of critical student outcomes for accreditation. In addition, mentorship in engineering degrees provides the opportunity for students to set themselves up for the expectations of the workplace, and garner the occupational experience that employers look for in candidates (Kaul et al. 2015).

Unfortunately, women and racial/ethnic minorities are less likely to receive mentoring than their white male peers. This mentoring disparity is due in part to less access to formal or informal connections to individuals in STEM fields (Beech et al. 2013). Moreover, positive outcomes of mentorship are not universal as disputes over work philosophies and styles, scheduling conflicts, quality of interactions, and heterogeneous relationships may complicate the establishment of productive and positive mentoring relationships (Schwartz 2012; Morales et al. 2018). Although extensive research has been done to examine mentoring in STEM, most studies focus on mentoring and pedagogical practice recommendations, and showcasing the benefits of successful mentoring relationships. In addition, many studies on mentoring in STEM take a quantitative approach to assess the productivity and satisfaction of mentoring relationships as they occur. However, there is limited research on mentee outcomes for women and racial/minorities in STEM, and most research overlooks what these students in specific consider to be a productive and satisfactory mentorship in their own words. Likewise, literature on mentorship in engineering degrees is outdated, and focuses mostly on how to establish mentorship programs to increase recruitment and retention, but very few focus on student experiences and outcomes. Further, there appears to be more research on mentorship experiences in engineering degrees in other countries, compared to the U.S. (McGuire 1996; Leao & Ferreira 2013).

Although engineering makes up about 19% of STEM jobs, engineering remains a key component of STEM education/employment, and the need to increase the pool of potential candidates is paramount for technological innovation, and to sustain public works such as roads, bridges, dams, tunnels, buildings, water, and sewage systems. By adhering to the notion that increasing the pool of qualified STEM/Engineer candidates will significantly benefit the United States' economy, by noting the fact that women and racial/ethnic minority students yearn to be involved in engineering, and by understanding the crucial role that mentorship plays in recruiting and retaining potential engineering students – particularly women and racial/ethnic minorities, it is important to address and examine what these underrepresented students consider what their ideal mentors ought to be. Without their voices, it is difficult to assess their needs, concerns, and suggestions for better mentoring relationships, which will ultimately provide a foundation for a more efficient way to prevent STEM, and particularly engineering pipeline leakage. Thus, this study poses the following research question: what do underrepresented engineering students consider their ideal mentor to be like?

Summary of the Literature Review

In this chapter, I presented four literatures introducing the shortage of STEM/Engineering workers, the issue of diversity and attrition, engineering students' motivation, and the benefits and issues of mentorship within STEM/Engineering disciplines. The purpose of this literature is to illustrate the value and importance of women and racial/ethnic minority inclusion into STEM, but most specifically engineering programs, as well as to demonstrate the limited state of literature concerning mentorship in engineering. In particular, I bring focus to the fact that current literature on mentorship is oriented in facilitating mentorship programs, and advising future or current mentors, as opposed to exploring the experiences and outcomes of women and racial/ethnic minority students. Before engineering programs concern themselves in diversifying their student bodies and improving their programs, based on their own perspectives of betterment, they should instead allow their women and racial/ethnic minorities to voice their opinions on what makes an engineering program better and inclusive.

In the next section, I present the purpose and rationale for this thesis, which largely presents a phenomenological approach to improving mentoring programs and relationships in engineering disciplines.

3. Purpose and rationale for the thesis

The intent of this thesis is to learn about the circumstances, experiences, and challenges of women and racial/ethnic minority engineering students as they pursue their degrees, and interact with their mentor(s). Moreover, this study seeks to enable a platform for underrepresented students to assess their current mentoring relationships, and discuss what traits and qualities a mentor should possess to establish a productive and satisfactory relationship in an engineering degree. The focus of this study will be on selected students from a mentorship and professional development engineering program, which for the purpose of confidentiality will hereafter be named MPDE. The MPDE program's goal is to increase recruitment, retention, student success, professional development and graduate degree attainment in Engineering, with an emphasis on low-income academically talented students with a demonstrated financial need (Morales n.a.). Central questions to the study include: Do these students identify themselves as engineers? How do these students feel about their mentors? Do homogeneous relationships matter in establishing good mentorship? How has the COVID-19 pandemic affected their mentoring relationship? Of course, more questions may arise as the research process continues and the author continues to obtain more clarity on what it means to have an ideal mentor in STEM as an underrepresented student.

This study seeks to provide a comprehensive look at mentoring relationships within the College of Engineering at HSI to assess the needs, concerns, and circumstances of underrepresented students and their mentors. It is the author's purpose to enable a way for underrepresented students to rationalize their mentorship relationships outside of a professional scope. Furthermore, this study will create alternate ways of understanding mentorship relationships for underrepresented students, which will create the foundation for more efficient and humane mentorship in STEM – particularly within engineering - and function as a way to improve current mentorship. It is the hope of the author that findings of this study will likewise aid potential mentors from different disciplines to establish productive mentoring relationships, and offer guidance to students seeking a mentorship collaboration. Moreover, this study seeks to add a qualitative perspective to an overwhelmingly quantitative literature on the topic of mentorship in STEM. In addition, this study seeks to fill in the gap of student's perspectives on what encompasses a successful mentoring relationship. Ultimately, this study seeks to aid the engineering community in preparing underrepresented student's success in engineering careers.

In the next section, I present the theoretical framework of this study, which is based on Pierre Bourdieu's theory of capital, and a tenet of critical race theory. This framework guides my analysis of the experiences of underrepresented students as they interact in their engineering programs, and with their mentors.

4. Theoretical Framework

For this thesis, I adopt and adapt Pierre Bourdieu's theory of capital, and incorporate a tenet of critical race theory as it pertains to capital to frame my understanding of the experiences that underrepresented engineering students have in their mentoring relationships. Braun's, Gormally's, and Clark's (2017) "Deaf Mentoring Survey," a mentoring survey built upon capital theory and critical race theory made to assess relationships between deaf mentees and their research mentors, is the inspiration for this framework. In particular, I focus on Braun's, Gormally's, and Clark's claim that attrition is not related to either initial motivation or ability. Instead, feeling disconnected to a STEM community, or in this sense, an engineering community, is the most important factor for persistence.

4.1. Bourdieu and Capital

Habitus, the cornerstone of Bourdieu's theory of capital, is the mental filter that structures an individual's perceptions, experiences, and practices. It refers to an individual's character through which the social world is apprehended and expressed through verbal and bodily language (Appelrouth & Desfor 2016). Habitus, Bourdieu contends, is structured by one's position in a social space, wherein an environment and people living in a similar conditions will dictate the habitus on an individual. Capital is what Bourdieu uses to situate people in social spaces, or "fields" as Bourdieu labels them. In simple terms, capital can be thought of as vouchers people use in social spaces, wherein these vouchers allow them admission to these spaces, and the acquisition of goods and services these spaces provide. There are three forms of capital, but for the sake of this thesis, I mainly focus on two: social and cultural capital. Social capital is essentially who you know; networks or relationships whose resources can be used to secure or advance one's own position. Cultural capital refers to the collection of symbolic elements such as skills, tastes, posture, clothing, mannerisms, and material belongings that one acquires through being part of a particular social class (Appelrouth & Desfor 2016). In this sense, engineering programs and professions can be labeled as fields with social and cultural capital abound, wherein habitus is developed. For example, engineers benefit greatly from networking; engineers possess a particular set of skills, knowledge, and mindset that is often unique to their field; and as the literature showed, prospective underrepresented engineering students seek to identify as engineers, and completely immerse themselves in the engineering experience.

4.2. Tenet of Critical Race Theory

Bourdieu's theory of capital is a useful tool in explaining the dynamics that take place within engineering programs, however, it is not sufficient on its own to understand the experiences of underrepresented engineering students in particular. This is because capital is mandated by the majority group, as it reflects the cultural tastes and practices of those in power. In the case of engineering, the majority group includes white male, able-bodied, middle class/affluent individuals. In turn, underrepresented engineering students are expected to adopt these predominant tastes and behaviors, and if they fail to adopt these traits, they are deemed culturally poor. In other words, they are made to feel inferior, or in the sense of this thesis, not able to identify as an engineer. Critical race theory becomes useful in this sense. In simplified terms, critical race theory posits that reality is situational and a social construct. One's reality differs from others' depending on one's cultural background, race, and socioeconomic status. In very simple terms, the experiences of white male engineers will greatly differ from those of a Latina engineer.

In essence, it is important to understand the cultural and social capital that takes place within engineering programs, and observe how these forms of capital affect or benefit underrepresented engineering students. In particular, this framework will provide better context to these questions:

- Do underrepresented students identify as engineers?
- Do homogenous relationships matter in establishing good mentoring relationships?
- How do underrepresented students feel about their mentors?
- What are the traits that underrepresented engineering students value most in assessing good mentoring relationships?

