COMPLEX CULTURAL IDENTITIES AND STEREOTYPE THREAT: AN INTEGRATIVE MIXED METHODS STUDY

By

Amalia Krystal Lira

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ABSTRACT

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A growing body of research in educational psychology points to the particular importance of examining identity processes in educational settings, especially those situated in racialized and gendered experiences. Given that identity development is impacted by social-cultural and contextual factors, it is also important to consider how perceptions about one's environment can lead students to develop adaptive or maladaptive beliefs about "who they are." As such, examining stereotype threat, in combination with multiple identities, is important for understanding how to support positive identities, especially among traditionally marginalized groups, and increase engineering achievement and persistence. I employed an explanatory sequential mixed methods design and collected quantitative data from N = 169 Black students and interviewed a subsample of 15 students. A latent profile analysis was used to identify unique identity/stereotype threat profiles, including a Low Engineering, Gender Stereotype Threat, and Moderate Ethnic (Profile 1); Moderate-High Identities, Ethnic Stereotype Threat, and Low Gender (Profile 2); and High Identities and Stereotype Threat (Profile 3). Profile membership varied as a function of gender and year in school, with women and underclassmen most likely to belong to Profile 3. Profile membership predicted engineering career intentions, with students most likely to be in Profile's 2 and 3 endorsing stronger intentions to pursue a career in engineering than those most likely to be in Profile 1. Follow-up interviews suggested profile-specific themes and triangulation was employed to further contextualize students' experiences.

To my mother, Amalia, my partner in life, Kenny, and my Angel, Artemio.

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Chapter 1:

Introduction

Despite decades of research aiming to increase diverse perspectives in engineering, inequities within the field of engineering continue to exist for Black[1] individuals within higher education contexts (Ladson-Billings & Tate, 1995). In fact, Black individuals have historically earned a fraction of the awarded engineering degrees in the United States. A recent statistic noted that, in 2018, Black students earned only 8% of engineering bachelor's degrees, despite representing approximately 14% of the broader U.S. population (National Science Foundation, 2018). Moreover, gender inequities also exist between men and women, with men largely overrepresented in the engineering workforce. In 2018, women only earned 22% of engineering degrees, despite representing 51% of the U.S. population (Humes et al., 2011; Yoder, 2018). Researchers have seen increases in engineering degree attainment over the past few decades, but progress has stagnated, as currently there are less than 0.1% yearly increases in degree attainment among Black students (Yoder, 2018). This is a central issue in the U.S. because a lack of racial and gender diversity in engineering fields perpetuates cultural and economic marginalization of Black individuals. Additionally, it limits the scope of who contributes to innovation in the field of engineering. The value of increasing diverse perspectives in the field of engineering is to better serve an increasingly diverse U.S. population and promote engineering progress through inclusion of individuals from varying backgrounds, upbringings, cultural norms, and values.

[1]In extant research, Black and African American are often used interchangeably, however, I chose to use the term Black to refer to the population of students under study given my primary focus on ethnic identity. Particularly in the qualitative results, I used African American or Black to be consistent with student voices.

There are several potential reasons for these persistent disparities. Unfortunately, much of the research within educational psychology has used deficit-based frameworks to explain this by portraying Black individuals to be low achieving, incapable, and at-risk of failing (Kim & Hargrove, 2013). However, systemic forms of oppression and marginalization suggest that limited racial diversity in engineering may be because, as a field, it is not racially inclusive and supportive of diverse individuals' needs and ideas. Indeed, research suggests that students in engineering experience issues with racial climate, such as negative interactions with professors based on race and gender (Anderson & Kim, 2006; Bernold et al., 2007; Hurtado et al., 2011). Science, Technology, Engineering, and Mathematics (STEM) fields have a history of being "White-centric" career paths that have the potential to create racially biased, discriminatory, and stereotypical experiences for Black students. These inequities have contributed to an oppressive system of disproportionate success for White students. Psychologists have questioned how to increase engineering degree and career attainment among Black individuals and have studied these phenomena through examination of psychological mechanisms and sociocultural contexts. Additionally, Critical Race Theory has recently been used as a guiding framework to interrogate individual and systematic forms of oppression and racism, which are central components in thinking about the history of Black individuals within the U.S. education system (Crenshaw, 2016).

These racial disparities in engineering have been examined within the field of psychology and education using identity-based constructs, such as racial/ethnic identity, and race-and-gender focused constructs such as stereotype threat (e.g., DeCuir-Gunby & Schutz, 2014; Fong et al., 2018). The affordance of using race-and-gender related constructs is to center racialized and gendered experiences that that can allow researchers to draw well-informed conclusions based on

these characteristics. Additionally, identity-related constructs provide a meaningful understanding of student persistence given that a positive and clear sense of self is related to positive academic and persistence outcomes (Eccles, 2009).

This dissertation study takes an explicit race-and-gender focus and employs a mixed-methodology by relying on both quantitative data and personal qualitative stories from Black engineering students. Specifically, I examine ethnic identity (the beliefs and attitudes about one's ethnicity based on known membership of an ethnic group; Phinney, 1992), and stereotype threat (the anxiety felt based negative perceptions and stereotypical judgment in a field or domain based on race or gender; Steele & Aronson, 1995) to study persistence and achievement of Black engineering students. Extent research suggests that these race-and-gender related constructs may positively or negatively predict persistence in STEM fields (e.g., Chemers et al., 2011; DeCuir-Gunby, 2020); these mixed findings help to highlight that there is much to learn about the complex nature of these constructs. For instance, a student's ethnic identity may be positive and salient making it serve as a protective factor (or buffer) in the face of race and ethnicity conflict in college (e.g., Martinez & Dukes, 1997; Wong et al., 2003). On the other hand, others positive sense of ethnic identity may serve as a barrier to their success because of the incongruence between their identities such as their domain identity (Settles, 2004). Indeed, understanding how students identify with the field of engineering (i.e., engineering identity, Carlone & Johnson, 2007) adds another layer of complexity, given that one's domain identity may interact with the racialized-and-gendered experiences of students of color and women.

To move the needle on understanding how to diversify engineering fields, it is especially important to focus on multiple aspects of one's identity. Studies that have focused on identity to address engineering persistence often concentrated on one aspect of identity, despite the

intersection of multiple identities in the lives of minoritized students (Cole, 2009). Given that identity is multifaceted, and individuals can value various social identities, such as their race, gender, career path, and familial ties, it is important that identity is examined using intersectional approaches. As such, this study uses a person-oriented approach and draws from intersectionality to study aspects of ethnicity and domain identity in engineering, but also the experiences of both gender and ethnic stereotype threat. A person-oriented approach centers the individual in the analysis and focuses on groups of individuals that have shared membership in profiles based on constructs of interest (e.g., Van Soom & Donche, 2014). In studies that use Critical Race Theory as a guiding framework, person-oriented methods align with the goal of centering the experiences of individuals and systems among those individuals. It also allows me to examine heterogeneity of experiences for individuals from one ethnic group.

In addition to the constructs and theories studied in educational psychology, there are gaps in the methods used to study the experiences of Black engineering students, as quantitative studies historically have taken priority in educational psychology. Other methodologies such as qualitative research and mixed-methods studies have historically played a less central role in examining phenomena, despite the affordances of these approaches to developing deep understanding of phenomena through storytelling and narratives (McCrudden et al., 2019; White et al., 2019). Thus, for my dissertation study, I employ a multi-theoretical and mixed methods approach for investigating how multiple forms of identity and experiences with stereotype threat relate to engineering achievement and persistence to better understand how to support engineering persistence at the undergraduate level.

This study also has implications for the field of psychology more broadly and for improving research practices to use asset-based methods and theories. Too many studies have

drawn from the experiences of minoritized students using deficit-based frameworks and have used race-and-gendered constructs by "controlling for them" as a secondary construct or creating inexact group comparisons that have inaccurately reinforced notions of power and privilege in engineering fields. For instance, studies have used race as a predictor variable to compare Black and White engineering students, which has served to elevate the successes of White students and highlight the "underachievement" and "underperformance" of Black students. Thus, this dissertation is key for broadening our understanding of Black engineering students' identities and experiences to better support the future generation of Black engineers.

Chapter 2:

Literature Review

"Identity permits us to think about the interconnectedness of the individual and the world." - *James Paul Gee (2000)*

This dissertation study is a multi-theoretical study that draws from a number of sociocultural and race-and-gender focused theories to examine engineering persistence and achievement through multiple identities and stereotype threat. As such, I draw from the following theoretical perspectives: Critical Race Theory (CRT; Ladson-Billings & Tate, 1995), Identity Development Theory and Social Identity Theory (Erikson, 1968; Tajfel & Turner, 1979), stereotype threat (Steele & Aronson, 1995), and intersectionality (Crenshaw, 1991). In the following sections, I describe how these theoretical frameworks inform my work and review the empirical literature of ethnic and engineering identities, as well as stereotype threat, on outcomes such as persistence and achievement.

Critical Race Theory

There is an urgent need for social and racial justice in education, and society more broadly. This urgency in research has led many fields, such as psychology and education, to move the needle towards critically assessing racialized experiences within and beyond educational contexts, with a focus on educational equity and anti-racism (e.g., DeCuir-Gunby & Dixson, 2004; Usher, 2018). Indeed, research that exposes and challenges systems of oppression, such as those within academic structures, is important for driving discussion and enacting reforms. In research practices, a critical race lens can be used to center and elevate the voices and experiences of marginalized individuals within work that strives for educational justice.

CRT posits that race and racism influence mental, physical, and emotional processes through the presence of racism in social, economic, and political institutions in the United States (Bell, 1992; Crenshaw, 1991). Originally conceptualized within legal studies and based on the work of scholars like Derrick Bell, Richard Delgado and Kimberlé Crenshaw, CRT was used to critique racial injustices in the law and within the general bounds of society (Delgado & Stefancic, 2017). Coupled with fields like ethnic studies and feminist studies, CRT includes an activist aspect which is to not only critique injustice, but to lead to concrete social change and impact broad advocacy and activism.

CRT has five general tenets, though there are disagreements among scholars regarding attention to specific tenets in their respective work (Bell, 1992; Crenshaw, 1991; DeCuir-Gunby & Schutz, 2014). First, race and racism are endemic and embedded in the social fabric of our institutions, often referred to as *"racism permanence."* In his seminal text titled *Faces at The Bottom of the Well*, Derrick Bell stated that "racism is an integral, permanent, and indestructible component of this society" (p. 4). However, he extends his argument on race permanence as a call-to-action suggesting that the "fight for racial justice" must continue despite the endemic nature of racism. The second tenet is the need to elevate through storytelling the omitted counter-stories of individuals who have been historically marginalized. Third, race neutrality (originally referred to as "colorblindness"), neutrality of law and meritocracy, and incremental change are problematic ideas that serve to perpetuate oppression. Fourth, basic rights for people of color were enacted in the interest of White individuals. This is known as "interest convergence" and assumes that White individuals must mutually benefit from laws to remain in high social strata. Lastly, intersectionality and multiple identities should be considered in research practices. While CRT was originally created in the context of legal scholarship, it was further expanded in 1995

by Ladson-Billings and Tate who conceptualized the notion of CRT within educational contexts, explained below.

Critical Race Theory in Education. Within education, CRT helps expose how curriculum and institutional structures of schools themselves conserve and reproduce White norms as a representation of the epitome of American life. Ladson-Billings and Tate (1995) specifically theorized a Critical Race Theory in Education to explain race and school inequity, in large part to challenge the narratives and discourse in education regarding students from minoritized groups, as these stories have often been rooted in prejudiced practice and used to subordinate students of color (Solorzano, 1998). Ladson-Billings and Tate (1995) theorized CRT in education under three main tenets. The first tenet is that race is a significant factor in determining inequity in the United States. This tenet speaks to the gross inequalities that are based on race, both within the bounds of educational contexts and beyond them. For instance, scholars argue that the use of high stakes standardized testing and oppressive disciplinary actions unfairly disadvantage and criminalize students of color, especially Black women (Au, 2016; Love, 2016; Morris, 2016). Second, U.S. society is based on property rights and Ladson-Billings and Tate (1995) suggest that this is due to a history of *race as property* and *access to property based on race*. A historical connection of African peoples as slaves and societies' commitment to protecting property beyond human rights has created a cycle of what CRT describes as *whiteness of property*. Importantly, given that property is said to be a "right," Whiteness in this case not only manifests as a self-identity but also as an external property in the public and legal sector. Lastly, they posit that intersection of race and property can be used as an analytical tool for addressing school inequity (Ladson-Billings & Tate, 1995). Building on Crenshaw's (1991)

concept of intersectionality, Ladson-Billings and Tate (1995) highlight how race, gender, and class merge to marginalize students in schools.

Ladson-Billings and Tate (1995) discuss how the history of racism in the U.S. has led to the discrimination and lack of opportunities for the success of people of color. Within the field of education, critical race theorists have worked to challenge and disrupt racism in educational theory, practice, and pedagogy (Howard & Navarro, 2016). Indeed, Ladson-Billings and Tate (1995) suggest that ineffective "institutional reimagination of schools" demonstrate the failed attempts of civil rights law, such as Brown v. Board of Education and the sustainability of ideals like neutrality, objectivity, and colorblind meritocracy. Additionally, they suggest a harmful discourse of Black students as being low achieving, engaging in devious behavior, and potentially needing special education or additional educational support upholds injustice and inequity in the academy. Similarly, studies have taken a "neutral lens" which have also perpetuated colorblind policies that are created at the expense of normalizing school cultures of anti-Blackness. Similarly, through a CRT lens, the school curriculum which is thought to be neutral, and objective may also be a site of racialized violence in schools based on the erasure of histories of Black individuals. Importantly, CRT work is also based in social justice activism, such that outcomes of CRT literature are intended to challenge systemic inequities and strive for social justice in contexts.

CRT has long been a central framework in fields such as Education and of course Critical Legal Studies. However, in Educational Psychology, CRT is recently gaining attention as an important theoretical framework, particularly due to the affordances it provides for interrogating race and racism in educational contexts. The field as a whole is currently being pushed to consider critical frameworks and to *intentionally* examine the experiences of students of color,

instead of focusing on majority and minority group comparisons, as one example (e.g., comparing White students to students of color; DeCuir-Gunby & Schutz, 2014; Usher, 2018). Within this multi-theoretical study, Critical Race Theory (CRT) provides a worldview for examination of *identity* and experiences in engineering with the goal of both enhancing student persistence among Black men and women and contributing to the broader literature aimed to obtain equity and justice in education.

Although CRT has several tenets that are all valuable, and all important for engaging in CRT work, I primarily draw from three tenets in this work, including *race permanence, counter-storytelling, and intersectionality*. Particularly in educational contexts, race permanence effects the lived experiences of Black students, and both counter-storytelling and intersectionality afford the opportunity to draw from the lived experiences of Black students in engineering broadly, but also unique experiences that are at the intersection of racial and gender oppression. I also use critical-race theory to focus on asset-based recommendations and interpretations that do not serve to uphold systemic educational inequities.

Conceptualization of Identity

To answer the question *What is identity?*, one may think about someone reflecting on the questions *Who am I?, What am I about?, and What is my place in my social group?.* As someone who studies identity, I have reflected on these questions quite a bit and have recently found myself answering these questions as: "I am a Latina woman, a scholar and educational psychology researcher, and a student and teacher." Before discussing the theoretical aspects of identity, it is important to acknowledge that identity is multilayered and the question, *Who am I*?, is not particularly something that one can fully address in a single study. Thus, I strive to understand parts of one's identity and begin examining them, with full acknowledgement that I

do not address the full complexity of the individuals in this study. Furthermore, individuals will also ask themselves, *How/Where do I see myself in the future?,* and this speaks to a fluid and ever-changing sense of self relative to goals and aspirations that an individual has. Within the STEM literature, there has been a strong value and emphasis in literature that aims to improve training of students but it's important to examine how students *see* themselves within STEM domains (Collins, 2018).

Erik Erikson was a prominent identity theorist who developed Identity Development Theory, which posits that identity formation is a developmental process that is influenced by the individual processes (e.g., internal psychological processes) and their social environment (e.g., relationships). Erikson (1968) proposed that individuals strive for coherence among their multiple identities, given how important identities are for academic success and persistence. In terms of the social influence of identity development, adolescents engage in "psychosocial reciprocity," such that they lean on their peers and their social environment to help shape their identity. Erikson (1968) suggested that peers shape one another's identities by acting as role models and providing very personal social feedback. While Erikson (1968) originally theorized that identity development begins in infancy, one's sense of personal identity forms in adolescence and continues to be shaped by various factors beyond adolescence. That is, identification evolves and shifts over time, and the development of one's sense of self is important for leading to ideas of who one wants to be in the future (Erikson, 1968; Phinney, 1996).

Identity development is on a continuum of self-conceptualizations, ranging from personal identity to social identity. While personal identities are those that serve the purpose of making an individual feel unique such as values, goals, and aspirations, social identities are those situated in

a larger social structure such as race, gender, religion, family, and one's domain (Eccles, 2009; Gonzales-Backen et al., 2015). Tajfel (1978) defines social identity as "that part of an individual's self-concept which derives from their knowledge of his membership of a social group together with the value and emotional significance attached to that membership" (p. 63). Tajfel (1978) further theorized that the sense of belonging to a social group provides individuals with the opportunity to situate themselves in their social world, which leads to positive feelings towards themselves and their group and can help individuals make sense of ingroup and outgroup relations (Graham, 2018). Given that there are several social identities with which individuals identify this process is a developmental task that occurs across various domains. For instance, Tajfel and Turner (1979) suggest that race, ethnicity, and gender are among the most salient social groups, but other social groups such as religion, sexual orientation, and occupation are also important for individuals' sense of self. Moreover, Tajfel (1981) suggested that when a social group is marginalized, such as an ethnic and racial minority group, members of the group are likely to strongly identify with those groups, which leads to the greater likelihood of being negatively impacted by stereotypes and discrimination. In the present study, I draw from Tajfel and Turner's (1979) conceptualization of social identity by considering group belonging and relevance to self-concept based on group membership for *ethnic identity and engineering identity*. In the next section, I provide a conceptualization of both forms of social identities (ethnic identity and engineering identity), review the literature that has examined these constructs, and then discuss their role as multiple identities and to explain intersectionality.

Ethnic Identity. In this dissertation study, ethnic identity is conceptualized based on Phinney's (1992) notion of ethnic identity as being "an aspect of a person's social identity that is part of an individual's self-concept that derives from his or her knowledge of membership in a

social group (or groups) together with the value and emotional significance attached to that membership" (Phinney, 1992; p. 156). Phinney (1992) further conceptualized ethnic identity as an individual's development from a state of limited awareness or disinterest for their ethnic group to a state of commitment where individuals may develop a clear understanding of their ethnicity and value of that group membership as part of their ethnic identity. Ethnic identity was originally operationalized as self-identification and ethnicity (i.e., through self-categorization), ethnic behaviors and practices, degree of exploration, and degree of commitment. However, Phinney and Ong (2007) revised their measure years later and suggested that ethnic identity is composed of achievement and belonging. Achievement is individuals' search for the personal value of their ethnic background and participation in cultural practices, whereas belonging refers to positive feelings towards one's ethnic group and a clear sense of commitment (Phinney & Ong, 2007).

When Phinney (1992) originally theorized about ethnic identity, she assumed that it may not function similarly across multiple groups and that it varied on a continuum from strong to weak. Indeed, Phinney (1991) stated that when individuals have high ethnic identity salience, they consider themselves to be "group members, evaluate their group positively, prefer or are comfortable with their group membership, are interested in, knowledgeable about, and committed to the group, and are involved in ethnic practices" (p. 194). On the other hand, if individuals have weak ethnic identity salience they engage in "little ethnic interest, knowledge, commitment, or involvement, and negative evaluation of the group and of one's membership in the group" (Phinney, 1991; p. 194). She further pointed out that ethnicity may not be as salient for White students as it is for students of color, as minoritized students experience differential treatment in society based on their race, including racism, discrimination, and prejudice. As such, ethnic identity may play an important role in the development of student's experiences and

pursuits within the academy, especially for students who identify as Black in predominantly White institutions.

In my discussion of Black identities, it is important to outline the distinction between race and ethnicity in a U.S. context and within the context of this dissertation study. In the U.S., race and ethnicity are two unique social constructions that were designed to segment individuals based on several determined factors, such as skin color, physical features, or cultural practices. Dating back to the 1400's when western Europeans began a global expansion into places like Africa, Asia, and the Pacific, a "recategorization" of people and spaces took place and the development of racial categories and race ranking began (Sanjek, 1996). While these initial racial categories were similar to modern conceptualizations of race (e.g., Black, White, Asian), racial ranking was based on an imperialist view of a hierarchy of races that suggested some races were simply inferior to others (Sanjek, 1996). Additionally, race was deemed both scientifically and biologically significant during that time, but today most social scientists agree that race is a social construction and not indicative of factors such as IQ and physical abilities. However, the remnants of race as "biology, hierarchy, and superiority" still permeate our society as we continue to experience racial injustice within communities of color. Additionally, race does not operate alone but along other heterogenous identities such as gender, class, sexuality, and ethnicity. Ethnicity often overlaps with race and within this dissertation I argue that they are unique contexts but can be studied within the same study as they often intersect in the lived experiences of people of color.

Helms and Talleyrand (1997) posited that race is not ethnicity. Instead, ethnicity is a social construction based on a set of shared social, cultural, and historical experiences to an ethnic group, whereas race is a social construction that has no biological basis and is used to

reinforce systems of oppression (Banks, 1995). I pull a definition of racism from feminist scholar Audre Lorde (1992), in which she defines racism as "the belief in the inherent superiority of one race over all others and thereby the right to dominance" (p. 19). Within the sociology literature, researchers discuss the history of ethnicity in the U.S. and contend that ethnicity has historically been used to characterize the sociocultural experiences of Europeans and Asians, and more recently Latin Americans (Taylor, 1979). Namely, there is a disconnect between the ethnogenesis, or development of an ethnic group, of Black Americans and other immigrant ethnic groups in the United States. Myrdal (1964) further suggests that, during enslavement, Black individuals were subjected to extreme deculturation, and this led to a unique culture preservation distinct from "American culture." For the purposes of this dissertation, I choose to discuss both race and ethnicity (not race/ethnicity) by acknowledging that they are distinct measures that are both important for the context of this work. Towards this end, I quantitatively study ethnic identity and ethnic stereotype threat and qualitatively study experiences related to both race and ethnicity. It is especially critical to consider how race and ethnicity as unique constructs lead to a Black, African/Afro-American, and/or African identity, given the ethnogenesis and racialized history of these groups in the U.S. As a result, ethnicity is studied among Black students only in this dissertation given the acknowledgement that interpreting ethnicity and ethnic identity in a multigroup context could potentially lead to inaccurate and harmful conclusions of Black folx.

Given the focus of this dissertation on Black engineering students, it is also important to consider the unique ways in which Black identity has been conceptualized in the literature. In a seminal text, Hecht and Ribeau (1991), describe a "dynamic Black identity" and argue that within the context of the U.S., Black individuals have been faced with unique challenges in their

identity development. Indeed, they suggest that "Black identities may be rooted in many different ways of defining self, such as biology, social interaction, and developmental processes" (Hecht & Ribeau, 1991, p. 502). For instance, social interactions in the form of language, may be used as a tool of resistance that shapes one's ethnic identity. Indeed, in educational contexts, language has the power to either positively reinforce or harm one's sense of self. Given this, there are several ways Black identity has been studied and conceptualized, which I draw from to inform my interpretation of ethnic identities among Black students.

While I draw from Phinney's conceptualization of ethnic identity, as noted above, it is also important to highlight the ways in which areas like Sociology, Ethnic Studies, and Africana/Black studies have conceptualized Black identity, as they inform my qualitative analysis of race and ethnicity. Notably, two prominent theoretical frameworks used to study Black identity are Theory of Nigrescence and Black Racial Identity. Cross's 1971 theory of nigrescence was developed to describe the various ideologies of Black identity that African American people may have. In 1991, Cross revised the model as a stage model that described the various stages of Black identity development. The revised 1991 theory comprised of four unique stages including Pre-Encounter, Encounter, Immersion–Emersion, and Internalization. In the Pre-Encounter stage, Black individuals may experience *assimilation* (a stronger connection to being American as opposed to being Black; being pro-American) and *Anti-Blackness* (self-hatred due to one's Black identity and miseducation and acceptance about negative stereotypes about Black individuals). The Encounter stage depicts the experience of an event or series of events that drives individuals to reevaluate their social group membership. In the Immersion stage, individuals who have experienced cognitive and emotional distress in the Encounter stage will then experience *Anti-Whiteness* (negative responses and rejection of Whiteness) and Intense

Black Involvement (immersion and adherence to Afro-centric values). Finally, in the Internalization stage individuals form Black acceptance and engage in activism.

As an alternative perspective, Sellers et al. (1998) originally defined Black racial identity as "the significance and qualitative meaning that Black individuals attribute within their self-concepts" (Sellers et al., 1998, p. 23). Moreover, it was conceptualized as both a situationally dependent and a stable-within-person identity. Sellers and colleagues (1998) operationalized Black racial identity as being composed of racial salience, racial centrality, racial regard (public and private), and racial ideology. Racial salience refers to the degree that racial membership is important for one's self-concept. Centrality refers to the stability by which one identifies themselves in regard to race. Racial regard describes both positive and negative feelings towards being Black. Lastly, ideology refers to individuals' broad feelings, beliefs, and perceptions of what it means to "be Black" and act accordingly.

In contrast to Cross's (1971, 1991) and Sellers et al.'s (1998) specific focus on the identity of Black individuals, Phinney's (1996) conceptualization of ethnic identity is based on a broader "universal" ethnic identity given that it was designed to consider multigroup ethnic identities, such as those of Asian-American, Black, Mexican American individuals. For the current dissertation, I rely on Phinney's broader conceptualization of ethnicity identity, focusing on the conceptualization of Black students' ethnic identities based on the dimensions of achievement and belonging. While I am not measuring either Seller's or Cross's constructs, I do draw from these perspectives when interpreting the findings given that both exclusively are based on Black student populations. I draw from past research that has used their perspectives in the study of Black student's ethnic identities in the following section.

Study of ethnic identity on persistence and achievement. Substantial educational and psychological research has established the positive relations of ethnic identity processes and educational persistence outcomes such as achievement. For instance, a strong ethnic identity has been linked to high academic achievement in numerous studies (e.g., Chavous et al., 2003; Rivas-Drake et al., 2014). For instance, Chavous and her colleagues (2003) found that racial identity and academic beliefs were positively related to perceptions of doing well in school (i.e., school efficacy) among a sample of Black adolescents. Other studies have examined the positive linkage between ethnic or racial identity and academic performance (Chavous, 1996) as well as career aspirations (Helms & Piper, 1994; Parham & Austin, 1994). Additionally, Copeland-Linder et al. (2006) and Wong et al. (2003) found evidence that one's identification with one's ethnic group was a buffer against the negative impact of racial discrimination on various academic outcomes. However, other studies have found that in the face of racism and discrimination, a strong ethnic identity can lead Black students to de-identify with a particular domain (e.g., engineering, science) (Cokley, 2002; Osborne, 1997). Similarly, individuals may be inclined to de-identify with their ethnic identity based on potential misalignment of their cultural beliefs and those of the Eurocentric norms of science (Archer et al., 2015).

Domain Identity. Carlone and Johnson (2007) and Eccles (2009) suggest that a domain identity is particularly important to consider in the context of race-and-gender identities to address questions related to persistence and achievement. Domain identity can be defined as the sense of personal connection and value for a domain that is particularly relevant for identity formation, including educational major/focus, occupation, religion, and politics (Carlone & Johnson, 2007; Marcia, 1993). A domain identity that may be particularly salient for college-enrolled students is their major, which is intended to prepare them for their future occupation and

as a result potential "future domain" identity. In this study, I consider the relative importance of one's *engineering identity* to one's sense of self, which is defined as an individual's identification and connection with the field of engineering.