5. Methods

In this chapter, I discuss the methodology of my work. I address how I was introduced to the research topic, introduce the research participants and settings, and the data collection and analysis procedures. I must note that his work is part of a larger, three-year long research plan, wherein surveys and semi-structured interviews were the two main methods of data collection. For the purpose of this thesis, I focus solely on the data collection and analysis from the semi-structured interviews.

5.1 Study Context

The mentorship and professional development in engineering (MPDE), from which the sampling of this study is done, is a program devoted to increase recruitment, retention, student success, professional development and graduate degree attainment in engineering, with a focus on low-income academically talented students with a demonstrated financial need. The program funded 20 students who enrolled in the Fast-Track BS/MS programs in engineering. In addition to providing funding to engineering students, the MPDE program has implemented a set of interventions to assess the effectiveness of the program. The interventions include a multi-faceted student support-system (includes mentor and family/social support), a research training program, a professional development program, and leverage established programs to optimize student participation in research experiences and internship opportunities. In order to examine the impact and the effectiveness of the interventions on students' decision to pursue and succeed in graduate school, the MPDE program implemented a research plan of three years, beginning in the fall semester of 2019, and culminating in the fall semester of 2024. The MPDE program selected Dr. Danielle Morales to lead the research plan; consequently, I, along with Alyssa Garza and Jacob Aun were selected to conduct data collection and data analysis for the 2021-2022 academic year.

As noted, data collection and analysis will be an ongoing process that will culminate in the fall semester of 2024. However, the data to be used for this study was collected in the fall semester of 2020, and has continued up until the fall semester of 2021. As part of the funding that the MPDE program provided, students were given the choice to become participants of the ongoing research plan. Thus, the MPDE program served as the pool from which the sampling of this study was done.

5.2 Participants and Setting

Participants of this thesis were recruited as a convenience sample (Singleton and Straits 2017). As previously noted, the MPDE program funding allowed students the opportunity to participate on the ongoing research plan. Thus, participants of this study include a 3-student cohort from the fall semester of 2020, and a new 7-student cohort from the fall semester of 2021. To be part of the cohorts, students had to have earned 90 undergraduate level semester credit hours; be Pell-grant eligible; be currently enrolled full-time in an engineering major; be a U.S. citizen, permanent resident, national, or refugee; and be currently pursuing an engineering fast-track program. Due to the social distancing efforts as a result of the COVID-19 pandemic, most data collection occurred online through the Zoom video-conference application. One face-to-face interview was conducted by one of my research teammates. First cohort members (Fall 2020) had already transitioned into graduate school and most obtained a part-time engineering position; second cohort members (Fall 2021) are current rising seniors preparing to make the transition to graduate school. Pseudonyms were provided for the cohort members that agreed to participate in the research study.

5.3 Data Collection

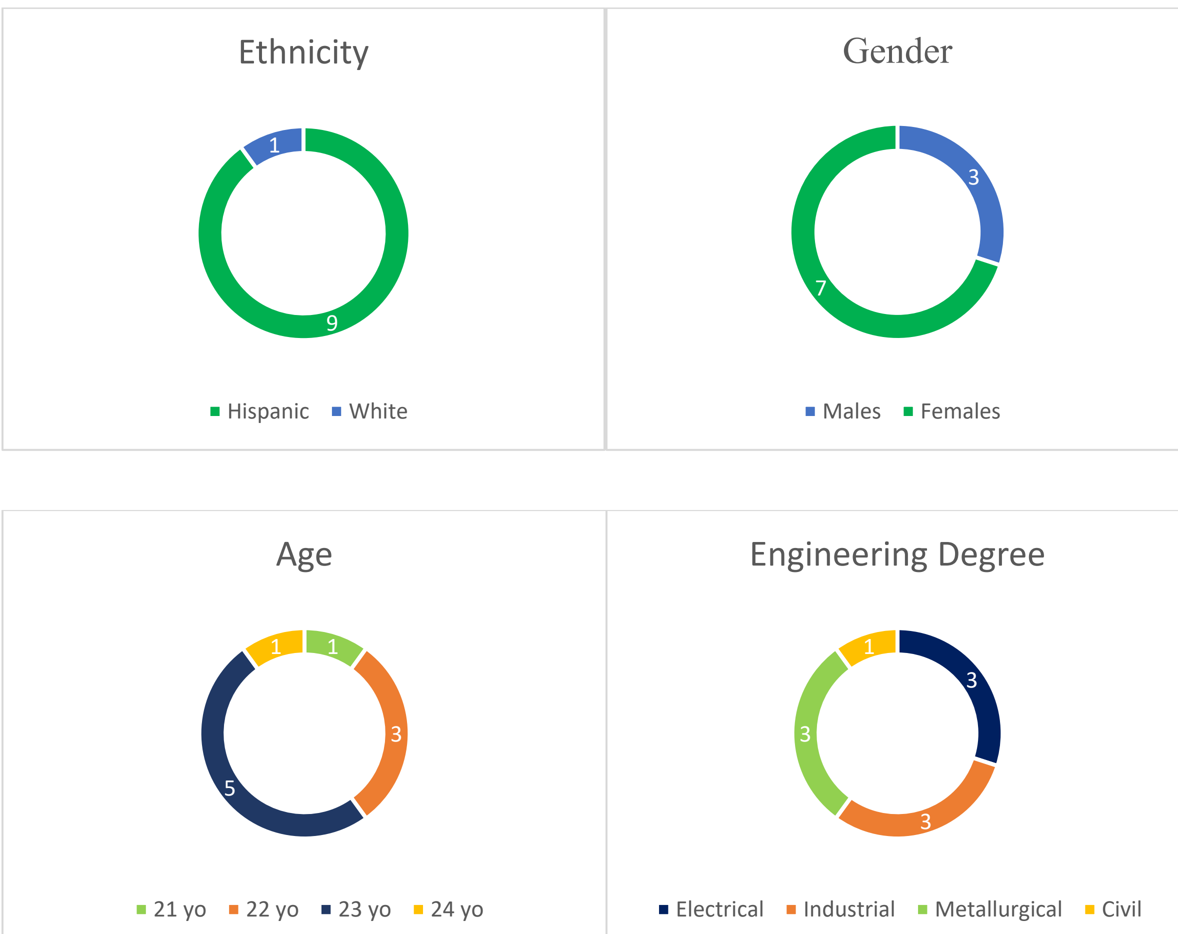
Before data collection began, Institutional Review Board (IRB) approval was granted by the Hispanic Serving Institution (HSI) from which this study is based. As previously noted, this study is part of a larger, three-year long research plan. Data collection for the research plan was/is collected through two methods: survey and semi-structured interviews. These data analysis methods were/are utilized by the research team. However, for the purpose of this study, I chose to implement a qualitative data collection/analysis approach. Given the phenomenological nature of this study, I believe a qualitative approach will be the best way to obtain an insider's view of reality (Singleton and Straits 2017). As part of the interview method, participants agreed to be interviewed through Zoom, the video-conference application, and one interview was conducted face-to-face. The interview revolved around topics such as MPDE program assessment, long term goals, fear and challenges, education, engineering experiences and identity, gender and ethnic bias, mentorship, and the COVID-19 pandemic. Interview sessions were video and audio recorded through the record function of the Zoom application. Prior to the formal interview, participants received verbal and written (through email, and prior knowledge from the MPDE program) information that introduced the study, its purpose, the right to withdraw from the interview at any time, and the confidentiality of data. Likewise, participants provided consent for the video and audio recording of the interviews, the transcription of the interviews, and its subsequent analysis for themes. Interview sessions averaged 1 ½ hours.

5.4 Data Analysis

Data analysis for this study was conducted by using primary data collected on Cohort 1 and Cohort 2 through the semi-structured interviews. Interviews enables us to address the limitations of the quantitative portion of the larger study. One of the key strengths of the qualitative approach is subjectivity, for it allows me to gain the perspectives of participating students on their educational and mentorship experiences. Furthermore, a qualitative approach is best suited to examine social processes (i.e., what qualities students look for in mentors). The data analysis process followed common coding practice. First, interviews underwent a transcription process. Second, interview transcriptions were coded into four main themes, which include mentorship, engineering, diversity, and covid. Coding was done through the NVivo qualitative analysis software. Additional sub-coding took place after, whereby initial codes (parent nodes) were broken down into more specific codes (child nodes). For instance, "mentorship" (parent node) included child nodes such as introduction, experience, and expectations. To improve validity, we paid keen attention to the piling of evidence that came from multiple observations within the same interview within each case.

6. Findings

This chapter is informed by the engineering student participants' experiences in their degrees and mentoring relationships. By analyzing these experiences, I am able to expand on Fleming's (2016) conclusion that minority students' foremost factor for success in engineering is the exposure to engineering itself, and that mentorship relationships play a key factor in engineering student's success (Kaul et al, 2015). In the following sections, I provide the thematic coding of the interview transcriptions in detail. The following pie charts provide a demographic breakdown of the study sample.