Carlone and Johnson (2007) originally theorized about science identity, however similar applications can be applied to other STEM domains like engineering. As such, engineering identity as a domain identity develops and changes through social experiences that align with the dominant engineering culture (e.g., using tools and language appropriately), public recognition by members of the engineering community, and competence (which they argue is the least socially dependent of the three factors). Carlone and Johnson (2007) also stated that identity develops through a cultural production cycle, such that an individual's culture directly impacts their identity development. As such, in the present study, I conceptualize engineering identity as an individual's feelings of belonging and social connection to the field of engineering.

Study of domain identity on persistence and achievement. While Carlone and Johnson (2007) spearheaded the work in STEM identity by studying the effects of role identities and gender on persistence and retention, later studies also found that students who highly endorsed their STEM-related domain identities were more likely to pursue STEM-related careers and experience positive psychosocial outcomes (Ceglie, 2011; DeCuir-Gunby & Walker-DeVose, 2013; Estrada et al., 2018; Johnson et al., 2011; Ko et al., 2014; Obiomon et al., 2007; Ong, 2005; Robinson et al., 2018). I review the literature on science identity, as it is the closest domain identity to engineering (unlike psychology or business) (Rodriguez et al., 2018).

Overall, the research on science identity and undergraduates' persistence suggests that high identification with science leads to positive persistence outcomes. For instance, Estrada et al. (2011) conducted a study on science identity and career outcomes and found that students

who were more likely to identify highly and positively with science were also more likely to pursue a career in the sciences in the future. Using growth mixture modeling to identify longitudinal trajectories of science identity among undergraduates, Robinson et al. (2018) identified three trajectories that explained changes in science identity during college. The three profiles were high with transitory incline (high science identity at the beginning and end of college with slight decreases across college), moderate-high and stable (high initial science identity and stability across college), and moderate-low with early decline (low initial science identity that decreased through the second year and stabilized after the third year). They found that college students in the high and stable science identity profiles were more likely to be involved in science-related careers or fields after graduation in comparison to students who endorsed moderate to low levels of science identity over time. They further found that women were more likely than men to be in the moderate-high and stable profile than in the high with transitory incline profile and racially minoritized students were more likely to be in the moderate-low with early decline than in the high with transitory incline profile. The likelihood of being in the moderate-low with early decline was associated with negative science career-related outcomes. They speculated that potential reasons for these findings for minoritized students may be related to experiences with stereotype threat, belonging threat, or incongruent perceptions of academic identity and gender or racial/ethnic identity in science (Murphy et al., 2007; Settles et al., 2009; Walton & Cohen, 2007). However, more investigation is needed to understand the nature of their findings. Similarly, Pierrakos et al. (2009) investigated the relation between engineering identity and persistence and found that students who persisted in engineering had high levels of knowledge, exposure, and feeling of fit with the engineering degree.

Limited work has considered Black students' engineering identities alone, without situating them against White or Asian students, or that has not used deficit frameworks to describe their experiences (Collins, 2018). However, Collins (2018) identified three primary threats to Black students' STEM identities, including underrepresentation in STEM, curriculum and pedagogy that is not culturally reflective and responsive, and the development of what she calls a counterproductive and conflicting identity that is based on imposter syndrome and low belonging in STEM. The present study seeks to further illuminate Black students' identity processes and experiences, particularly those related to engineering persistence and achievement.

Intersectionality and Multiple Identities. Identity is dynamic and one's "sense of self" is made up of multiple, sometimes competing, other times complementary, parts. This is especially important to consider for students from minoritized populations, such as Black women in engineering given that they only make up less than 1% of engineering employees despite making up 6.4% of the U.S. population (National Science Foundation, 2018; Yoder, 2014). Intersectionality was originally developed to describe overlapping "identities, disadvantage and difference" (Cole, 2009, p. 170) and examine how and when multiple aspects of those identities interact and provide unique lived experiences for the individual (Stewart & McDermott, 2004). Overlapping identities can be described as the interactions in experiences from race, ethnicity, class, gender, sexuality, religion, citizenship, ability, and age, as some examples.

In the early 1990's, Crenshaw coined the academic term intersectionality to provide a framework for understanding multiple oppressed identities. Crenshaw (2011) originally aimed to understand "double-discrimination" among Black women in the workplace given the experiences of intersecting patterns of racism and sexism they faced. Moreover, she believed it was important to merge real world experiences into research and practice and suggested that "although racism

and sexism readily intersect in the lives of real people, they seldom do in feminist and antiracist practices" (p. 1242). She also argued that the investigation of race or gender or other facets of identity can clash if recommendations for one facet of identity (e.g., race) takes precedence as being most important. Black women in engineering must navigate systems that have been historically White and male as well as grapple with the potential congruence or incongruence of their identities as a Black person, a woman and an engineering student.

Settles (2004) documented multiple identity interference, like identity in/congruence, to refer to the potential clash that happens between identities that leads to interference. For instance, in a male-dominated field like engineering, women of color may experience identity interference between their ethnic, gender, and engineering identity. This clash may be driven in part because engineering has historically not been a field that is inclusive, diverse, and culturally responsive. These feelings of "clashing" may also be prompted by interpersonal experiences related to racism and discrimination, such as receiving inequitable treatment, not being included in groups for class projects, the communication of low expectations, and facing microaggressions (e.g., a woman being told "I'm surprised you were able to pass that exam in engineering 100"). Moreover, individuals with multiple oppressed identities suggest they typically experience more stress in the face of discrimination, which usually leads to poorer performance (e.g., Morris & Bunjun, 2007).

Within educational psychology, researchers have historically taken a one-dimensional approach to understanding identity processes; intersectionality has only more recently gained deserved attention as an important process for understanding the experiences of Black women (Cole, 2009). A few reasons for the one-dimensional study of identity are in part due to the unique challenges of investigating an abundance of constructs in one study and the difficulty for

model estimation and interpretability. This also explains why intersectionality studies have commonly been examined in qualitative instead of quantitative research, and further speaks to the extant research that has considered CRT in qualitative but not quantitative research.

Study of intersectionality and multiple identities. Intersectionality and multiple identities, such as race, gender, and sexuality, have historically been studied among Black women in engineering or STEM. Indeed, Ireland et al., (2018) recently provided a synthesis of studies that have considered the intersectional experiences of Black women in STEM. They identified key themes among the existing literature to explain the experiences of Black women in STEM, including the relevance of 1) intersectional identities, 2) STEM interest, engagement, and persistence, 3) competence beliefs and achievement, 4) and key socializers and support systems. In one study, Charleston et al. (2014) studied the experiences and challenges faced by Black women in computing sciences. Among their findings, they note that among other identities, Black women found their gender and racial identities to be most salient and described instances of social isolation and discrimination in their workspaces by non-similar peers and professors. Interestingly, the Black women described their ability to persist in the face of adversity and attributed their persistence to having a collective understanding [via normalcy] of the challenges Black women face in computing sciences and from their abilities and successes in the major (Charleston et al., 2014). In another study, Ong et al. (2011) explored counterspaces for Black women within STEM contexts. They defined counterspaces as "safe academic or social spaces" that primarily serve underrepresented student groups on campus, such as affinity groups (e.g., Black Student Caucus, National Society for Black Engineers) (Ong et al., 2011; Solorzano et al., 2000). Ong et al. (2011) found that counterspaces may be an important way of increasing

student's sense of belonging in STEM and support students who may be facing racial discrimination and microaggressions and feelings of isolation.

Shields (2008) suggested that qualitative methods have been primarily used to study intersectionality, there are many affordances to using a quantitative perspective. Indeed, several educational researchers have more recently employed a QuantCrit approach to address intersectionality by incorporating critical perspectives and quantitative methodology to answer their research questions (e.g., Fong et al., 2019). QuantCrit was developed to challenge deficit frameworks, particularly within the quantitative literature, which serve to reinforce White hegemony and supremacy (Gillborn et al., 2018). Furthermore, Ireland et al., (2018) asserts that there is much to be learned still about the role of intersectional and multiple identities and other psychological processes, such as stereotype threat.

Stereotype Threat

My dissertation examines intersectionality as the interplay of complex identities within an environment where students may experience either or both ethnic-and-gender stereotype threat. Stereotype threat is defined as the psychological threat of confirming or being reduced to a negative stereotype either within the context of their gender or race and ethnicity (Steele & Aronson, 1995). In this dissertation study, I conceptualize stereotype threat as the associated stress that compounds with the threat of confirming negative stereotypes about ones ethnic (or racial group) and gender group. In their seminal study, Steele and Aronson (1995) found that Black students experienced stereotype threat in contexts where stereotypes about their racial group were salient, which led to anxiety over being judged negatively and stereotypically or confirming the negative stereotype. Consistent with a situative theoretical perspective (where knowledge and learning is situated in context; Greeno, 2011) and identity theory (Erikson, 1968),

identity development is directly impacted by one's environment, such that any messaging learned in an environment will directly impact one's identity development, and one's identity development will impact how an individual interacts with their environment. Additionally, research suggests that for stereotype threat to be relevant and to have deleterious effects, individuals need to be aware of the stereotype of their group, have domain identification in that area, and there must be some level of difficulty associated with a task or domain (Lewis and Sekaquaptewa, 2016). Additionally, Lewis and Sekaquaptewa (2016) suggest that stereotype threat triggers negative thoughts, appraisals, and emotions in the presence of a stereotype.

Stereotype threat manifests through interference with intellectual functioning and disengagement or deidentification (Steele & Aronson, 1995**).** While decreased intellectual functioning has been demonstrated through performance and achievement, deidentification is characterized as a "defensive detachment of self-esteem from a particular domain'' (Schmader et al., 2001, p. 317, qtd. in von Hippel et al., 2011). Indeed, von Hippel et al. (2011) suggest that deidentification is particularly likely in contexts where individuals may experience a lot of stereotype threat and deidentification may serve as a "buffer" or protective agent of their self-esteem (e.g., Cokley, 2002; Crocker et al., 1998; Osborne, 1995, 1997). In STEM environments, where Black students are underrepresented and susceptible to facing discrimination and racism, stereotype threat can lead students to experience identity incongruence or negative beliefs about their identities based on their perceptions of their environment, which has implications for persistence and achievement. Much like experiences of discrimination and racism on threats to identities, stereotype threat also has the potential to harm one's sense of self. In line with Steele's (1997) original conceptualization of stereotype threat, this dissertation study investigates stereotype threat as being directly related to intellectual performance (via GPA and persistence)

and deidentification (via ethnic and domain identity). I focus specifically on racial (or ethnic) as well as gender stereotype threat, both of which are discussed below.

Racial (or Ethnic) Stereotype Threat. While I conceptualize stereotype threat in terms of ethnic stereotype threat, hundreds of studies have found that individuals feel the need to perform in a manner that disconfirms stereotypes about their race (e.g., Spencer et al., 2016), but that doing so may impact performance due to the overwhelming fear of conforming to the negative stereotypes (Bosson et al., 2004; Nguyen & Ryan, 2008; Steele et al., 2002). However, fewer studies have considered how stereotype threat operates in the context of relevant identities such as ethnic and engineering identity. This dissertation seeks to address that gap. In their seminal study, Steele and Aronson (1995) found that Black students performed significantly worse than their counterparts when they were told a test was diagnostic of ability but showed no difference in performance when the test was said to be non-diagnostic of ability. The researchers concluded that Black individuals' intellectual performance was disrupted based on their overwhelming fear of conforming to the negative stereotype. In a field like engineering where high-stakes testing is integral for progression in the major, Black students may experience these feelings of stereotype threat, which could affect their motivation, persistence, and achievement in engineering fields (e.g., Bosson et al., 2004; Totonchi et al., 2021). Indeed, recent studies examining stereotype threat have found evidence for decreased grades, enrollment, persistence, and degree attainment among Black students (e.g., Corra & Lovaglia, 2012). Moreover, according to identity incongruence, experiencing stereotype threat in a context like engineering may also lead individuals to feel the need to protect their self-esteem, which could lead to de-identification with engineering or de-identification with their ethnic identity (Settles, 2004).

The studies and findings discussed point to Black students receiving messages of academic incompetency based on their race or ethnicity, further having the potential to deter persistence and achievement in STEM. While I am interested in persistence and achievement outcomes, there are also other important outcomes such as belonging uncertainty and lower interest in the stereotyped domain (Thoman et al., 2013). Most of the stereotype threat literature has exclusively focused on persistence outcomes, but the affordance of my mixed methods design is that I can use my qualitative study to examine how ethnic stereotype threat, coupled with gender stereotype threat, also relates to students' well-being, belonging, and interests in engineering.

Gender Stereotype Threat. Extant research has focused on the consequences of racial and/or ethnic stereotype threat on Black students success and well-being STEM (e.g., Murphy et al., 2007; Steele & Aronson, 1995; Walton et al., 2015), but it remains unclear how students who experience intersecting systems of oppression, such as Black women, may also face instances of "double-stereotype threat" in male-Eurocentric centered space like engineering, especially in the context of relevant identities (Ong et al., 2011; Spencer et al., 1999). Additionally, stereotype threat has often considered race or ethnicity in a single study, with limited studies considering gender stereotype threat (e.g., Smith et al., 2015) and even fewer studies considering them both in the same context (Rowley et al., 2007). Moreover, the stereotype threat literature has also not been expanded to consider the interplay of important identities such as race, gender, and sexuality (Ireland et al., 2018).

Despite the lack of research considering gender and ethnic stereotype threat, several studies have considered gender stereotype threat and other bias among women. In one study, Steele et al., (2002) found that women undergraduates in male dominated fields reported higher

levels of gender discrimination and stereotype threat and were also more likely to report considering their major to fields that were more gender inclusive. Similarly, Murphy et al. (2007) found that women showed decreased interest in math and science topics when men numerically dominated the space, which also aligns with a finding by Gupta and Bhawe (2007) who found that women expressed less interest in a field where male characteristics were deemed important for career success.

The current study extends the past literature by considering the intersectional nature of stereotype threat by examining both gender-and-racial stereotype threat in engineering, but also as it uniquely relates to the experiences of Black women and Black men, and potentially relevant identities (i.e., engineering, ethnic identity). There is value to understanding stereotype threat in a mixed methods study, and by using person-oriented approaches, given the affordances to understand identities and stereotype threat simultaneously, and affordance to share student voices about their experiences with stereotype threat in the field of engineering, which otherwise may be challenging to interpret in quantitative data.

Person Oriented Approach

Given the complex nature of identity and stereotype threat, it is valuable to use person-oriented approaches that allow the creation of profiles consisting of multiple variables to capture heterogeneity of patterns. Stereotype threat is important to understand in the context of ethnic and domain identities given the potentially complex interplay between student's identities and ethnic-and-gendered experiences with those identities. Profiles of identities and stereotype threat can help us understand the complex ways in which students engage with parts of their identity and perceptions of ethnic-and-gender stereotype in a context like engineering.

Within the psychological literature, person-oriented approaches can be used to investigate individuals as "a dynamic system of interwoven components that is best understood in terms of whole-system properties" (Crocetti & Meeus, 2014, p. 2). von Eye and Bogat (2006) note that person-oriented approaches assume that subgroups may exist within populations and the aggregate-level parameters within those subgroups may or may not also be estimated for groups or individuals. Variable-oriented approaches, on the other hand, are those that consider relations among variables and are the key units under study, such as how a predictor is directly related to an outcome. According to von Eye and Bogat (2006), variable-oriented approaches assume that populations are homogeneous and individuals belonging to the same population are interchangeable. In contrast to variable-centered approaches, person-oriented approaches allow for taking a "holistic and dynamic view" of study (Magnusson & Allen, 1983). Indeed, Magunsson and Allen (1983) stated that in person-oriented approaches "the person is conceptualized as an integrated totality rather than as a summation of variables" (p. 372). Given that this dissertation considers complex identities and perceptions of stereotype threat, a person-oriented approach is needed to understand the individuals on a holistic level rather than relations among variables themselves. Moreover, understanding intersectionality among identities is important to do within a person-oriented framework because it enables us to consider how identities work in combination with one another.

The Present Study

While prior research suggests that diverse students in the field of engineering are susceptible to facing stereotype threat given low representation and potentially inequitable treatment in engineering fields (e.g., Murphy et al., 2007), it remains unclear how ethnic identity, engineering identity, and stereotype threat may interact to predict persistence and career

intentions in engineering. To examine the intersectional nature of experiencing stereotype threat based on multiple aspects of one's identity, I examine both gender and racial stereotype threat in engineering using a person-oriented approach. The present study examined complex patterns of ethnic and engineering identities and gender-and-racial stereotype threat among a sample of Black undergraduate engineering students at a predominantly White land-grant institution in the Midwestern, United States.

Using an explanatory sequential mixed methods study design (QUANT→Qual), I collected and analyzed quantitative data first and then collected qualitative data based on the quantitative findings (Creswell & Creswell, 2017). Within an explanatory sequential design, there is a primary emphasis on the quantitative portion of the study, and quantitative data is collected first which informs the qualitative data and analysis (notated as QUANT → qual) (Figure 1 details this approach). There are four unique phases in an explanatory sequential design, including 1) the design and implementation of the quantitative portion, 2) use of strategies to decide on what quantitative results need follow-up, 3) design and implementation of the qualitative phase, based on the quantitative results, and 4) interpretation of the results from both phases (Creswell et al., 2011).

For the quantitative portion, I used a person-oriented analytical approach to create profiles of ethnic identity, engineering identity, and racial-and-gender stereotype threat based on patterns of heterogeneity among individuals. The identified profiles were then used to predict outcomes and to descriptively examine unique samples based on demographics (e.g., gender; year in school). This is a novel analytical tool for examining multiple identities because it considers how multiple variables combine based on underlying patterns in the data to predict outcomes, rather than considering the unique contribution of one or more variables or their

interaction on outcomes (i.e., variable-oriented approach). For the qualitative portion of the study, I drew from the quantitative findings and selected a sub-sample of participants from the broader quantitative sample to supplement the person-oriented findings. Students were interviewed that represented the different profiles and provided in-depth testimonials about their engineering experiences.

A mixed methods design had several affordances for this work. Importantly, this mixed methods design was aligned with my goal of critically understanding the experiences of Black students in engineering. While person-oriented approaches have the potential to center the student, rather than construct, in the analysis, a mixed methods design further allowed me to consider the lived experiences and voices of the students in this sample. It was important to *contextualize* the profiles by learning from lived experiences of students in engineering, which not only provided validity to the profiles themselves but incorporated a voice for the students in the sample beyond their survey responses. A mixed methods approach allowed me to gain a better understanding of the research problem, with the assumption that neither quantitative nor qualitative analyses, alone, allowed me to deeply understand students' identities, experiences with stereotype threat and racism and discrimination, and persistence.

Research Question 1: What are the multiple latent profiles of ethnic identity, engineering identity, gender stereotype threat and ethnic stereotype threat?. To my knowledge, there are not studies that have considered profiles of ethnic and domain identities and stereotype threat, though studies have considered the relations between these constructs in the form of path analyses and moderated effects (Armenta, 2010; Weber et al., 2018). Researchers found that positive group identification, in general, increases susceptibility to the effects of stereotype threat (Schmader, 2002). Indeed, studies have posited that experiences with

racial or gender stereotype threat can negatively impact ethnic identity or domain identification, or positive identification with ethnic and domain identity may act as a buffer against the negative effects of racial or gender stereotype threat (e.g, Wheeler & Petty, 2001). However, the complex ways in which these identities are meaningful for students, and the complexity in experienced stereotype threat, may be well understood in terms of profiles and through an exploratory lens.

As such, I hypothesize that I will identify a profile where Black students will highly endorse their ethnic identities and strongly identify with the field of engineering, while still experiencing elevated levels of either ethnic and/or gender stereotype threat (particularly for women in engineering). This is based on the literature that suggests ethnic identity may act as a buffer when students experience stereotype threat, which may partially explain how they are able to maintain some level of identification with the field of engineering (Oyserman et al., 2001). On the other hand, research also supports the notion that students may experience high levels of ethnic and gender stereotype threat, and this can negatively impact their ethnic and STEM or engineering identity by leading to dis-identification and attrition (e.g., Davis et al., 2006). As a result, I hypothesize that I will identify a profile where individuals report high levels of either ethnic or gender stereotype threat (or high levels of both) and low identification with their ethnic group and engineering. However, it is also possible that facing ethnic and gender stereotype threat may lead to a profile where perceived gender and/or ethnic stereotype threat is high and students de-identify with their domain but not their ethnicity (or deidentify with their ethnicity but not domain), which speaks to the complexity of identities.

Research Question 2: How are gender and year in school related to the probability of being in one profile versus another?. I hypothesize that Black women will be most represented in high ethnic identity profiles and high engineering identity profiles, when gender

and ethnic stereotype threat is low (Phinney, 1992; Zhou et al., 2019). However, when gender and ethnic stereotype threat is high, I hypothesize that Black women will be represented in a low ethnic and engineering identity and high gender and ethnic stereotype profile. In general, Black women have gender stereotype threat as a unique threat to their well-being and coupled with ethnic stereotype threat will speak to the overlapping systems of oppression that are present in STEM domains (Crenshaw, 2011). I will also consider differences based on the year in school of students, given that identity theory and research suggest that identity development shifts throughout the course of one's life, and even identity levels may shift throughout college (e.g., Robinson et al., 2018). For instance, there may be individuals who enter college with a high degree of engineering identity based on positive experiences in high school, but there may also be individuals who enter college uncertain about their connection to engineering. I also would not expect students in this sample to enter college as "blank slates" in relation to their ethnic identity, as racialized experiences begin early in life for minoritized individuals. As a result, it is possible that ethnic identity may be high, moderate, or low for first year and second year students, and remain the same or change for third- and fourth-year students. I think second year students may look similar in terms of first-year students because students are not typically admitted as "engineering majors" until the end of their second year. Therefore, I will group students into two groups: first/second year and third/fourth year. I hypothesize that students in their first two years of college will be in distinct profiles from third- and fourth-year students based on recent literature suggesting that identities shift during the first two years of college (Zhou et al., 2019).

Research Question 3: Are students of these different profiles more or less likely to intend to pursue engineering careers and more or less likely to achieve in engineering (based on GPA)?. Consistent with past research, I would expect members in high identity and low stereotype threat profiles to be more likely to have engineering career intentions and a high GPA. This is based on literature that suggests having positive connections to parts of our identity is important for informing life decisions and overall well-being (Phinney, 1996). For career intentions and GPA, I believe that individuals who highly identify with engineering and their ethnic group and have low levels of gender and ethnic stereotype threat, will be more likely to have higher engineering-related career intentions. In terms of GPA, I would expect that individuals who may not identify as highly with the field of engineering and experience high levels of stereotype threat may have a lower cumulative GPA (Sellers et al., 1998).

Research Question 4: What themes are found among Black undergraduate engineering students related to their identities as well as their experiences with racism and discrimination and persistence in engineering? Are there differences in themes based on profile membership and how do these themes support or contradict the quantitative findings?. This question aims to understand student's experiences in engineering based on ethnic identity, engineering identity, and ethnic-and-gender stereotype threat, and particularly those that serve to provide more information about the identified profiles. I expect to learn in-depth information about student's identities and experiences with stereotype threat, among more direct experiences with racism, discrimination, and microaggressions. I do not make specific hypotheses, as I expect to identify these themes based on the qualitative data.

Positionality Statement

I am a female Latinx/Chicanx PhD candidate in an educational psychology and educational technology doctoral program. In my undergraduate and graduate career, I have been driven to understand human cognition and behavior with a special emphasis on STEM motivation, persistence, and identity. I have also been drawn to understand these constructs by using an explicit race and equity focus, often drawing from critical race theory or other critical and feminist frameworks. These curiosities stemmed from a common experience faced by friends of mine, and even me, as a high school and college student: being discouraged and "weeded-out" from STEM pathways. As a high school student in a low-income community with other Black and Brown students, many of my close peers were discouraged from taking STEM-related courses and those who did experienced the "weed-out" effect. To use myself as an example, I wanted to declare a Zoology major in college, but my college counselor suggested that I would not be prepared given that I did not take enough science courses in high school. They instead suggested a route in the humanities based on my other interests. From then on out, I wondered about student decision-making, career goals, and motivation to persist in a chosen field, and particularly how it may disproportionately impact communities of color and from low-income communities.

Based on my academic herstory, and experiences with my own complex identities, I reflect on my positionality and how it may have influenced my interactions with participants and the interpretation of the results. Experiencing my own challenges within STEM, and seeing the experiences of close friends and peers, has led to perception of the importance of race in STEM contexts. My approach to framing the study and interpretation of the results is guided by Critical Race Theory. It is important to note that my study of Black men and women is not necessarily

comparable to the issues I experienced or those within the Latinx community, as they are unique from the historical context of Black individuals in the U.S.

Chapter 3:

Quantitative Study: Research Questions 1-3

This study was a mixed methods explanatory sequential design that drew from both quantitative and qualitative data to inform the research questions. A mixed methods approach allowed me to gain a better understanding of the research problem, with the assumption that neither quantitative nor qualitative analyses, alone, allowed me to deeply understand the trends in student experiences, perceptions, and outcomes. Chapter 3 focuses on examining Research Question 1 (*What are the multiple latent profiles of ethnic identity, engineering identity, gender stereotype threat and ethnic stereotype threat?*), Research Question 2 (*How are gender and year in school related to the probability of being in one profile versus another?*), and Research Question 3 (*Are students of these different profiles more or less likely to intend to pursue engineering careers and more or less likely to achieve in engineering (based on GPA)?*). I begin by describing the method, which includes information on participants, procedure, measures, and analytical strategy. I also describe the results from the quantitative data, followed by a brief discussion.

Method

Setting and Participants. The quantitative data were collected as part of an ongoing, longitudinal study of undergraduate engineering students at a large, predominately White land-grant university. The purpose of the longitudinal study was to examine contextual supports and underlying psychological mechanisms (e.g., motivation, belonging) associated with persistence in studying engineering. The broader longitudinal study was a cohort-sequential design; participants were assigned to a respective cohort every fall semester (during the baseline survey completed just before the start of students first year). The first cohort was assigned in Fall 2015

(C1), followed by Cohort 2 in Fall 2016 (C2), Cohort 3 in Fall 2017 (C3), Cohort 4 in Fall 2018 (C4), and Cohort 5 in Fall 2019 (C5). I utilized the follow-up survey from Spring 2020, given that measures for ethnic identity and gender and ethnic stereotype threat were added in this wave of data collection and were essential to the research questions.

The Spring 2020 survey was administered to 6,877 participants (3,557 completed the survey) and was completed by students from all five cohorts. Students from the five cohorts were invited to complete the survey via one of two survey options: a paid survey or a course survey. More details about the survey administration procedures are provided in the procedure section. The proportion of students of who received a paid survey was 51% and course survey was 49%. proportion of students who received a paid survey by cohort were: C1, 29%; C2, 63%; C3, 63%; C4, 51%; C5, 31%. The proportion of students who received a course survey by cohort were: C1, 71%; C2, 37%; C3, 37%; C4, 49%; C5, 69%. The overall response rates across both the paid and course survey was 52% (by cohort: C1, 64%; C2, 44%; C3, 44%; C4, 52%; C5, 63%). The overall response rate (including cohorts 1-5) who received the paid survey was 26% (by cohort: C1, 40%; C2, 24%; C3, 24%; C4, 27%; C5, 31%). The overall response rate (including cohorts 1-5) who received the course survey was 78% (by cohort: C1, 73%; C2, 79%; C3, 80%; C4, 78%; C5, 78%).