It must be noted that the sample originally included 11 participants, but one student was not included in the coding process. The participant in question identified as a white, 34-year-old male, which made him ineligible for the denomination of women or racial/ethnic minority, which is the target group of this thesis. Additionally, another participant identified as white, but I decided to keep her in the sample as she identifies as a woman, a target group of this study. As noted, with the exception of one participant, all participants identified as Hispanic. Most participants are women, totaling 7, and the remaining 3 are men. The median age of all participants is 23 years of age, wherein 5 out 10 participants were aged 23; 3 out of 10 were aged 22; and the remaining two participants were aged 21 and 24. In terms of engineering backgrounds, 3 participants are electrical engineering students, 3 participants are industrial and systems engineering students, 3 participants are metallurgy and materials engineering students, and one participant is a civil engineering student. Through inductive thematic analysis I found that four main themes emerged from the interviews, which include mentorship, diversity, engineering, and COVID-19. Below, I begin the discussion of my findings by addressing the new ways in which mentorship impacts my participants' academic lives.

6.1 Mentorship

Literature on mentoring in STEM notes that mentorship and professional development programs are regarded as an efficient strategy to mitigate rates of attrition in engineering degrees (Wilson et al. 2012). In particular, close relationships with mentors enhance mentees' self-efficacy for conducting research; contributes to a stronger interest in, and commitment to, having a STEM degree; and fosters mentees' identities as scientists (Stelter, Kupersmidt & Stump 2021). As such, a key aim of this study is to get an insight of underrepresented engineering student's overall experiences with their mentors. As we conversed with participants about their experiences with their mentors, there were four main themes that arose out of the larger mentorship theme. Introduction (how participants were introduced to their mentors), expectations, interactions, and homogeneity emerged out of the interviews with students.

6.1.1 Mentorship: Introduction

Participants were introduced to their engineering mentors in a variety of ways. For example, there were participants who were assigned to their mentors by the MPDE program. The mentor/mentee match-ups were based on similar engineering background, as in, faculty members that specialized in civil engineering would be matched up with students majoring in that area. If this match up was not possible, mentors and mentees were paired together based on similar research interests, or similar interests in engineering. Alex's introduction to her mentor is the former. She explains,

> So, the mentor was assigned to me, it was the only professor that was part of the [MPDE] program from my degree, or I believe he picked me. I'm not sure how that went, but he connected with me like "hey, I'm going to be your mentor. These are going to be the requirements. Let's meet".

Alex was not exactly sure how her mentor picked her, but there was little pressure for her to choose someone from the faculty to ask to be her mentor. In this way, being part of the MPDE program facilitated the opportunity for her to connect with someone that she would advise her about what she should be doing as part of the graduate program. Still, sometimes match-ups happened because professors had agreed to be a part of the MPDE program and may have not been in the same area of engineering, but did have some of the same interests as their assigned mentees. Ultimately, the MPDE program did their best in pairing mentors and mentees in a way that would benefit mentees. There were also participants who reached out to their mentors, often establishing early rapport because they were going to be enrolled in professors' courses. For instance, Nick talked about how he approached his mentor first. He shared,

> I approached her as an undergrad and I told her I was interested in research, so she took me in.

There were also instances in which students were also reached out to by their mentors, usually for research opportunities that invariably evolved into mentoring relationships. Much like the previous example, participants who were students in their (future) mentors' courses, were likewise asked by professors to work with them. Such is the case with Daniel Ray, who excelled as a student in his current mentors' course. This caught the attention of his professor who offered to mentor him. Daniel commented,

> He [professor] noticed that I was trying to get my presence known. And I guess he started reaching out to me because, what he tells me now is that he saw a lot of potential in me, and he wanted to make sure I reached that potential.

Interestingly, the classroom was not the only social space (or field) in which professors scouted students for research opportunities, or vice versa. The engineering departments at the HSI have set up a welcoming environment where students can interact before or after classes. Some of these spaces are the student lounges. Here, students often work on homework, rest, eat, or socialize with one another. Unsurprisingly, professors occasionally come down to these lounges to mingle with students, sometimes simply to socialize, or as was the case with Hugo, to scout students for research. In the case of Hugo, it was a two-sided introduction.

> He would always come into the lounge and I would see him often, and I just kind of figured out that I would ask him [to be his mentor]. He reached out to me for research, and I mean, that's how it happened.

The classroom and student performances in those spaces allows professors to identify students that can potentially work with them on research projects, internships, and who would make good graduate students that they can mentor. Nick, Daniel, and Hugo took the initiative to make themselves known, whether it be by approaching a professor and asking about research positions and whether they were taking on or mentoring students, and by performing well in the classroom. These interactions resulted in positive outcomes for students since they were able to gain mentors from these early actions.

Most introductions with mentors took place within the engineering fields, which in the experiences of participants included the classroom, engineering departments' lounges, and through the MPDE program. The introduction of Anne to her mentor stands out, since it offers a unique look at social capital being used through family connections, as opposed to students asking peers or professors for research opportunities. Anne met her mentor through her sister, who attended the same program years before. She recalls,

> So my sister actually went to this program, and they helped her get scholarships for college and everything. So I was the next one to go into this program, and they knew me since I was little. I would go to their office at [HSI] and we would just talk about mentorship.

There were participants who had relatives (usually parents) who were engineers themselves, but Anne was one of the only students who had early childhood connections to the engineering department, which developed through her sister's experience as an engineering student. What is also important to note is that Anne's early interactions provided her the opportunity to speak with people from the program about funding opportunities. She not only felt welcomed in the department, knew the school, and people from the program, but she was also advised early on about scholarship opportunities. Her social capital helped to frame her identity as an engineer, and made her inclusion into the engineering program smoother and fruitful.

Introductions to mentors varied for the students we interviewed. It is interesting to note the importance of networking in the introductions of mentors and mentees. With the exception of being assigned a mentor through the MPDE program, mentors and mentees interacted with one another for research opportunities, or connected through a family member in order to obtain mentorship. Of course, as participants reach out to, are reached out by, or are assigned mentors, they possess a number of expectations of what their relationships will be like. In the following section, I explore what expectations participants had on their mentoring relationships.

6.1.2 Mentorship: Expectations

Practically all participants expect their mentors to keep consistent communication with them to offer advice, and to provide them autonomy when conducting projects. As noted, the MPDE program recruits students enrolled in Fast-Track B.S/M. S engineering programs, which essentially means that they are very busy as they are completing their bachelor's degrees and also conducting graduate level work in engineering. Participants of this study devote their attention to their courses, their research tasks, their jobs (sometimes already as engineers), and their personal lives. As such, their time is of the essence, as emphasized by Maggie,

> I think I really like for them to respect my time… so I think that is something really important for me, that he let me be in the end working. And you [mentor] be there if I have questions and stuff like that, but let me do my work.

Maggie was efficient with her time and did not expect her mentors to be looking over her shoulder at all times. Instead, she wanted her mentor around if she had questions about the work she was doing. Because participants have various responsibilities, they appreciate mentors who afford them a bit of autonomy, as in, mentors that allow students to work at their own pace in research projects, or as Nick puts it, mentors without micromanaging tendencies. In simpler terms, participants, such as Nick and Alex, expect their mentors to be "hands-off". Nick noted that he and their mentor were a good fit for each other,

> I guess in a way that we are kind of perfect for each other. Also, I'm not someone who likes to be micromanaged and she was definitely – she was a very hands-off mentor. So I like that, too. Yeah, she was very hands-off, so I was able to do whatever I wanted and told her what I was doing.

Alex had a similar experience, below she notes,

> Allowing them [mentees] to make their things at the time they want. Of course, giving them deadlines, but not like "for tomorrow you need to do this and then on Wednesday you need to do this, and then by Friday you need to do this…" Allowing my mentee to work at their pace.

Some participants explained that they did not feel it necessary to schedule daily or weekly, as long as communication between mentors and mentees is consistent. Hugo expressed this sentiment, noting that meeting with mentors can be unnecessary. Below he explains,

> I mean, I personally don't feel like I have to see them [mentors] every week, or see them every day or I have to have their input all the time. I feel like emails can be just enough to stay in touch.

In addition to wanting a sense of autonomy, and keeping consistent communication, participants expect mentors to provide a space where mentees feel comfortable asking for anything, whether it be professional or personal advice. Reyna and Anne expressed this expectation. Reyna shared that,

> It's the feeling of confidence that you're… it's more like that there's a safe place for you to ask questions, and that they understand you.

The feeling of being understood by their mentors seemed to be an important factors for students, and the autonomy encouraged and provided by mentors led to confidence building for students. This helped students develop their identity as future engineers. For instance, in the following quote the participant share how much they value guidance and good communication with their mentor:

> In a mentor, I look for somebody that, I guess, can get to know me just not so much as his student but maybe share professional development of just guidance overall. That's what I value. Just a guidance, I think, on how they can help me. Being with them, having good communication.

Anne's response reflects most of how the other participants felt toward the prioritization of autonomy when interacting with their mentors. As noted, participants undertake many responsibilities inside and outside of their engineering field, and because of this, there is a feeling that time and time management are very important. Fortunately, most of these expectations were met by participants' mentors. In fact, participants primarily described their interactions with mentors as positive. In the following section, I present some of the ways that participants described their interactions with mentors.