The current study investigated a sub-sample of 169 Black undergraduate students. The sample was 32% women (n = 55); 32% (n = 55) of students reported being first-generation college students. During Spring 2020, the participants in the study consisted of students who were both pursuing engineering majors (81.2%; n = 137) and who left engineering for a different major within the same university (18.8%; n = 32). This study utilized a cross-sectional sub-sample of first year through fifth-year students, with examination of cohort 1 through students in

cohort 5 who had not yet graduated and were still enrolled in college. The distribution of the study sample by cohort were: C1 = 15 (9%); C2 = 29 (17%); C3 = 27 (16%); C4 = 46 (27%); C5 = 52 (31%). I would expect that the response rates within the subsample generally mirror the response rates for the overall sample by cohort and by the paid and course survey methods.

Procedure

Survey Data Collection. Data collection for the longitudinal survey began at the start of students' first year in 2015 and has continued as a longitudinal cohort sequential design. Students were surveyed with online follow-up surveys each Spring. The follow-up survey consisted of two primary data collection methods. Students either were targeted in their engineering-related courses and received course credit or extra credit upon survey completion or were sent a survey link for which they received a $10 amazon gift card for completing the survey. All students in the initial cohorts received follow-up surveys, even if they had not responded to any prior surveys and/or had left engineering. This study was deemed exempt by the Michigan State University Institutional Review Board, Study ID #STUDY00005607.

Institutional Data Collection. As part of the larger study, students consented to have their GPA data released to the research team each time they took a survey. These data were delivered from the Office of Institutional Records to the research team, where the data were then de-identified and matched with survey data based on Study ID number.

Measures. Both self-reported and institutional variables were collected for this study. The self-reported constructs that were used to estimate the profiles were *ethnic identity, engineering identity, ethnic stereotype threat, and gender stereotype threat.* The predictor variables included gender and year in school. Lastly, the outcome variables were cumulative GPA and engineering career intentions. See Appendix C for a comprehensive list of measures

and individual items. Additionally, confirmatory factory analyses (CFA) were tested on all constructs to understand their factor structure, presented below under each measure.

Ethnic identity. Ethnic identity is defined as the part of a person's social identity that is related to their connection to a particular ethnic group and influences their sense of self, based on affirmation/belonging and achievement (Phinney, 1992; Tajfel & Turner, 1979). Ethnic identity was measured in Spring 2020 using a 5-item total self-report scale (Phinney, 1992; $\alpha = .90$) with two items assessing affirmation/belonging and three items assessing achievement. One example item for achievement was "I have spent time trying to find out more about my ethnic group such as its history, traditions, and customs." One example item for affirmation/belonging was "I have a strong sense of belonging to my own ethnic group." Students rated items on a Likert-type scale ranging from 1 to 5, with 1 = strongly disagree and 5 = strongly agree. For ethnic identity, CFA indicated that a two-factor structure fit the data well, $\chi 2\ (24) = 47.95$, RMSEA = .08, CFI = .98, TLI = .97.

Engineering identity. Engineering identity refers to the degree to which an individual identifies with the field of engineering and believes it is relevant to one's sense of identity (Estrada et al., 2011; Pugh et al., 2009). Engineering identity was measured in Spring 2020 using a 9-item self-report scale ($\alpha = .92$) with items adapted from two existing scales: Pugh et al. (2009) and Estrada et al. (2011). One example item was "I can see myself doing engineering in the future." Students rated items on a Likert-type scale ranging from 1 to 5, with 1 = strongly disagree and 5 = strongly agree. CFA results indicated that a one-factor structure fit the data well, $\chi 2\ (31) = 49.47$, RMSEA = .08, CFI = .98, TLI = .96.

Ethnic stereotype threat. Ethnic stereotype threat is defined as the perception that one can be judged or treated negatively based on a stereotype about their ethnic group, or that one

might act in a way to inadvertently confirm the stereotype (Steele et al., 2002). Ethnic stereotype threat was measured in Spring 2020 using a 4-item self-report scale (Steele et al., 2002; α = .91). One example item was "How often do you feel that because of your ethnicity.. Some people believe that you have less ability." Students rated items on a Likert-type scale ranging from 1 to 5, with 1 = strongly disagree and 5 = strongly agree. For ethnic stereotype threat, the CFA results indicated that a one-factor structure fit the data well, $\chi 2$ (2) =3.94, RMSEA = .08, CFI = .99, TLI = .98.

Gender stereotype threat. Gender stereotype threat is defined as the perception that one can be judged or treated negatively based on a stereotype about their gender group, or that one might act in a way to inadvertently confirm the stereotype (Steele et al., 2002). Gender stereotype threat was measured in Spring 2020 using the same 4-item self-report scale used to assess ethnic stereotype threat, but focused on gender (Steele et al., 2002; α = .93). One example item was "How often do you feel that because of your gender.. People of your gender face unfair evaluations because of their gender..." Students rated items on a Likert-type scale ranging from 1 to 5, with 1 = strongly disagree and 5 = strongly agree. For gender stereotype threat, the results indicated that a one-factor structure fit the data well, $\chi 2$ (2) = 5.70, RMSEA = .10, CFI = .99, TLI = .99.

Engineering career intentions. Engineering career intentions assessed students' intentions of being involved in an engineering-related career after graduation. Engineering career intentions were measured in Spring 2020 and asked, "To what extent do you intend to pursue a career in engineering?" on a 10-point scale, with one being "I definitely will not" and ten being "I definitely will."

Achievement (GPA). Cumulative GPA was collected from the institutional data office to assess students' undergraduate cumulative GPA at Spring 2020. The COVID-19 pandemic started during March 2020, which played a factor into how GPAs and grades were being distributed and calculated. In Spring 2020 all students had the option to receive a numeric grade (based on 0.0-4.0) or a satisfactory or unsatisfactory (S/NS) for their coursework that semester. The threshold for undergraduate students that chose between an S and NS was 1.0. Given this variability in GPA, I recalculated students cumulative grade point average based on "unmasked" GPA data provided by the institutional office. This "unmasked" data showed what would have been students' numeric grade in any given course and provided a numeric value that was used to recalculate GPA. The final GPA variable was calculated by taking an average of all final numeric grades for Spring 2020.

Gender. Self-reported gender was collected during Spring 2020 using a three-category indicator: male, female, and other. The sample did not include any responses that were "Other," otherwise it would have been hand coded and changed to represent the category (e.g., transgender, non-binary). Therefore, self-reported gender was a binary variable (female = 1, male = 0) and was measured to understand likelihood of profile membership based on gender. More information about gender identification was collected qualitatively and more detail is provided in Chapter 4.

Year in school. Year in school was collected from institutional records, including first, second, third, and fourth-year students, and was measured to understand likelihood of profile membership based on year in school. For the analyses, I created a dichotomous variable (first/second = 0; third/fourth = 1) through dummy coding. This decision to group students into two categories was based on students' progress through the engineering program at the

university. Students in their first and second year were expected to be comparable given that they are typically not officially admitted as an engineering major until sometime in their second year and are distinct from third- and fourth-year engineering students, the majority of whom will have been admitted (or left/been rejected) from engineering.

Analytical Plan

Preliminary Analyses. Preliminary analyses included the examination of descriptive statistics, bivariate correlations, normality statistics, confirmatory factor analyses (CFA), and measurement invariance. Descriptive statistics, including correlations and normality tests, were conducted in SPSS version 25; all other analyses were conducted using MPlus Version 8.4 (Muthén & Muthén, 1998–2019) and missing data were handled using full information maximum likelihood (FIML) estimation (Graham, 2003). In addition to conducting CFAs to understand the general factor structure of the measures, measurement invariance (MI) was conducted on gender stereotype threat for men and women. The value of understanding measurement invariance among men and women for gender stereotype threat was to ensure that the construct was interpreted consistently across the two groups. Given that this was a cross sectional study, I did not conduct missing data analyses, but provided general response rates for the target population earlier in the method section. A Grubbs' test (1950) was used to identify and consider individual outliers in the data (Grubbs, 1969; Stefansky, 1972). Considering outliers in the data is important for subsequent analyses, given the ability for outliers to skew primary results of the study. Typically, outliers are dropped all together from subsequent analyses, but it is important to assess them on an individual basis given the degree to which they could potentially affect results.

Latent Profile Analyses. The primary analytical test was a latent profile analyses (LPA), using structural equation modeling (SEM, Collins & Lanza, 2010). Specifically, an LPA was used to select profiles using the identity (engineering, ethnic) and stereotype threat (gender, ethnic) variables. Person-oriented approaches such as LPA allow for examination of meaning systems among individuals, such that it is possible to investigate how multiple constructs converge to predict meaningful persistence outcomes. On the other hand, traditional variable-oriented approaches assume that populations are homogeneous and individuals belonging to the same population are interchangeable. There are important distinctions between these two approaches, and affordances of using a person-oriented approach in the context of this work.

Extant research on identities and/or stereotype threat, discussed at length in Chapter 2: Literature Review, have employed variable-oriented approaches and this work has primarily used multiple regression or Analysis of Variance (ANOVA) (e.g., von Hippel et al., 2011). In variable-oriented research the constructs are the key units under study and there is a particular emphasis on how one or more constructs predict outcomes. In contrast with variable-centered approaches, person-oriented approaches prioritize the individual as the center of analysis and the factors that characterize or are related to the individual (Bergman & Trost, 2006). According to Bowers et al. (2012), a latent profile analysis allows the researcher to understand whether a single pattern or mixture of patterns (i.e., latent profiles) exist within a single distribution. Examining profiles of identities (engineering, ethnic) and stereotype threat (gender, ethnic) allows me to understand how patterns (or profiles) of identities and stereotype threat may be similar or different from one another.

An LPA framework provided affordances for modeling my research questions. First, consistent with my theoretical framework, this modeling technique allowed me to examine

multiple constructs simultaneously to determine profile membership. It also allowed me to consider how the patterns/profiles were similar or different from one another. Considering my focus on identities and stereotype threat, it was important for me to address the multidimensionality of identities and experiences with gender and ethnic stereotype threat (particularly for Black women) in a single model. I also chose to use LPA, rather than a cluster analysis, as prior research indicated it was better at estimating structural differences between unobserved groups (mean differences, differences in covariances, etc.) and provides model fit indices (Nylund et al., 2007). Moreover, LPA is suitable for continuous indicators, whereas Latent Class Analysis (LCA) is more suitable for categorical indicators (Nylund et al., 2007).

Latent profile analysis can be achieved using a one-step approach or an automated three-step process, often referred to as R3STEP (Asparouhov & Muthén, 2014; Vermunt, 2010). I used the R3STEP approach for this study. The advantage of using the R3STEP approach to analyze the data, instead of the traditional 1-step approach, is that profile probabilities are saved throughout the steps and do not shift when including covariates in the model (Asparouhov & Muthén, 2014). R3STEP is used to determine profile membership by estimating the latent profile model using latent profile indicator variables (Asparouhov & Muthén, 2014; Vermunt, 2010). The R3STEP method entails estimating the LPA model (step 1), then the latent profile variable is assigned from the posterior distribution obtained from the first step (step 2), and finally the assigned profiles are evaluated with the auxiliary and outcome variables using the BCH approach. The BCH command is used to estimate a model with auxiliary variables where the distal outcome is used as a latent profile predictor inside a multinomial logistic regression in addition to the latent profile model (Asparouhov & Muthén, 2014).

To test Research Question 1 (*What are the multiple latent profiles of ethnic identity, engineering identity, gender stereotype threat and ethnic stereotype threat?*), I used LPA (Collins & Lanza, 2010) to identify based on students' self-reported ethnic identity, engineering identity, ethnic stereotype threat, and gender stereotype threat. A primary component of LPA is to select a model (profile solution) that fits the data well, which is also the first step of the R3STEP approach. In the first step, model fit was determined based on fit indices for non-nested models including Bayesian Information Criterion (BIC), adjusted BIC, and entropy, with smaller values (except for entropy) indicating better fit, and theoretical interpretability (Grimm & Ram, 2009). I determined which profile solution was the best representation of the data by comparing models against one another based on a series of fit indices. Following Nylund-Gibson et al. (2013), model selection was primarily based on Bayesian Information Criterion (BIC) and theoretical interpretability, though I considered adjusted BIC and entropy as well but with less weight (Grimm & Ram, 2009). While entropy is important for understanding the stability of a profile, it should not be weighed as heavily as BIC and theoretical interpretability (Masyn, 2013).

To test Research Question 2 (*How are gender and year in school related to the probability of being in one profile versus another?*), I examined how gender (man or woman) and the year in school (first/second or third/fourth) were associated with most likely profile membership (based on the analyses for RQ1). To estimate gender and year in school, I used the R3STEP with BCH estimator (Asparouhov & Muthén, 2014). Specifically, this analytical tool allowed me to see how the likelihood of being in one profile versus another varied by being of a specific gender (male/female) or based on what year in school a student was in (first/second or third/fourth).

To test Research Question 3 (*Are students of these different profiles more or less likely to intend to pursue engineering careers and more or less likely to achieve in engineering (based on GPA)?*), I examined how the probability of membership in the profiles identified in RQ1 was associated with specific outcomes, including engineering career intentions and GPA. Specifically, I used the BCH estimator to measure the relation between the profiles and distal outcomes, including cumulative GPA and career intentions.

Results

Preliminary Analyses.

Descriptive statistics and bivariate correlations. Descriptive statistics are presented in Table 1. The descriptive statistics demonstrated that skewness and kurtosis fell within normal ranges, with skewness between − 3 and + 3 and kurtosis between − 10 to + 10. Another important step when conducting a latent profile analysis is to identify outliers in the data, given that outliers can mischaracterize profiles based on a few outliers. The Grubbs' test is a method that was designed to identify outliers in a univariate data set that follows a normal distribution (Grubbs, 1969; Stefansky, 1972). No outliers were identified using the Grubbs' test.

A correlation matrix can be found in Table 2. As expected, ethnic identity and engineering identity were highly correlated. Additionally, ethnic stereotype threat was correlated with gender stereotype threat, and gender stereotype threat was correlated with ethnic identity. GPA was not correlated with ethnic or engineering identity, or with gender or ethnic stereotype threat. Additionally, career intentions were strongly correlated with engineering identity, but not ethnic identity or ethnic or gender stereotype threat.

Measurement analyses. Complimentary to the confirmatory factor analyses (CFA) presented above, I also tested measurement invariance on gender stereotype threat to ensure that

the same latent variable was found across men and women (Wicherts et al., 2004). Establishing longitudinal measurement invariance ensures that observed differences in constructs are due to true change and not change in how participants understand the construct (Widaman et al., 2010). To test measurement invariance, I fit a series of models that progressively added constraints (i.e., making them more invariant). The configural model constrained the factor structure to be consistent across gender. The weak invariance model constrained the factor loadings to be the same across gender. The strong invariance model constrained the intercepts for gender. The strict invariance model added a final constraint of the residual variances for observed factor indicators for each gender group. The measurement invariance testing showed that partial strong invariance was achieved for gender stereotype threat across men and women, as the Comparative Fit Index (CFI) did not decrease by greater than -0.01 (Cheung & Rensvold, 2002) and there was not a significant decrease in χ^2 when increasingly invariant models were applied to the data (Bollen, 1989). While I did not reach strong or strict measurement invariance, Byrne et al., (1989) suggest that partial invariance (where at least two loadings and intercepts are constrained equal across groups) is enough to make valid inferences about the differences between latent factor means in a model. I established partial measurement invariance for gender across men and women ($\chi 2$ (3) = 142.22, RMSEA = .04, CFI = .99, ΔCFI = .001). See Table 3 for fit indices of the partial measurement invariance model.

Latent Profile Analysis. The primary analysis for research question one was a latent profile analysis using the SEM framework (RQ1: *What are the multiple latent profiles of ethnic identity, engineering identity, gender stereotype threat and ethnic stereotype threat?*). Model selection for the best fitting model (e.g., number of profiles) was based on Bayesian Information Criterion (BIC) and theoretical interpretability (Nylund-Gibson et al., 2013). Smaller values of

BIC indicated better fit, and the literature supports the utility of the BIC in latent profile analyses and cluster analyses (Nylund et al., 2007). For research question two (RQ2: *How are gender and year in school related to the probability of being in one profile versus another?*). I employed the automated three-step procedure (R3STEP; Asparouhov & Muthén, 2014) to examine differences in gender and year in school on profile membership. For research question three (RQ3: *Are students of these different profiles more or less likely to intend to pursue engineering careers and more or less likely to achieve in engineering (based on GPA)?),* I estimated outcomes by profile membership, and this was through a BCH estimator that allowed me to understand the relations of most likely profile membership with engineering-related career intentions and GPA. See Figure 2 for the full SEM model.

Identification of identity and stereotype threat profiles. I used a total sample of 169 participants for the Latent Profile Analysis. I started by estimating a series of one to five profile models to understand which model represented the data best. According to Collins and Lanza (2010), there are several parameters by which to select a model amongst a set of attempted models, though in general a decision is based on empirical evidence, theoretical interpretability, Bayesian Information Criterion (BIC; Schwarz, 1978), and Bootstrapped Likelihood Ratio Test (BLRT) (Nylund et al., 2007). Indeed, BIC and BLRT have been shown to perform the most reliably (Nylund et al., 2007). Entropy relates to better or worse probability of being successfully classified into a latent profile depending on how many latent profiles are selected. It provides useful information but should not be heavily weighted in a final profile solution (Masyn, 2013). Other important parameters that are less critical in making a final decision but should be considered include Akaike Information Criterion (AIC; Akaike, 1974), consistent AIC (CAIC; Bozdogan, 1987), and adjusted BIC (a-BIC; Sclove, 1987).

As indicated in Table 4, I started by estimating a one-profile solution, which was not a suitable solution when weighed against a two-profile solution, as indicated by the large decrease in BIC. In considering a two-profile solution against a three-profile solution, I noted that the two-profile solution had a higher BIC (BIC should be decreasing for best fit), significant BLRT (significant BLRT indicates better fit), and higher entropy (higher entropy values indicate better probability of successful profile classification). Additionally, the two-profile solution had one "large" profile (75.29%) and one "small" profile (24.71%), which drove me to consider if the larger profile could be further differentiated to explain a unique set of individuals. Model comparisons for the three and four-profile solutions indicated that a three-profile solution fit the data best, but the four-profile solution could have also been a reasonable solution. For instance, BIC only increased by less than 2.00, BLRT remained significant ($p < .001$), and entropy slightly increased by .02. However, given how little the parameters shifted, I also considered how a four-profile solution aligned with theoretical interpretability and concluded that it did not add anything new to the three-profile solution given that it branched out into a "moderate all" profile which was too similar to Profile 2 (see profiles below) in the same profile solution. I also weighed recommendations by Lubke and Neale (2006) which are to critically assess a profile that has less than 25 cases, as it may not be able enough to meaningfully interpret. The four-profile solution had a profile of $n = 18$, which did not align with recommendations by Lubke and Neale (2006). However, given that there are disagreements about this rule in the literature I did not make my decision to reject the four-profile solution solely based on this rule (Spurk et al., 2020). The disagreements are reasonable and often make the case that a small profile of 25 or less could be indicative of small group of "outliers" whose experiences are just as valid. As noted above, the fourth profile did not seem to represent a small group of outliers, but rather

branched out into a similar profile found in the three-profile solution. Taking these considerations into account, I selected the three-profile solution because it had the lowest BIC, a significant BLRT, and the profiles were theoretically interpretable (see Table 4 for profile comparisons).

I labeled the three profiles *"Low Engineering, Gender Stereotype Threat (ST) and Moderate Ethnic"* (Profile 1), *"Moderate-High Identities, Ethnic ST and Low Gender ST"* (Profile 2), and *"High Identities and Stereotype Threat"* (Profile 3) (see Figure 3). I used a descriptive process to name the profiles, by simply describing the mean levels of each latent construct. For instance, Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic ST*) included students who did not strongly identify with their engineering identity (*Low Engineering*), had low mean scores for gender stereotype threat (*Low Engineering, Gender ST*), and moderate-strong mean scores for both ethnic identity and ethnic stereotype threat (*Moderate Ethnic*). I also intentionally avoided using any unnecessary trichotomous terms, such as "adaptive" "neutral" and "maladaptive," to classify experiences and avoid portraying a deficit comparison about students in an "adaptive" profile versus a "maladaptive" profile.

Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic, n* = 31, 18% of the sample) was characterized by students who had a low engineering identity, a moderate-high ethnic identity and ethnic stereotype threat, and moderate-low gender stereotype threat. What is interesting about this profile is that it had the lowest mean score of engineering identity, which was significantly lower than that observed Profiles 2 and 3 (see Table 5), suggesting that students most likely to be assigned to this profile may not be identifying with the field of engineering. This low identification with engineering occurred while students experienced moderate to high levels of ethnic-and-gender stereotype threat and moderately identified with their ethnicity; these

levels were generally similar to Profile 2 and significantly lower than Profile 3. Additional information on mean comparisons can be found in Table 5.

Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST, n* = 105, 62%) was characterized by students who had a moderate-high engineering identity, moderate-high ethnic identity, moderate-high ethnic stereotype threat, but low gender stereotype threat. Given that this was the largest profile among the three profiles, it is important to note that these individuals were the only group experiencing low gender-stereotype threat, which was significantly lower than both other profiles. In a male-dominated field like engineering, I expected to find a profile where students had low perceptions of gender-stereotype threat, especially among men who may not have personally experienced gender stereotype threat in engineering. Despite having low mean scores of gender stereotype threat, this profile had moderate-high levels of ethnic stereotype threat and ethnic identity, which were similar to those observed for Profile 1 and significantly lower than those observed in Profile 3. Students most likely to be assigned to this profile had among the highest levels of engineering identity, which did not differ from Profile 3 and were significantly higher than Profile 1 (See Table 5). This suggests that individuals may have been guarded from the negative effects of ethnic-stereotype threat, especially regarding their ethnic identification and domain identification.

Profile 3 (*High Identities and Stereotype Threat, n* = 33, 20% of the sample) was a "high all" profile that is classified as high engineering and ethnic identity and high ethnic-and-gender stereotype threat. Students most likely to be assigned to Profile 3 had significantly higher levels of both gender and ethnic stereotype threat than the other two profiles, while still strongly identifying with the field of engineering and with their ethnicity. This profile may be explained through a lens of resilience given that despite facing both forms of stereotype threat at high

levels, students most likely to be assigned to this profile strongly identified with engineering, which was significantly higher than Profile 1. Students also highly identified with their ethnicity, which was significantly higher than the other two profiles. This may suggest that students most likely to be assigned to this profile had high levels of identification with their ethnicity and engineering despite the potential negative effects of stereotype threat. Additional information on mean comparisons can be found in Table 5.

Gender and year in school by profile membership. Using the R3STEP procedure, gender (men = 0, women = 1) and year in school (0 = first/second, 1 = third/fourth) were modeled as auxiliary variables to predict profile membership. Multinomial logistic regression coefficients and odds ratios for each pairwise comparison are presented below and each coefficient can be interpreted as the difference in log odds of being in a profile (vs. the reference profile) associated with a 1-unit difference in the predictor variable, controlling for the other predictors. Additionally, coefficients can also be found in Table 6.

In terms of gender, women were 30 times more likely than men to be in Profile 3 (*High Identities and Stereotype Threat*) compared to Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST*) ($b = 3.37$, $p < .001$, odds ratio = 29.17). Given that Profile's 2 and 3 significantly differed based on gender stereotype threat levels, this finding suggests that women were more likely to be assigned to a profile with higher levels of gender stereotype threat in engineering. Women were also more likely to be in a profile where ethnic stereotype threat, ethnic identity, and engineering identity were high. Similarly, women were also less likely than men to be in Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic*) than in Profile 3 (*High Identities and Stereotype Threat*) ($b = -1.67$, $p < .02$, odds ratio = .19). The pattern of findings suggests that women were less likely to be in a profile where engineering identity was

low, gender stereotype threat was moderate-low, and ethnic identity and ethnic stereotype threat were moderately-high, then a profile represented by high levels of identities and stereotype threat. This could point to the relative representation of more women in a profile where they highly experienced stereotype threat (both gender and racial) but also still highly endorsed their domain and ethnic identities. A pattern such as this may potentially speak to a sense of determination and resilience among women in these profiles. Moreover, women were also five times more likely than men to be in Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic*) than in Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST*) (b = 1.70, $p < .02$, odds ratio = 5.47). The important distinction between Profile 1 and Profile 2 was that students in Profile 1 reported lower levels of engineering identity and moderate-low levels of gender stereotype threat, whereas in Profile 2 engineering identity was moderate-high and gender stereotype was lowest among the three profiles.

With respect to year in school, third- and fourth-year students were less likely than first- and second- year students to be in Profile 3 (*High Identities and Stereotype Threat*) compared to Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST*) (b = -1.96, $p < .01$, odds ratio = .14). Third- and fourth-year students being less likely to be in the "high all" profile may point to the density of experiences more advanced students have with their identities and stereotype threat in engineering given that they have spent more time in the major. It is possible that third- and fourth- year students may negotiate parts of their identities through their experiences with stereotype threat and other microaggressions and discrimination, which may have led to more moderate (rather than high) levels on their identities and experiences of ethnic stereotype threat. On the other hand, third- and fourth- year students were more likely than first- and second- year students to be in Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic*)

than in Profile 3 (*High Identities and Stereotype Threat*) (b = 2.61, p < .001, odds ratio = 13.62). This may indicate that advanced students may be endorsing lower levels of their engineering identity and moderate-strong levels of ethnic identity and ethnic stereotype threat given their longer history as engineering majors and experiencing what it may be like to be a Black man or woman in an engineering major. In general, it seems that students in their third and fourth years had more complex identities and experiences with ethnic and gender stereotype threat than introductory students, who in their first two years may be more likely to be in a profile where they have high engineering identity, high ethnic identity, and high gender and ethnic stereotype threat. It is alarming that students in their first- and second- year of college may be experiencing such elevated levels of ethnic and gender stereotype threat.

Persistence and achievement by profile membership. The automated 3-step approach in Mplus was used to assess differences in career intentions and GPA based on students' profiles (see Table 7). This model approach does not include predictors of profile membership, as the 3-step approach does not simultaneously model both the predictor and outcome variables but uses the BCH estimator to estimate the outcomes on the profiles. A Wald Chi-squared test, also known as a Wald test, was used to understand how profiles significantly differed from one another based on career intentions and GPA. The findings suggest that those most likely to be assigned to the *Moderate-High Identities, Ethnic ST and Low Gender ST* (Profile 2) had significantly higher career intentions then those most likely to be assigned to the *Low Engineering, Gender ST and Moderate Ethnic* (Profile 1) ($\chi 2$ (2) = 52.57, p < .001). This finding makes sense in the context of engineering identity, given that individuals in Profile 1 also had significantly lower engineering identities than individuals in Profile 2, which in turn would impact their goals for pursuing an engineering-related career. Profile 2 not only had higher

engineering identity than Profile 1 but also had higher ethnic identity, and low gender stereotype threat in engineering, which could partially explain their interest in an engineering-related career. Additionally, the *High Identities and Stereotype Threat* (Profile 3) had significantly higher career intentions than the *Low Engineering, Gender ST and Moderate Ethnic* (Profile 1) ($\chi 2$ (2) = 61.19, $p < .001$). Similarly, individuals in Profile 3 had higher engineering career intentions while having high engineering and ethnic identities and experiencing high gender-and-ethnic stereotype threat. For individuals in Profile 3, their strong identification for engineering and ethnic identities may be serving as a buffer for their experiences with gender and ethnic stereotype threat, in turn reflecting through their engineering career intentions.

Interestingly, for GPA, the results suggested that the various profiles did not significantly differ from one another, and, in general, GPA was comparable among the three profiles. This might suggest that generally students perform at similar levels despite having complex experiences with their identities and experiences with stereotype threat.