6.1.3 Mentorship: Interactions

As noted, participants mostly experienced positive interactions with their mentors, because they felt a sense of autonomy and received guidance when necessary. Interestingly, however, is the way that "positiveness" is described by participants. For example, there were instances when mentors provided consistent and useful final project or thesis oversight. There were also times when mentors provided students with career advancement opportunities (i.e., research; or internship opportunities). These were referred to by mentees as positive interactions. Likewise, instances of mentors making themselves available, approachable, and offering support were deemed as positive. Daniel's experience with his mentor illustrates this point, below he expresses gratitude and praise for the advice, approachability, and availability of his mentor.

> There's been many times where I refer to him if I have any questions about how to expand my career, right? Over spring break, I didn't know what concentration to go for in electrical engineering and I decided to go ask him about it. And he sat down with me very last minute for like two hours, trying to figure out what to do with my life, basically. He was giving me a lot of advice.

Often students do not know what future career opportunities may look like for them and, like Daniel, they appreciate mentors taking the time to help them figure out what possibilities may be out in the job market. This practical advice often helps students relieve some of the stress of not knowing what the future may hold. Practical advice and support, as in mentors encouraging mentees to continuously apply to internships, is very valuable for participants. Maggie, for instance, describes her mentor as being really good because he provides encouragement for career advancement opportunities. Here he shares,

> He [mentor] helped me a lot. He's a really, really good mentor. He puts that pressure on you to get that internship that is good, to keep applying, to keep having interviews. And then he taught me a lot. He helped me a lot to decide which internship should I take because I got a couple of offers.

Maggie's mentor encouraged her to apply to several internships, and she was able to secure one after multiple offers. These kinds of experiences are invaluable for students who often do not realize what the application process for internships may be like or that they need to apply for multiple opportunities in order to receive just one offer sometimes. These experiences allow students to use this knowledge in the future.

Although mentor/mentees interactions with were similar to Daniel's and Maggie's accounts, there were still a couple of negative interactions that participants experienced. For instance, Reyna noted being frustrated with her mentor, who was new to the engineering program and was also a first-time mentor. Reyna acknowledged that her mentor was open about his struggles, but she still found difficulty in establishing good communication with her mentor. Reyna said,

> He's barely getting the hang of what's going on here and stuff, but I think he's very open about it. He has a little bit of issues of just communicating, but he says things with technical knowledge like, "oh, you're going to do this, this, this, and that, and we're going to do this". Then when I'm not really sure, I don't have the technical works, I don't really know what you're talking about.

Reyna's mentor lack of experience as a mentor hindered their communication, and made research tasks for Reyna unclear, and complicated. Reyna nonetheless accomplished her tasks, but her experience reveals the importance of clear, and consistent communication with mentors, one of the assets that students value most in their mentors.

Anne's account is also interesting, because she shared her desire for her mentor to be more affable. Unfortunately, for Anne, her mentor placed more relevance on the completion of research tasks and took no time to get to know Anne beyond her research assistantship. Anne shares,

> I wasn't very connected with my mentor. For example, the mentor only got to know our progress in a research-level, but never cared. I didn't want to talk about it, but he never really cared how we were as a student, what we were going though, or how we were overall. It was just what matters was the deliverables that we had weekly

Students have noted practical traits they look for in their mentors, such as being given a sense of autonomy, and advice. However, Anne's experience reveals the importance of having affable mentors, even in disciplines as practically oriented as engineering. Anne wanted to get to know her mentor as a person, not just as a professional. Mentors with affable personalities make it easier for mentees to get comfortable in their positions as research assistants, and makes communication between mentors and mentees better.

Participants spoke fondly of mentors who provided career advancement opportunities, such as in professional advice, or help with internship and job applications. Participants also appreciated mentors who offered professional advice, such as in Daniel's case. With the exception of Anne, most interactions with mentors were assessed as either positive or negative in a practical sense. In the case of Reyna, for example, she showed frustration with the lack of communication, which stunted her ability to complete research tasks. Interestingly, this perspective of practicality also comes across in conversations of gender and racial/ethnic homogeneity with participants. In the following section, I explore participants' thoughts on homogeneity (i.e., where mentor/mentees share the same race/ethnicity or gender) within engineering programs.

6.1.4 Mentorship: Homogeneity

One of the central questions of this study is whether homogeneity is important in seeking out mentorship relationships. Homogeneity refers to a mentor and a mentee sharing similar social denominations, such as gender, race or ethnicity. As such, we specifically asked participants if they felt it was important that their mentors shared the same or similar ethnic and gender background as them. Most participants stated that both gender and race/ethnic identity were non-factors in seeking out mentorship, or in determining good mentoring relationships. Despite not personally considering homogeneity as a factor for themselves, participants nonetheless endorsed the diversification of engineering programs, particularly calling for the inclusivity of women in prominent positions within engineering. However, the context of these responses varied between male and female participants. For example, although men endorse diversity in engineering, they place more value on the practical aspect of engineering. Nick's and Daniel's account illustrate this finding. Nick shared,

> I don't look at that [relating to race and gender]. I think the match up [of mentors] should be focused on similar interests, topics they enjoy and also hobbies.

Similarly, Daniel noted,

> To be honest with you, I don't care about those things. Of course, I support women engineers, but if I have a female professor, it's the same way like I would look at a male professor. I just see them as people in general. I don't see them as a stereotype. I don't see them as black or white or male or female. It's just for me, that I see them as people, so I really don't care about that. As long as they're good professors, that's all I really care about.

I had a small pool of male participants in this study, so it would have been interesting to see how other male engineering students responded to some of the ways in which gender, race, and ethnicity play out in their experience as students. I think it is also important to note how structural racism and sexism may play out in these spaces where women and racial/ethnic minorities have been historically excluded from.

Though the women expressed similar views, Sarah's response shines more importance on a woman's passion and competence for engineering, as opposed to just being a woman in engineering. For instance, she says,

> It was really refreshing to see someone who was passionate about engineering who was also a woman in engineering. So I definitely think it would be nice to have more. But of course, it's like you don't just want to have women in engineering with lacking that drive. I feel like, of course, they have to have that drive and that passion.

Sarah does note the importance of enabling more women to enter engineering programs, but emphasizes the occupational importance of engineering. This feeds into the seemingly meritocratic nature of engineering, where engineers move up the professional ladder based on their competence as engineers. Sarah explains that as good as it may be for more women to enter engineering programs, it is all superfluous if those women do not demonstrate drive or passion.

Although showing similar responses to the men of this study, women provided answers that demonstrated more of an approval and encouragement of gender homogeneity compared to the men. Anne and Sophia went as far as to note that it can be easier to approach a women professor, although these situations are not necessarily what they dwell. For example, Anne shared,

> Sometimes I do think about it. I'm like, there's some… there's even a shortage of women representation in education for engineering. But it makes me feel… I guess I don't really notice it, but it's nice sometimes having a female professor you can approach. They understand. They went through the same thing that you went through.

Anne acknowledges the gender disparity that exists in engineering programs and engineering occupations. Anne goes as far as to say that it is good to have female professors to approach, compared to male professors. Sophia provides a similar comment. She says,

> I felt like I was better able to be like, "I have a question," when the professor was a woman, and I was more hesitant to ask a question when the professor was a male. So that's just my experience. That's how I felt. But my hope is that the STEM field will diversify sooner rather than later.

Anne and Sophia speak on the importance of gender representation in engineering, particularly on the importance of women's inclusivity in faculty positions. Both Anne and Sophia even expressed how it can be easier and more comforting to approach engineering professors who are women. However, engineering programs are very occupational oriented, as in, students are indoctrinated to focus on engineering experience, tasks, and potential job opportunities. Because of this, participants like Anne and Sophia become engulfed in the occupational aspect of their degree (i.e., research tasks, internships), and pay not a whole of mind to issues of diversity within their programs.

For the participants in this study, gender, race or ethnicity, as it turns out, did not play a major role in assessing mentoring relationships. Still, the women in the study did feel that is important to have more faculty representation, particularly for the inclusivity of women in prominent engineering positions. When it comes to gender or race/ethnic discrimination at the HSI, participants commented that they rarely experienced any sort of discrimination. In the following section, I address participants' conversations around issues of diversity.

6.2 Diversity

As I previously mentioned, this research was conducted at an HSI. Still, the discipline of engineering in the United States has historically been led by white men. Needless to say, the lack of gender and racial/ethnic diversity is one of the main issues plaguing engineering programs and occupations today. Since this thesis investigates the mentorship and engineering program experiences of underrepresented engineering students, namely Hispanic women and men (with the exception of one white woman), it is important for me to analyze if participants feel included in their programs on the basis of their gender and race/ethnicity. As we interviewed participants about issues related to gender, race, and ethnicity, there were two main themes that arose, including ethnicity and gender.