Brief Discussion

Within this explanatory mixed methods design, I conducted a latent profile analysis as part of the quantitative portion of the study to better understand the potential profiles of ethnic identity, engineering identity, ethnic stereotype threat, and gender stereotype threat among a sample of Black engineering students (N = 169). For research question one (*What are the multiple latent profiles of ethnic identity, engineering identity, gender stereotype threat and ethnic stereotype threat?),* I found support for three-profiles, which were characterized as being a low engineering identity, and moderate ethnic identity and ethnic stereotype threat profile (Profile 1), a moderate-high engineering and ethnic identity but low gender stereotype threat

profile (Profile 2), and a “high all” profile that had high identities and high stereotype threat (Profile 3).

While there are no prior studies that have considered profiles of ethnic and domain identities and stereotype threat, there are studies that have considered the relations between these constructs in the form of path analyses and moderated effects and can provide insight into the profiles themselves (Armenta, 2010; Weber et al., 2018). For instance, extant research has found that strong and positive connections to one’s ethnic identity may serve as a buffer against the potential negative effects of racial and gender stereotype threat (e.g., Wheeler & Petty, 2001). Indeed, in Profile 3 (i.e., the “high all profile), individuals who had high means on both ethnic and gender stereotype threat also highly identified with their ethnic identity and their engineering identity. This was also the case for individuals in Profile 2, in which students had moderate-high means on engineering and ethnic identity, but also a moderate-high mean on ethnic stereotype threat (but low mean score on gender stereotype threat). There is also a large body of research that explains resilience as a potential explanation for students positively and strongly endorsing relevant identities in the face of adversity (e.g., McGee & Spencer, 2012; Oyserman et al., 2001). Indeed, Black students in engineering may be experiencing what McGee and Spencer (2012) theorize as a cycle of vulnerability and resilience, such that experiencing significant risks and challenges might serve as a protective factor in the face of adversity. On the other hand, research has found that group identification, in general, could increase the susceptibility to the effects of stereotype threat and in turn negatively affect group identification (Davis et al., 2006; Schmader, 2002). Indeed, Wright (2009) describes an “oppositional stance” that leads Black students to remove themselves from educational harm given the way they have been negatively presented and affected through the curriculum. This is in opposition to deficit perspectives that have stated

de-identification may be because of students' actual abilities. In the case of Profile 1, individuals had low mean scores on engineering identity and moderate-high mean scores on ethnic identity, but moderately high ethnic stereotype type and moderately low gender stereotype threat. One potential explanation for this pattern is that individuals' domain identity may be negatively affected by their experiences with ethnic and gender stereotype threat. Unlike students who may be experiencing buffered effects, through vulnerability and resilience, these students' engineering identity, and even ethnic identity, may be at a greater risk of being harmed.

For research question two, *How are gender and year in school related to the probability of being in one profile versus another?*, I sought out to understand how profile membership varied based on gender (man/woman) and year in school (first/second or third/fourth). Notably, women were more likely than men to be represented in Profile 3 (relative to Profile 2), which can be assessed through CRT and Black feminist perspectives. Indeed, Black women's marginality in engineering can be conceptualized in terms of the intersections of their race, class, and gender (Cole, 2009; Crenshaw, 2011). Women's greater likelihood of being in the "high all" profile (relative to Profile 2) may suggest that they have high means of ethnic and gender stereotype threat, while also identifying with their ethnicity and as an engineering student. It is important to consider that while Black women may be experiencing high gender-and-ethnic stereotype threat, and high identification with engineering and their ethnicity, it might be at a significant cost. For instance, there may be potential psychological stressors that are not examined in this study that can speak to the marginality and deleterious effects of being a Black woman in engineering. It is also noteworthy to mention that across all three profiles ethnic stereotype threat was moderate to high, and this can be understood in terms of the history of anti-Black racism in STEM. Experiences of "threat in the air" and negative perceptions about oneself in a space can be

situated in the historical context of Black individuals being perceived as having no meaningful intellectual or cultural development (Gordon, 2008). This racialization is relevant across both men and women in engineering, though might have unique effects based on the gendered and racialized experiences of Black women. I also examined group differences among first/second and third/fourth year students. I found that advanced students were more likely than introductory students to be in Profile 1 (relative to Profile 3), where it is characterized by a low engineering identity, moderate-high mean scores on ethnic identity, but moderately high ethnic stereotype type and moderately low gender stereotype threat. This finding may speak to the breadth of experiences, particularly within identity development and experiences with stereotype threat, that advanced students have experienced.

My final research question addressed how profile membership predicted intentions to pursue an engineering-related career and cumulative GPA (*Are students of these different profiles more or less likely to intend to pursue engineering careers and more or less likely to achieve in engineering (based on GPA)?*). The results indicated that the *High Identities and Stereotype Threat* (Profile 3) had the highest mean score for career intentions, which may suggest that having a high engineering and ethnic identity may buffer potential negative effects that high ethnic and gender stereotype threat may have on engineering career intentions. Inversely, the *Low Engineering Identity, High Ethnic ST* profile (Profile 1) had the lowest career intentions mean score, which supports the idea that individuals who do not strongly identify with engineering may also not have intentions to pursue engineering related careers, though more examination is needed to understand why. Interestingly, I did not find significant differences in GPA among the three profiles, suggesting that individuals have comparable levels of achievement. Contrasting this with the findings for engineering career intentions is interesting

and may suggest that despite varying levels of identities and perceived stereotype threat, individuals in this sample are high-achieving and share that with one another.

Chapter 4:

Qualitative Study: Research Question 4

The second phase of this explanatory mixed methods design was to qualitatively examine a sub-sample of students from the quantitative sample to contextualize the profiles and learn more about these students' identities and experiences stereotype threat, racism, and discrimination in engineering. Chapter 4 focuses on examining Research Question 4: *What themes are found among Black undergraduate engineering students related to their identities as well as their experiences with racism and discrimination and persistence in engineering? Are there differences in themes based on profile membership and how do these themes support or contradict the quantitative findings?* I begin by describing the method, which includes information on participants, procedure, interview protocol, and analytical strategy. I also describe the results from the qualitative data, followed by a brief discussion.

Method

Participants. Given that this study is an explanatory sequential mixed methods design, the qualitative data were collected from a sub-sample of participants who were in the analytic quantitative. A sub-sample of N = 15 current engineering, past engineering, or recently graduated students were interviewed (73% female, 27% male, 33% first generation status). Based on interviewees self-reported race, ethnicity, and gender during the interview, racial self-categorizations included Black (n = 5), Black or African American (n = 6), African American (n = 3), and Tanzanian American (n = 1). In terms of ethnicity, self-categorizations included African American (n = 3), African (n = 1), American (n = 1) Black (n = 3), Mixed (n = 1), Nigerian (n = 1), Canadian (n = 1), Tanzanian American (n = 1), Cameroon and Togo (n = 1), and none/no ethnicity (n = 2). It is important to note that many individuals did not differentiate

their identity based on race and ethnicity and struggled to make an important distinction between the two categories for their identities.

Participant Flow. Of the 169 number of participants eligible to participate in an interview, I invited 131 participants (78% of total sample), received interest from 16 participants, and interviewed 15 participants after one student did not keep the interview appointment. I provide information below about how the 131 invited participants were selected. Participants were recruited for a one-on-one interview based on their "membership" in one of three profiles identified from the quantitative data analyses. In the latent profile analysis, individuals were categorized into one of three profiles based on the probability of alignment with a profile. For instance, one individual may have had an 87% probability of being in Profile 1, but a 13% probability in Profile 2; in this case, the individual would be assigned to Profile 1. I used the profile probabilities command in Mplus (or CBROB) to save individuals into respective profiles (Asparouhov & Muthén, 2014; Vermunt, 2010). I selected individuals based on their profile membership and individuals were selected to be in any given profile if their probability of being in that profile was 70% or higher. I also created a strategic plan for recruitment to avoid saturating the interview respondents as coming from one representative profile.

My plan for recruitment was to invite as many participants as possible, with the assumption that only a subset of individuals would be interested in participating and I could not over commit by scheduling more interviews than I had the budget for ($750 total, for 15 total people, $50 per person). I engaged a nonprobability sampling procedure, given that I had parameters that I intended to meet, including sampling individuals from each profile, and obtaining variability in gender and year in school. While my goal was to have an equal sample among all indicators, sampling was not equally balanced as some groups were more represented

than others within the profiles (See Table 8 for Sampling Grid). Also found in Table 8 is the breakdown of the quantitative analytic sample, broken down by gender and year in school for each profile based on most likely profile membership. I engaged in a random staggered sampling approach where I grouped individuals within profiles and randomly selected individuals within the profiles to recruit using a staggered process (See Table 9). Specifically, I invited individuals in specific rounds, with three unique rounds. I reached out to individuals a total of 3 times within each round and after the third contact attempt I continued to cycle through all rounds before considering contacting them a 4th time. I did not need to contact anyone 4 times, as by the time I had reached the 3rd round of participant emails I had received enough interest to meet my goal of N = 15. Participants were explicitly told in the invitation that the slots were "first come, first served" and should sign up as soon as possible to secure a spot. The breakdown of individuals reached to participate in an interview, including their profile membership and demographic variables, is included in Table 10. To protect the identities of the individuals, pseudonyms are assigned in Table 10, as well.

One important point to make is that women were oversampled for qualitative interviews, representing 73% of the qualitative interview participants but only 36% of the quantitative sample. One potential reason for this was that women are more likely to participate in research studies (compared to their male counterparts) and may have been more inclined to accept an invitation for participation in the interview. Of note, while the distribution of women versus men across the quantitative profiles significantly differed and there were almost twice as many men than women in the quantitative sample, women were still represented across all three profiles. Indeed, it is not surprising that I only received responses from women from Profile 3 for the interview given that many individuals most likely to be in Profile 3 were women. There were

also variations in year in school between the quantitative sample and qualitative samples, a difference that is clearest with respect to Profile 3, where almost 80% of participants most likely to be assigned to Profile 3 were in their first/second year for the quantitative survey but none of the Profile 3 interviews were conducted with former first/second year students.

As previously mentioned, participants were recruited for the study with the researcher being aware of their profile membership. The reason for unmasking most likely profile membership categories to was to ensure that participants from all three profiles were invited for interviews. Once participants signed up for interviews and were added to the participation contact list, their identifying information and profile membership assignment were unmasked to the interviewer. This is important to consider for potential bias that may have been introduced into the interviews as the interviewer knew which profile participants represented. When the data were being prepared for data analysis, the transcripts were all grouped together without consideration of profile membership. These masked data were analyzed collectively for the development of original codes. Once the codes were developed, I unmasked participant profile membership and analyzed the data to identify themes within each profile.

Procedure

Students were contacted via email during the Fall 2021 semester and were invited to participate in a 60-minute interview about their experiences as current or past engineering students (see Appendix D for email language). Given that the survey data and interviews were collected more than one year apart, there were students who were no longer current students and had recently graduated with engineering or non-engineering degrees. Additionally, students were in different years of school, with most previous first/second students being third/fourth students (or graduated) at the time of the interview (see Table 10 for their year in school at the time of the

interview). Participants were contacted via email and invited to participate in a structured online interview using Zoom. Aligned with safety protocol from COVID-19, interviews were exclusively conducted online. Participants were not matched based on ethnic/racial background to the interviewer given that all participants identified as Black, African American, or African (or based on a specific region in Africa). The interviewer was a Latina woman of color who identified as heterosexual and female, making it possible to match on gender for women but not for men. Participants who completed the interview session were compensated with a $50 Amazon gift.

Interview Protocol. Based on the explanatory sequential mixed methods design, the qualitative data collection efforts were informed by the quantitative data analysis (QUANTITATIVE → qualitative = explanation). My design included the initial quantitative survey measures and analysis, followed up by the qualitative interviews that are intended to help explain and contextualize the survey findings (detailed in Chapter 3). As a reminder, I found evidence for three unique profiles of individuals. Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic, n = 31*) was characterized by students with a low engineering identity, a moderate-high ethnic identity and ethnic stereotype threat, and moderate-low gender stereotype threat. Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST, n = 105)* was characterized by students with a moderate-high engineering identity, moderate-high ethnic identity, moderate-high ethnic stereotype threat, but low gender stereotype threat. Lastly, Profile 3 (*High Identities and Stereotype Threat, n = 33*) was a "high all" profile that was represented by students with high engineering and ethnic identity and high ethnic-and-gender stereotype threat.

Based on the quantitative findings, my goal with the interview questions was to gain a better sense of students' complex identities, such as the "high, medium and lows" of ethnic and

engineering identities. I also was interested in other parts of one's identity that were not quantitatively measured, such as gender identities, familial identities, and any other important parts of "the self." The questions were developed with the quantitative findings in mind but were kept general enough that they could be asked across the profiles. For instance, while the quantitatively identified profiles had specific "high, medium, lows" on engineering and ethnic identity and gender and ethnic stereotype threat, I did not ask questions of students as to prime their responses about the specific levels found. As an example, I did not ask a question framed as "based on our analyses, you have reported experiencing moderate-high levels of ethnic stereotype threat; can you speak to your experiences with stereotype threat?" While I was interested in the quantitative mean-level differences across the profiles, it was more meaningful to me to allow students to freely express their experiences with their identities and experiences in engineering, as a result I asked questions that would help me understand their identity, as well as broader experiences beyond stereotype threat, such as those with racism, discrimination, and microaggressions.

The interview began with questions about students' general educational history, reasons for pursuing their major, and about their racial and gender identity. Given that students were not explicitly asked about their gender identity in the quantitative data collection (but just their gender in a question formed as "what is your gender: male, female, or other"), I felt it was important to explicitly ask about gender identity to allow a broader range of responses. Then, interviewees were asked about their various identities, identity salience, and intersectionality. Following this was a set of questions about their experiences with racial and gender microaggressions, racism, and discrimination within the field of engineering. I also included a set of questions for individuals who switched their major out of engineering and specifically wanted

to know why they chose to do so. I was also interested in interviewees' feelings of belonging, overcoming barriers, and experiences with affinity spaces and extracurricular activities. Finally, I asked questions related to future career plans and goals after college. The interview protocol can be found in Appendix C.