6.2.1 Diversity: Ethnicity

Discourse about race can be dichotomous, in that it mostly involves discussions of white vs. non-white narratives. Race is a human classification that is socially constructed to distinguish between groups of people who share phenotypical characteristics (Ray & De Loatch 2018). In our interviews, issues related to race did not emerge Instead, conversations centered around ethnicity. Ethnicity describes shared culture – the practices, values, and beliefs of a group. This may include shared language, religion, and traditions (Little 2016). In this sense, participants in our study, specifically raised issues related to language. Moreover, the topic of citizenship, or legal status, also emerged as a social status that impacted students. Daniel's account is particularly remarkable. He was the only participant that disclosed how legal status affected his experience as an engineering student. Below he shares his experience with being undocumented and then receiving legal permanent residence.

> I don't think I ever felt excluded in the sense of race, or gender, or anything like that. It was mostly with nationality, of course, because I mean, I was just born two miles that way [referring to Mexico]. So I do think I was excluded in that sense. I'm a resident, but I can't apply to jobs that require citizenship. I cannot apply to jobs with the government. There's not much opportunities for residents, you have to be a citizen.

Daniel found out he was undocumented in high school, which coincided with his engineering program applications for college. As such, Daniel's options were suddenly limited. While his counterparts were applying for engineering programs around the country. Daniel had to consider the cost and location of programs outside of his hometown. Although he was eventually able to enter an engineering program, he later missed out on internship opportunities because of his legal status. Fortunately, he has since received his legal permanent residency, which may open some opportunities. Still, he experiences limitations when applying to government employment positions. Daniel's account is likewise interesting since it was not a specific person, or a group of people, that have *othered* him for being undocumented. In fact, it is unlikely that his friends and peers knew – or cared – about his legal status. Instead, current harsh anti-immigration policies place individuals like Daniel at a significant disadvantage (Johnson 1998; Molina 2014; Speed 2020).

During our interviews, language also proved to emerge during conversations related to ethnicity. Anne, for example, noted being *othered* for her English fluency at work and while doing an internship.

> When I go out to work or to internships, everybody tells me, "Is English your second language?" I know I have an accent, but I am able to communicate. Sometimes there's some words that I do need to practice, but overall, it's kind of hard because we live in this borderland, and in [HSI], everybody speaks Spanish, so I don't really get to practice [English fluency].

The HSI and living along the U.S.-Mexico border may prove to be protective spaces for some students for whom English is their second language. However, when students, like Anne, take part in internships, sometimes outside of their hometown, they are questioned about their English proficiency. For many individuals attending the HSI and living along the U.S.-Mexico border, this will be the first instance of discrimination that they will experience, and unfortunately not likely the last.

Language was also an issue that Sarah confronted, but it was the Anne's experience. This study takes place in a prominent border city, where according to the U.S. Census, approximately 82% of the population identifies as Hispanic. Located along the U.S.-Mexico border there is also a strong Mexican cultural presence. Sarah, noted how her lack of Spanish has affected her socializing abilities in this region.

> I don't think I've ever felt personally excluded, but something I've struggled with since moving here is, of course, I'm not from here, and the predominant culture here is not the culture I grew up with. I'm not fluent in Spanish. I've been practicing and I can say certain phrases and I hear better than what I can speak, but sometimes I do feel like that disconnect to where I don't maybe meet as many people as I would hope to.

For Sarah the acquisition of Spanish was not an issue at the HSI, but rather something that she felt due to living in a city along the border. She was making efforts in order to learn more Spanish, and language was not something that she necessarily felt as a challenge while in the engineering program.

All of the experiences took place outside of the engineering program and the university. Most participants noted to never have been victims of racial/ethnic discrimination by their mentors or in their degree programs. Nick went as far as to say that the engineering industry is quite diverse. He explains,

> The industry, it's very diverse. We have a lot of… there's a lot of people that come from the outside of the U.S. to be engineers here. We produce too little engineers [in the U.S.], and places like India, they produce too many engineers. So, a lot of them come over here.

Nick is correct in discussing the inclusion of international engineers in U.S. engineering positions, which is a great opportunity for international students. Nick does note the fact that the U.S. is producing too little engineers (Roy 2019), and unfortunately, much of those engineers are not people of color. This is a problem, as engineering positions are opening up faster than what engineering students are graduating, and the inclusion of international engineers are not filling all engineering positions.

Similarly, to conversations surrounding ethnicity, most participants of this study did not perceive gender discrimination to be an issue that they dealt with at school. Instead, they experienced problematic gendered situations outside of campus. Given that the majority of participants in this study identified as women, discussions around that topic emerged more frequently than those revolving around race and ethnicity. There were plenty of accounts shared by female participants about with male peers, mentors, and professors. And, male participants shared their views about their female peers. In the next section, I explore some of these accounts on gender perceptions and interactions.

6.2.2 Diversity: Gender – Interactions

One of the questions we asked during the interviews dealt with whether participants perceived gender bias against them. We were looking at any experiences in the classroom, in the workplace, in the research labs, or with mentors where participants may have felt discriminated. Most participants reported never to have been victims of discrimination at the HSI's engineering programs. In fact, women participants in this study expressed feeling as though they were on equal standing with their male peers, and even noted their interactions with male peers, mentors, and professors were pleasant. For example, Anne illustrates how she felt a sense of equality, noting how she can "forget" that she is a woman as she interacts with her male peers within an engineering space. She said,

> It's just funny because sometimes I feel like maybe they forget I'm a female. I guess I blend in with the guys. I haven't had any conflicts.

Reyna and Andrea also reveal that they perceived equality at the HSI. Reyna makes an interesting point in noting that the gender disparity within her degree is not prominent, or she does not feel this in her classes. Because of this, it is easier for her to perceive a sense of equality among her female and male peers. Below she shares how the actual number of female students plays a role in this experience. She said,

> I think here at [HSI] I haven't felt that way just because I think in my major, which is metallurgy, we do have a very good number of female students. Not like half-and-half, but at least 40% of them are woman, so I've never felt left out because of being a woman.

Andrea, another participant in this study, expressed surprise and gratification at how polite and focused her male classmates were, originally thinking they would be "lazy," and feeling hesitant about being grouped together with only men. Below, she shares how this gendered situation surprised her,

> I've always thought girls kind of grew up together with the girls and the girl groups. And I got paired with a guy group in that class that I liked. And it surprised me, working with two guys, that they weren't lazy or anything. That's how I feel like I see guys. But no, they were very… they had their stuff and they were very kind and sweet. They were good kids. I really enjoyed working with them.

Men and women are viewed differently in our society, with different characteristics attributed to them. We can see how Andrea had adopted views about men as being "lazy", but she was pleasantly surprised when her male groupmates were kind and sweet to her.

Unfortunately, not all interactions with male peers were as positive those noted above. Sophia shared two gendered interactions that took place at the HSI. The first experience describes her raising her voice explaining a topic to a male peer, and how he reacted defensively to her explanation. The second experience describes Sophia's interaction, or lack thereof , with a group of Middle Eastern male students in her electromechanics course.

> I remember this time, I stayed after school for a study group. And we were just taking notes, we were teaching each other, and I wasn't discriminated. But I was like, "hey this is how you do it, because this, this, and this". And I didn't notice that I raised my voice, but I didn't mean it to offend or even… I was just being me and then at the end, when I finished, he [male classmate] was like, "okay, but don't raise your voice at me." … Also, when I took electromechanics, it was mostly men in that class. That was the most men I've ever had in a class. It was just four women, and then everyone else was men. And I got a group with mostly men, I think they were from the Middle East, and it was just one other girl. I remember giving my suggestions, but they were like "oh yeah, yeah, yeah," and then they would continue with their conversation.

Women, and particularly women of color, are reprimanded for being assertive (Cordova 1998). Sophia's experiences reflect some of this. When women raise their voice or show even an inch of passion, they are told to "calm down" or "lower their voice." In her explanation of the second experience, Sophia justified the lack of attention she faced from her Middle Eastern classmates, brushing it off as a cultural thing. Nonetheless, Sophia recalls this experience as a negative interaction with male peers in her degree. Sophia did not raise this as an issue with anyone, much less her male peers, and she may have internalized the experience. Still, just like with ethnicity, participants faced instances of discrimination outside of the school environment. Alex's account shows this "rude awakening," where she notes how she felt on equal standing to her male peers at the HSI, but once she graduated, she began experiencing gendered bias at work. She notes,

> I believe it was pretty even all around, either male or female classmates will approach me to ask "hey, can you help me with the homework?" or, "do you want to be in my group?" or "do you want to work on this project together?" I will say they were equal. – Alex

Alex went on to elaborate that, although she did not experience gender bias at school, she started experiencing bias at work,

> When I started as a co-op [work], they would not take me seriously. They would not take me seriously, and they were mainly males. I was the planner of the raw materials, and one of the departments are all males, all of them. I will say we have eight people working there. All are males and old ones like 55, 60 years old… they didn't want to take instructions from me. They wanted me to go first with a supervisor, and the supervisor

> would then tell them how to do it… it took me some time, I would say two months before they started believing that I was doing my job right.

It was difficult for Alex to not being taken seriously by her co-workers, and notes how frustrating it was that it took two months for her co-workers to finally believe she was competent at her job. Alex faced the realization that her sense of equality with her male peers is, sadly, not universal. Fortunately for Alex, however, is that she was able to finally get her co-workers to acknowledge her contribution. This situation is indicative of another issue, wherein women often have to work twice as hard than their male peers just to prove they are competent at their positions.

I do not believe it surprising that, male participants in the study did not feel or experience any instances of gender discrimination. As part of the study, we asked them about how they perceive their female counterparts. In a similar fashion, male participants showed feelings of equality, and even showing admiration and respect for their female peers. Hugo and Daniel, shared with us how inspiring it is to see women in engineering succeed, and even noted feeling proud of them. In the following quote we see how Hugo felt about this,

> I think a lot of the women that I met in the field, they know what they want, and they're go-getters, and I have massive respect because you're being a minority within the minority. So I think for the most part, they are able to communicate well and interact well.

Hugo acknowledges that women in his field are minorities within the minority. That is that they are racial/ethnic minorities and women as well and because of this he respects their success within the field. Moreover, Daniel says,

> I have noticed the women in engineering, although there's very few of them, they're successful. They're very successful with the ambition of being the perfect engineer. My friends that are ladies, you have to see their resume, what they've worked on, and kudos to them. They're even more successful than the guys.

As kindhearted as Hugo's and Daniel's comments are, there is a gendered perception in the way that they describe the success of their female peers. The context of their praise could be taken as condescending, giving the impression that women's who success in engineering is a feat in and of itself. When women in engineering succeed, it is rare and thus worthy of respect. This perspective makes it seem as though women are incapable of becoming engineers, and so when it happens, that is the only occasion where men recognize it. Despite this gender predisposition, as it pertains to engineering identity, or what makes an engineer, gender nor race/ethnicity were used to make these descriptions. It is also noteworthy to address that discussions around mentorship, the larger question within this study, was never brought up. In the following section, I explore how participants' identity as engineers, and the value of community formation within engineering spaces.

6.3 Engineering

In utilizing a theoretical framework based on Bourdieu's theory of capital, it is important for me to analyze the experiences of participants within their programs, and if they identify as engineers. For this reason, I pay attention to interactions within the "fields" (engineering departments) and whether participants build the habitus and behave in accordance to their field. Recall that habitus is the mental filter that structures an individual's perceptions, experiences, and practices. Two themes that arose from participants' responses were about their identification as engineers and their connection to an engineering community.

6.3.1 Engineering: Identity

By and large, participants identified as engineers, or acknowledged that they were engineers in the making. It is interesting to note that engineers defined what makes an engineer in the occupational sense, and their perceptions of themselves as engineers also had occupational connotations. For example, there were participants that identified as engineers based on their work experience or degree completion. If a participant had completed his bachelor's degree in engineering, obtained a job as an engineer, or had prominent internship and research experience, then they identified as engineers. Sophia and Reyna describe how their engineering identity formation was based on degree completion and occupational experience.

> I do picture myself as an engineer mainly because I already graduated and I'm an engineer and I have the job. But what was interesting was that going to school while still doing the studies, it wasn't always like that. It was like, oh well, I've always thought I will not be an engineer until I have my degree and I have a job".

While Sophia was studying for her engineering degree, she did not think of herself as an engineer even though that was what she was being trained as and what her future career would be. Similarly, Reyna is waiting for graduation to consider herself as an engineer. Still, her experience with internships and research have expanded her view of herself as an engineer. Below she explains,

> I think so. I mean, I would have to graduate, and then I would consider myself an engineer. But because I had the opportunity to work on internships and research, I think of myself already almost as an engineer.

Likewise, there were participants that identified as engineers by virtue of being engineering students. Daniel notes how he felt the education he has received in his degree places him on par with engineers already in the field. He explains,

> I do consider myself an engineer now because, although I haven't really finished my bachelor's, I think I am already at the same level (…) whenever it comes to understanding the new system, understanding how something works, now I'm able to figure out it, how it works, stuff like that based off my education as an engineer.

Interestingly, the examples I just shared differ by respondents' gender. That is, Sophia and Reyna hesitated when identifying as engineers and were waiting to receive their degrees to say they were engineers. However, Daniel's confidence in identifying as engineer, even before he completes his degree is perhaps indicative of a gender bias, in that men are more likely to receive support, and acknowledgment of their accomplishments in engineering compared to women.

Participants also received encouragement by their mentors, professors, and peers to begin thinking of themselves as engineers. Hugo, for example, provided a beautiful show of confidence in noting that he is the first person that comes to mind when he thinks about an engineer. He shares,

> [When asked about what does an engineer look like] Myself… I think had you asked me six years ago, I would have probably gotten someone with the building hat [hard hat] and a pencil and paper. But yeah, what an engineer looks like, I think about myself.

Hugo's account is indicative of the importance of community development in engineering programs. Hugo's interactions with peers and his mentor helped shaped Hugo's identity as an engineer, and even the degree of confidence he has when making this assertion. Hugo's confidence of identity as an engineer is very similar to Daniel's.

In terms of describing what an engineer looks like, practically all participants provided occupational descriptions of engineers. For instance, most descriptions included people working with computer programs, engines, or drafting models. Physical descriptions usually included somebody wearing a hard-hat, holding blueprints, or dressing semi-formal at an office space. Interestingly, there was not a single account of participants describing engineers in terms of race, ethnicity, or gender. Alex's account illustrates the way in which practically all participants defined an engineer.

> If I picture someone saying, "oh, I'm an engineer," I always picture them either working on machines like fixing gears or, I don't know, making everything work perfectly, smoothly, something like that, or in a computer making sense of numbers.

This finding is consistent to participants' views on homogeneity. Participants of this study do not see gender or ethnicity as factors that significantly impacted their own experiences as engineering students. Thus, it makes sense that participants would not use gender or race/ethnicity when describing an engineer. This is also indicative of the emergence of cultural capital, as participants exposure to engineering experiences, such as networking for career advancement opportunities, coursework, research experience, or even part-time experience as an engineer have framed their understanding of themselves as engineers, or at the very least the acknowledgment that they are engineers in the making. Participants all have developed skills, used terms, and gone through similar experiences with peers as it pertains to engineering. Indeed, the presence of peers is very important to participants since they provide different career advancement opportunities, and networks of support.

6.3.2 Engineering: Community

In our conversations with participants, a common theme that arose was the importance of networking with peers for career advancement opportunities and how they are networks of support. Unsurprisingly, it is common for participants to get together to do homework together, study together, and even help each other out with internship or job applications, even if they were competing for the same positions. Hugo describes his "community" as great and denotes the willingness of his peers to look out for each other.

> I think we just had a great community. Everyone brought something different. And we were just always helping each other. We were studying late at night. And even though it was for a different class, it was just knowing that there were other people that you trusted and you appreciated. Another example is we were going for the same interview and for the same position and for the same company. And we're helping each other out.

In a similar sense, Reyna noted how it can actually be easier to make friends in her engineering degree compared to high school. She describes how she and her peers share similar experiences, since they attend the same classes, have the same professors, and go through the same struggles.

> It's been easier to make friends in engineering than it was before in high school. Because in engineering, you're taking the same classes, you're talking about the same stuff. We talk about the same professors, talk about classes, and I think you get the struggle other students are going over like homework, quizzes, exams, and work. Most of my friends work and study at the same time. So, we all understand that role, and I think that just made it easier to connect with people from engineering.

Hugo and Reyna were able to benefit from their peers. Hugo was able to hang out with his classmates and get coursework done together, and even receive help through internships, or job application processes. Reyna noted how in pursuing the same degree as her peers, she was able to empathize with their experiences, noted that they tend to be very similar. Most importantly, both Hugo and Reyna made it known that they feel included in their degrees.

The sharing of similar experiences within these engineering spaces, a form of cultural capital, allows participants to identify as engineers, and feel as though they belong in their degree. More importantly, they embody their engineering degree, be it electrical, civil, or industrial, and carry themselves as if they belong to a team. This creates an interesting instance of competition among engineering programs, which provide the only instances of engineering exclusion that we found in this study. For example, Anne shared that she felt part of her degree, but once she began interacting with students from different engineering degrees, she began to feel a sense of exclusion.

> So far in my classes, I had never… had felt excluded. But when I did research, I was with a masters' student. And the entire team was different, different majors. So I was the only electrical engineer there. And it was kind of difficult for you to gain credibility, especially from that masters' student.

Anne was an undergraduate fast-track bachelor to master student during this experience, so it could be that the graduate student expressed seniority during this situation. Anne also did not share the graduate student's gender or race/ethnicity, which would have been interesting to know more about. Still, what is interesting is that Anne did not feel a need to share that information. She may have adhered to the feeling of "we are all engineers" that others have expressed. However, as Anne notes, there are differences between the larger engineering discipline based on specific degrees, and this was the only time when she felt a sense of exclusion or separation from the larger community.

Community formation is very important to participants, to the point where exposure to their degrees creates a sense of belonging, helps foment engineering identity formation, and provides students with career advancement opportunities and networks of support. As such, when the COVID-19 pandemic struck, this sense of community faltered and it impacted the experiences of participants.

6.4 COVID

All participants of this study had the misfortune of experiencing their mentoring relationships, and the better part of their graduate school – and undergraduate senior year – experiences impacted by the COVID-19 pandemic. Because of the significant influence that the COVID-19 pandemic had – and continues to have – on the world, it is important for me to analyze how participants' experiences as engineering students and mentees were affected during this time. Unsurprisingly, most responses pertaining to COVID-19 had negative connotations, with the lack of social, face-to-face interactions being noted as the main hindrance to full and enjoyable experiences as engineering students.

6.4.1 COVID: Impact

The COVID-19 pandemic proved to be a hindrance for participants in this study. Participants shared that they were unable to completely enjoy their degrees because of the pandemic. As I previously noted, community formation is something that participants valued on par with good mentoring relationships. Hugo, for example, stated how pursuing his master's degree during the pandemic took the fun out of learning, and how he even considered dropping out of the program. He did not feel incapable, but rather had an issue of pursuing a master's degree through online instruction. He comments,

> I think it was just more like, "do I want to keep doing the master's during COVID? Yeah, never in my mind was it more of like, "I don't think I can do this." It was more like, "Do I want to do this?" Learning wasn't as exciting, that personal connection wasn't there for me. That COVID thing took a lot of the fun out of learning.

For Maggie it was an issue of transitioning to online instruction and even difficulty adapting to it. However, she explains that she eventually became accustomed to online instruction. She shares,

> I think the pandemic was really hard. It is really hard mostly because you need to keep living your life and at the same time, there's a lot of people dying in your family, in your friend's family, so it's a lot. At the beginning it was really tough for me because I didn't know how I would be able to keep going with my classes. At the same time, I gained confidence after everything was virtual. There was good stuff. I really like virtual meetings, and I work remote, so that is how it's good.

Maggie expresses many of the concerns that students throughout the larger HSI community were dealing with. For many students it was not only about adapting to online learning, but facing life outside of an academic environment where family and friends were ill and even dying as a result of the COVID-19 pandemic. Further, Maggie went on to note that, although she eventually got used to online instruction, she yearns for the physical presence of her community, noting that despite the best efforts of the program, seeing peers online is not the same as doing so in person.

> [When asked if there was a felt disconnect from peers] Yes because you don't see them. You don't talk to them. You go to class in that set. You went to a meeting and that's it. You don't get to talk to anyone prior or after class. We had team projects and stuff like that where you have to meet, but sometimes, the camera wasn't even on, you know what I mean? You keep texting your friend from here [home], but it's not like you can go to lunch with them or even study together in the library.

Similarly, Andrea and Anne expressed the limitations that the COVID-19 pandemic had on their interactions with peers and mentors. Andrea Turner shared her difficulty with online instruction, noting how she missed being able to attend courses in the classroom and interact with her community in person.

> It was hard because I love going into a classroom and interacting with people and the professor. Being online, it really split the people who I have become close with. It was hard not being able to interact and study with people.

Anne even noted how the pandemic prevented her from getting to better know her mentor outside of research tasks that she had to complete.

> [When asked about if participant has gotten to know her mentors during the pandemic] Yes, but the only downside is that since it's all virtual, I haven't had the chance to get to know them very well or connect with them. Yeah, I know them, but I don't think they even know me in person because they never saw my face. – Anne

Alex went as far as to criticize the MPDE program's efforts to create networking opportunities for the cohorts but noted how the pandemic hindered their efforts.

> [Speaking about MPDE] A big goal of the program was to kind of create this community with professors and students who are working together. And I mean, obviously, you found your place with your mentor and everything. But I've talked to a few different people and they've kind of all said the same thing, the student network wasn't really there, but they've attributed a lot of that to the pandemic.

Despite these obstacles and criticisms, participants were able to accomplish their research tasks and excel in their courses. Nick, for example, shares that he felt that his education did not suffer during the pandemic, and even noted that he was able to accomplish his research goals.

> At least in the classes I had during COVID, I think all the material was pretty well conveyed. So I don't think it put a hindrance on the topics I learned and what I learned. I

> don't really think my education suffered. My mentor was able to support me throughout the pandemic, and I got a lot of my goals accomplished.

The COVID-19 pandemic posed a challenge to mentees and mentors and their ability to communicate. As difficult as it was for participants to initially navigate their education online, their mentors played a key role in making sure this transition was as smooth as possible. Mentors and mentees continued to communicate, and mentees, as in the case of Nick, were able to accomplish their research tasks.

These findings are interesting, in that they reveal that social capital could still be obtained during the pandemic, but for students paled in comparison with the social capital obtained in face-to-face environments. This further reveals the importance of community. It seems as though once students transitioned to the online environment their sense of community weakened or began to falter. Even the assets that come with community formation, such as career advancement opportunities and networks of support, did not have the same impact as when those same assets were offered in person. Nonetheless, and despite these limitations, participants were largely able to accomplish their coursework and research tasks online.

7. Discussion

Taken together, the results provide several indicators that to participants, the value of their mentoring relationships and experiences as engineering students is the exposure to, and experience of engineering itself, which lies in accordance to Fleming's (2016) own findings. Although participants expressed the importance of mentors providing professional advice and recommendations for career opportunities (i.e., internships and job opportunities), good mentorship is not the sole factor in determining underrepresented students' success in engineering degrees. As it turns out, community development is a key factor in determining underrepresented students' success in engineering degrees. Participants spoke on the importance of "getting together" with peers for networks of support. When engineering students converge, they are able to support each other emotionally, as they go through similar academic experiences, and they are able to support each other with homework assignments, study sessions, final projects, and research projects. Further, it is through community development that students are able to support each other professionally, as plenty of networking opportunities for career advancement stem from interactions with peers, just as much as networking opportunities from interactions with mentors. Professional support is actually expected, as Andrea Turner's and Hugo's experiences show, as students actively seek out students who are already employed by a company, or currently participating in an internship. Additionally, students will help each other out with job and internship application processes, even if students are competing for the same position.

Nevertheless, mentoring relationships are still very important in the development and success of engineering students (Kaul et al., 2015). A noted takeaway among participants is their mentor's ability to provide professional support. Students spoke fondly of mentors who helped mentees make career decisions, provided advice on internship or job applications, and outright "opened doors" to internship and job opportunities. Daniel Ray, for instance, was moved in the way his mentor met with him in short notice, and held a two-hour meeting where his mentor provided advice on what degree Daniel Ray should pursue. Underrepresented engineering students also sought out professors who shared similar interests to students, or were currently working on a research project. Actually, within engineering student groups, engineering students asked peers for recommendations on what professors to seek out for research projects, and potential mentorship relationships. Not all underrepresented engineering students sought out a mentor, as some were assigned their mentor by a third party, such as the MPDE program, and others were reached out by professors, mostly through class but also just by hanging out in the departments' lounge. Regardless of how participants were introduced to their mentors, participants were grateful of getting experience doing research projects and internships, as it is through these activities that participants got a "taste" of the occupational aspect of being an engineer.

In addition to providing professional support, underrepresented engineering students look for mentors that keep consistent communication, but afford their mentees independence. Most participants noted the importance of mentors who were "hands-off". Nick, Hugo, Alex, and Maggie Scott, for example, all spoke positively on their mentors' lenient approach to mentorship, noting that they did not enjoy being micromanaged, or thought no need to meet with mentors daily or even weekly. Underrepresented engineering students do not want to be left "hung out to dry," as they consider consistent communication with their mentors important. Although students do not feel it is important to meet with their mentors in person frequently, they hope to keep a steady stream e-mail exchange or text messages for instructions on research projects, and updates on research tasks. Keeping these traits in consideration, underrepresented engineering student's interactions with their mentors were mostly positive. There were two noted experiences that were not optimal for participants, such as the case of Anne Davis and her mentor's disconnection, or Reyna's mentor who was new to the program and thus getting the "hang" of being an educator and a mentor. Nonetheless, participants showed satisfaction at their mentors' ability to provide professional support in the form of advice and career opportunities, and their mentors' ability to provide lenient oversight of their research projects, while staying in contact through text messaging and/or e-mails. Just as important, participants showed gratitude to getting occupational experience as engineers through research and internships.

Indeed, as it pertains to mentorship, underrepresented engineering students place more value to practical traits as opposed to social categorizations. Participants, above all else, wanted to get engineering experience, and mentors who afforded participants the opportunity to get their "feet wet" in engineering sufficed the expectations that participants had on their mentors. In contrast, background homogeneity between mentors and underrepresented students was not considered a significant factor in determining good mentorship, or in determining underrepresented students' success. The context of these responses is interesting, as participants noted it was not important to them to have mentors who "looked like them," but felt it is important to diversify faculty to create homogeneous mentoring relationships for other students. For example, Anne Davis, Reyna, Sarah Green and Sophia Roberts, noted how refreshing it is to see women in engineering positions, and how they even feel more comfortable approaching a woman professor as opposed to a man professor. Additionally, for these participants, it is easier to look up to a woman professor as a role model, as they see these women as living embodiments of perseverance and that they "can also make it." Nonetheless, these participants also noted more value to their mentors – who were male – ability to provide engineering experience, except for Reyna mentor who was barely getting used to his role as a mentor. It is interesting to note that, across the board, participants placed more relevance to gender diversity in faculty (and thereby mentoring relationships), as opposed to racial/ethnic diversity. I attribute these perspectives to the fact that participants attend a HSI, which provided a unique environment where participants were not racial/ethnic minorities. It must be noted, however, that although most participants did not feel racial/ethnic or gendered prejudice at HSI, participants began experiencing instances of discrimination at internships and jobs. The case of Alex stands out as she had no unpleasant experiences at school, but started to feel prejudice at work when her male co-workers did not take her seriously for months. As it pertains to school though, men participants of this study spoke with respect and admiration of their women peers, and women participants in the most part reported no negative interactions, often speaking positively of their men counterparts as well.

In revisiting Bourdieu's theory of capital, it is true that there is social and capital gain abound in the engineering departments that participants attended. As noted, networking occurs often and is essential for underrepresented students' success in their engineering degrees. Unsurprisingly, participants embody their identities as engineers within these fields. Whether in electrical, or industrial, or metallurgical engineering departments, participants view themselves as engineers or as engineers in the making. Given underrepresented engineering students' value for practical traits in their mentoring relationships, they also define the "image" of an engineer in the practical and occupational sense. Most participants identified engineers as a person wearing a hard hat, working with computer programs designing or reviewing models, or working with machines in some laboratory or garage. Not one participant identified an engineer in terms of race/ethnicity or gender. In fact, Hugo remarkably said that, when he thinks of the image of an engineer, the first thing that comes to his mind is himself. In a similar sense, most participants already view themselves as engineers by virtue of being in an engineering program, being encouraged by their mentors and professors to think of themselves as engineers, and by virtue of the education they have received in their respective programs. Daniel Ray made note of this, as she mentioned that although she has not finished her degree, she felt that her education was on par of that of a working engineer. Other participants identified as engineers in terms of experience; some participants noted that they were only engineers if they held a job as an engineer, or if they finished their degrees. For instance, G-Kid considers herself "almost" an engineer, as although she has gotten occupational experience through internships and research, she is yet to find a job as an engineer.

As noted, for participants the most important aspect of their mentoring relationships and their experience as engineering students is the exposure to engineering itself. Participants even defined the image of an engineer in a practical and occupational sense. Thus, when the COVID-19 pandemic struck, many students felt disheartened by taking their education online. Compared to other disciplines, engineering is very "hands-on," in that engineering students work with machines or computer programs mostly available on campus, and rely heavily on the face-to-face interactions with their peers. As it was noted by most participants, pursuing an engineering degree online "took out the fun" of learning, and this feeling was further exacerbated by the inability to work in the laboratories available at HSI. Furthermore, during the height of the pandemic, students yearned for in-person interactions with their peers, as they felt that, although Zoom conference calls were effective in conveying information and communication, they were simply "not the same" as being in person. The MPDE program attempted to create networking opportunities for their students (mostly in the sense of having participants interact with one-another remotely), but their attempts were criticized by participants for being inconsistent and restrained by the pandemic itself. Despite the effect of the pandemic, students were still able to carry on with their education, stay in touch with their mentors, and even complete research tasks remotely.

8. Study Limitations

This study is limited due to its sample size and largely Hispanic sample pool. Although this study focuses on the experiences of underrepresented students, participants of this study attend a Hispanic Serving Institution (HSI), meaning that in this environment they are not ethnic minorities. In fact, as of the Fall Semester of 2021, 84.8% of undergraduate students in this institution identify as Hispanic. Thus, it is important to note that our participant's experiences may have been different than that of other students pursuing engineering degrees in different institutions. Nonetheless, women, which comprise most of my sample, are a notable minority at HSI's college of engineering, wherein 21% of engineering undergraduate students identify as female, compared to 79% that identify as male. Still, a larger sample of students, including underrepresented engineering students outside the MPDE program or from different universities would have enabled me to consider further differences in the experiences of students with different demographics.

The main disadvantage of qualitative methodology is that findings cannot be extended to wider populations with the same degree of certainty that quantitative analysis can. This is important to note since this study is made up of a convenience sample of participants that are members of a mentorship and professional development program, which limited the sample size to 10 participants. However, this study is concerned in learning more about underrepresented engineering students' own perspectives on their mentoring relationships and experiences as engineering students. As such, generalizability was not the purpose of this study.

Another limitation of this study is the fact that it took place during the COVID-19 pandemic. The lack of face-to-face interactions between participants with their peers, mentors, and professors impacted their experiences as engineering students. Although the pandemic was beyond anybody’s control, it would be beneficial to collect data at a time where students are fully integrated back to in-person education to get a better sense of their mentoring and student experiences. Furthermore, it would have also been beneficial to interact with participants in their “fields” to get a first-hand account on what its like to be an engineering student. I believe an ethnographic approach could have added more depth to students’ perspectives on mentoring, and their experience as engineering students. Indeed, the pandemic made it very difficult, if not outright impossible to take this approach. Moreover, although my research team met every two weeks through Zoom, and kept in contact through text messaging, I think the data collection and analysis of this project could have been improved if we had done in person. I think feedback and collaboration could have been more immediate and precise in person, compared to how it was through an online setting.

As noted, this thesis is part of a larger research project, meaning that data collection was done by three different researchers (including myself) with varying degrees of research experience, and in different settings. Although most interviews were conducted through Zoom, the physical setting of participants and researchers alike, along with the varying levels of experience of the researchers, may have influenced the interaction between researchers and participants. Thus, the responses collected for this project may have been influenced. Finally, data analysis for this study was only conducted by myself. It would have been beneficial to have multiple codes for the same data in order to pick up any nuances that I may have missed during the coding process.

9. Conclusion

Before more engineering programs continue to diversify their student populations through mentorship and professional development programs, they must get a sense of what makes good mentorship directly from underrepresented engineering students. Bourdieu's theory of capital enabled me to understand the abundance of social and cultural capital that exists within engineering programs. Participants of this study relied on their peers and mentors for career advancement opportunities, which is in itself a form of social capital, and all were able to identify as engineers to some extent in a practical and occupational sense, which is a form of cultural capital. To my surprise, the social categorizations of race/ethnicity and gender did not play a significant factor in acquiring social and cultural capital. As such, the use of critical race theory for this thesis is better applied to a project with a larger, and more diverse sample size, as the background of participants of this study is largely homogeneous. Nonetheless, the experiences of my participants provide a valuable glimpse into what makes an ideal mentor to underrepresented engineering students. My thesis aligns to the findings of Fleming's (2016) own study, in that underrepresented engineering students value the "engineering aspect" of engineering. Underrepresented engineering students, like all engineering students, frankly, desire to make connections with peers and professors for research, internship, and job opportunities. Furthermore, underrepresented engineering students desire to obtain occupational experience in their degrees. Although participants of my study did not personally yearn for homogeneous mentoring relationships, they endorsed the inclusion of more women into engineering education and occupations. In other words, underrepresented engineering students largely define an ideal mentor as the one that allows mentees to be engineers, regardless of their own race, ethnicity, or gender, and regardless of their mentor's own race, ethnicity, or gender.

This means that, above anything else, mentorship and professional development programs aimed at diversifying engineering programs, must foment underrepresented students' ability to feel and identify as engineers through networking, and occupational opportunities. Granted, future direction of this project should consider a larger and more diversified sample to get a more solid answer as to what makes an ideal mentor. Nonetheless, I believe this study provides a good foundation in understanding, and showcasing the experiences of underrepresented engineering students, of which current and new mentors should take keen attention to. In listening and understanding these experiences, I believe mentorship and professional development programs will be informed, and be better able to create more effective recruitment, and most importantly, retention efforts for underrepresented engineering students.

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11. Vita

Sergio Alexeiev Armendariz was born in Chihuahua City, Chihuahua, and later moved to El Paso, Texas at 13-years-old. Armendariz began his college education in the fall semester of 2016 at The University of Texas at El Paso (UTEP), where he received his B.A. in Political Science with a minor in Sociology in May of 2020. After graduating with his Bachelors, Armendariz began the Master's program in sociology at UTEP in the fall of 2020. As a graduate student, Armendariz worked as a teaching assistant for Dr. M. Cristina Morales and Dr. Aurelia Lorena Murga, and as a research assistant for Dr. Danielle Morales. Armendariz will continue pursuing his graduate studies in the fall of 2023, as he will take a year to gain teaching experience as a lecturer.

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