Analytical Plan. A total of 15 audio recordings were saved onto a password protected server. The audio files were transcribed verbatim by the transcription service and once prepared they were downloaded and saved back onto a password protected server. I reviewed the transcriptions for quality and alignment by selecting a small subset of interview transcripts (N = 6) to ensure that audio files accurately matched the transcribed files. In general, the audio files only had minor errors, including spelling/grammar errors or audio issues that interrupted transcription in limited areas. All transcripts were edited by replacing the identifying names and replacing them with their respective pseudonyms, which are used throughout all tables and text.

For this qualitative portion of the study, my research question was: *What themes are found among Black undergraduate engineering students related to their identities as well as their experiences with racism and discrimination and persistence in engineering? Are there differences in themes based on profile membership and how do these themes support or contradict the quantitative findings?*. I addressed this question through a thematic analysis of students' multiple identities and experiences with stereotype threat in engineering fields, using ATLAS.ti qualitative software for data storage, coding, and theme development. According to Braun and Clarke (2006), thematic analysis is a qualitative analytical tool used to identify, analyze, and disseminate patterns/themes within the data. I followed Braun and Clarke's (2006) recommendation for six steps to data analysis: 1) familiarity with the data, 2) development of initial codes, 3) development of initial themes, 4) reviewing potential themes, 5) defining and

naming themes, and 6) producing the final report. The steps are described in more detail and outlined in Table 11.

Step 1: Becoming familiarized with the data. Aligned with recommendations by Braun and Clarke (2006), the first step in the thematic analysis was to transcribe all 15 interviews and spend time reading all the transcripts. I also took physical notes during the interviews, and I went back to read those notes. In my second iteration of reading the transcripts I developed memos for all participants and began the initial process of code and theme development. In this first step, I also began selecting parts of the interview protocol that could specifically describe or provide more context about the profiles. For instance, I was interested in understanding more about why I found a profile where engineering identity was low (Profile 1) and what the experiences of those students were. Therefore, I focused on sections where students discussed their identities and specifically if they made any connections to their engineering or academic identities more broadly. In the next stage, I defined my codes more specifically based on factors that could help explain the profiles.

Step 2: Development of initial codes. Step 2 in thematic analysis is the development of initial codes (Braun and Clarke, 2006). I accomplished this step using inductive and deductive coding strategies. Moreover, the goal of initial coding in thematic analysis is not to code word-by-word or line-by-line but to "discern the gestalt of the data and therefore examine (un)related and (dis)confirming points or perspectives as evidenced in coding patterns" (Lochmiller, 2021; p. 2035). The initial coding was motivated by understanding both interesting and relevant parts that could help explain and provide more context to the quantitative findings. My initial codes were either pre-determined research aims, research questions, and individual questions asked in the interviews or found through reading and reviewing the transcripts. For instance, one code that

was pre-determined was “identities” as I had broadly asked about participants’ identities and there was much data to speak to the various parts of one’s identities. Also, this code would be later used to understand themes around identity broadly. An example of a code that was not pre-determined was reliance, as this was something I observed when reading the interviews that seemed relevant in the context of understanding academic persistence in engineering. I eventually developed a list of 17 initial codes that broadly described Black students’ experiences with identities, stereotype threat, racism, discrimination, and persistence in engineering contexts. These initial codes, their definition, and primary examples from the data can be found in Table 12.

Step 3: Identifying for themes. Step 3 in thematic analysis was to construct themes through the codes. A theme can be developed when a pattern in the data is identified through qualitative analysis around a subset of individuals or within an individual (this is dependent on what level one is analyzing the data). While the development of a theme is dependent on a pattern, the theme itself does not require a predetermined number of responses and the number of patterns/responses does not equate to a more critical/important theme. I organized my data based on “networks” of individuals to understand patterns within the profiles rather than across all profiles. So, while broad codes were developed with the broader data set in mind, I developed sub-group themes within profile groups (See Figure 4 for my networks of students). At this stage I began to create themes based on meanings and patterns in the conversations and apply the a priori codes to understand how they explained phenomena within each profile. I organized these codes to create overarching/broader themes among the individuals within each profile. For instance, I had a string of codes that were “identities,” “salient identities,” and “intersectional nature of identities.” Among the responses coded for this, there was a pattern among individuals

who endorsed non-engineering identities, such as those related to passions such as sports and academic clubs. Thus, for Profile 1, the broader code was “identities,” which formed the basis for a “non-engineering specific identity” initial theme (discussed in more detail in results).

Step 4: Reviewing potential themes. At this stage, I considered profile-specific themes, and their relation to first level codes. I accomplished this by organizing my codes and themes in a visual map to understand the progression and connectivity of codes to final themes, described below in Step 5. Given that data were coded within the networks/profiles, I developed thematic maps for each distinct profile. The thematic maps for Profiles 1, 2, and 3 can be found in Figures 5, 6, and 7 in Appendix B. At this stage, I developed initial themes, which then informed defining and naming final themes that happened at step 5.

Step 5: Defining and naming themes. This final step was to refine and define my themes. This process was primarily based on collating/combining initial themes that shared connections given that themes should be broad level. The final theme development was also driven by their ability to address the research questions. This exercise was particularly beneficial for this project given that it afforded me the opportunity to think about how the themes helped explained or contradicted the quantitative findings.

There are also three types of thematic analysis, including reflexive thematic analysis, codebook thematic analysis, and coding reliability thematic analysis (Byrne, 2021). As their names suggest, each is bounded by their structure, such that for instance coding reliability thematic analysis uses a structured coding process and uses reliability statistics for establishing validity and credibility. In my dissertation, I used a reflexive thematic analysis given the flexibility it affords for theoretical and epistemological applicability. Given the exploratory nature of my quantitative data analysis (via latent profile analysis), it was important to find a

complimentary analytical approach for the qualitative data that could also be interpretive and reflexive.

Triangulation. Creswell and Creswell (2017) set forth a number of procedures to consider for establishing trustworthiness in the data, including triangulation of data, member checking, use of rich and thick descriptions of data, clarifying researcher bias, using counterexamples, spending prolonged time in the field, peer debriefing, or using an external auditor. I engaged in data triangulation of the quantitative and qualitative data to understand how well or not the qualitative findings supported the quantitative findings. Indeed, triangulation can work to converge information from various sources in four ways, which are through method triangulation, investigator triangulation, theory triangulation, and data source triangulation (Denzin, 1978; Patton, 1999). Data source triangulation afforded me the opportunity to further contextualize the quantitative data and add validity to the mixed methods approach. In this dissertation, triangulation primarily played out in the analytical interpretation stage, and this was achieved by thoroughly examining the ways in which the qualitative data, namely experiences of Black students within engineering, either supported or contradicted the latent profile analyses. It is important to note that there is much disagreement about the way triangulation should be employed (Hesse-Biber, 2012), as some studies describe it as a convergence tool while others describe it as a tool for divergence. I drew from Denzin (1970, 1989) who described triangulation as a ‘‘dialectical process’’ that serves to provide a more nuanced understanding of research findings, as well as to place contradicting findings in dialogue with one another to highlight the convergence and divergence of the findings.

Results

The following sections detail the results, which are organized by profile and theme. For instance, I begin by discussing findings among Profile 1 and the respective themes that I identified within that profile, followed by a discussion of the themes I identified among Profiles 2 and 3. I weave in information about triangulation throughout each theme, where I discuss the findings within the context of each theme and how the relevant qualitative findings may support or contradict the quantitative findings.

Profile 1: Themes. Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic*), quantitatively described as the profile with students who had a low engineering identity, a moderate-high ethnic identity and ethnic stereotype threat, and moderate-low gender stereotype threat, was examined closely to better understand the patterns and themes in the data. I developed themes from the first-level codes based on the specificity of students' experiences in this profile (n = 3).

During the original development of themes for Profile 1, I identified eight unique themes all based on patterns of responses from the three individuals in Profile 1. These themes were 1) high family expectations/influences, 2) loss of STEM interest, 3) endorsing many relevant non-engineering identities, 4) coping strategies for dealing with stereotype threat, microaggressions, discrimination, 5) low perceptions from institution, 6) overcoming barriers: institutional, faculty, and peers, 7) gender underrepresentation in engineering, and 8) racial underrepresentation in engineering (Profile 1 initial themes are defined in Table 13). In the final thematic development phase, these themes were condensed and appropriately combined into final themes, and more clearly discussed in the next sections. The three final themes were 1) reasons for pursuing and leaving engineering, 2) low perceptions/negative treatment 3) and overcoming barriers: affinity

spaces are described in the following sections. Figure 5 provides a Thematic Map for Profile 1 and helps to illustrate how the initial themes were synthesized into final themes. To protect the identity of the participants, the individuals in this profile pseudonyms are Jerry (M, Junior), Harmony (F, Senior), and Sean (M, Senior).

Reasons for pursuing and leaving engineering. A primary pattern I identified among the individuals interviewed from Profile 1 was their shared connections around deciding why to pursue an engineering degree as well as why they chose to leave the major at one point or another. Early in the interview, all participants were asked to reflect on why they chose to pursue engineering and to speak about their academic interests throughout K-12. I identified two patterns among all three individuals, such that their families played a major role in the decisions to pursue engineering and they all had non-engineering specific interests. They described their parents and immediate family members as having several college degrees and/or endorsing perceptions about engineering being a very good career path and therefore valuing it as a major. For instance, Sean described his family as having roots in an African country [exact country omitted for confidentiality] where obtaining a degree in engineering is very prestigious, and came from a family where his father, sister, and brother all pursued engineering. In speaking about why he decided to go into engineering, Sean said the following:

> "Coming from a different country, my parents brought us here for more education purposes. And so, actually they wanted us to do something that would make money so that we could support ourselves. So engineering is just the path that they chose, and the path that was presented to us as well. Because they've gone through it, so they already knew that once you're out of it, like the stability is there." [Sean, Male]

Similarly, Harmony switched her major from computer science to creative advertising in her second semester as a first-year student and went into engineering after telling her parents that she wanted to go to school for photography. When she told her parents about this decision, they said that she could not go to school for photography and talked her into engineering. She stated, "But closer to when it was time to apply to schools I was talking to my parents, and I told them that I wanted to major in something photography based because I was really into photography at that time. And, like I said, I always wanted to do something more creative. But my parents were like, "No, you're not going to school for photography." So, they talked me into engineering and that's how I ended up deciding to go into computer science" [Harmony, Female]. She further mentioned that when she was ready to switch her major to creative advertising, she did not tell her parents until she went physically home because she did not want them to talk her out of it. She also spoke at length about feeling more aligned with a career in creative advertising as it was something more natural for her.

Jerry described being from a family where both of his parents held doctorate degrees, but he also spoke to making the decision about going into engineering based on his potential to find something of interest in the STEM field. He mentioned that his parents were role models for him, and he always aspired to be a stellar academic. Jerry said the following:

> "I didn't want to come in undecided because I figured the time and the money is precious and I didn't want to waste time or money at all. And I was like okay, so I want to do something in the STEM field, because that's where the money is and that's where I think I'll find something that's interesting and that is kind of fulfilling to me." [Jerry, Male]

All three students in this profile also shared a similar pattern in their reasons for leaving or having plans to leave engineering, which was also interesting in the context of their year in

school. It is important to note that Harmony was the only one who left engineering in her first year of college for another major, but both Jerry and Sean continued to persist in engineering while having intentions to do something different after college. In the interview students were asked to reflect on their career paths and life after graduation, and both Sean and Jerry expressed their interest in taking different paths from engineering and they were both third- and fourth-year students at the time of the interview. Specifically, Sean spoke at length about having plans to go back to school for linguistics or teaching abroad and doing research on linguistics. Jerry expressed an interest in either pursuing another major, pursing his interest in sports, or having a career in cyber-security. While he had not completely decided against pursuing engineering, Jerry had options he was weighing for his future.

> "Yeah. So, I've actually been thinking about that a lot more lately. Because of COVID we get—so like even though this is my fifth year, I technically get another year. I could stay and [participate in my sport] [specific sport omitted for confidentiality] again next year and I'm considering doing that. Post—and I don't know if I'd go to grad school for that or if I do another major, I'm not quite sure. After that, I do want to keep playing the sport, so I want to kind of give, what they call like the senior circuit, or like the Olympic, Olympic style." [Jerry, Male]

The theme, reasons for pursing and leaving engineering, has some alignment with the quantitative findings from Profile 1, particularly in relation to their ethnic and engineering identities. In terms of alignment/misalignment with *a low engineering identity*, all three students in this profile were not particularly enthusiastic about engineering in relation to other interests and had decided or were weighing the idea of leaving engineering altogether. While I think there is a case to be made that Jerry was weighing engineering and non-engineering related pathways

(he also had a higher engineering identity level than Harmony and Sean), it was still apparent that his sports-interest was something important for his identity, and similarly for Harmony and Sean who were following paths in creative web development and linguistics (See Profile 1 comparisons; Table 16). This was further evidenced by the fact that when these individuals were asked to speak about their most salient identities, they all had a similar pattern to having salient non-engineering identities (See thematic map; Figure 5). Jerry shared that his most salient identities were his sports identity, being a student, and a friend. He described his sport as being a big part of who he is, given that he spends a lot of time thinking about it and doing it. Sean named his faith as being his most salient identity given that it was where most of his personal and social relationships stemmed from. And Harmony mentioned being a Black woman as the most salient part of her identity given that it affects her day-to-day life the most. Notably, Harmony reported a moderate-high level of ethnic identity on the prior quantitative survey, and this was supported by Harmony being the only individual to make clear connections to the importance of being a Black woman for her sense of self. Among the identities and their importance, Sean and Jerry did not mention their race or ethnicity as being particularly salient or important for their sense of self. This was surprising for Sean, given that he had the highest ethnic identity level among the other two students.

Low perceptions/negative treatment. Another pattern I identified among individuals in Profile 1 was their reflection on low perceptions and negative treatment that their professors and peers had on them as Black men and women. As indicated in the thematic map (Figure 5), the three students in this profile shared connections about negative treatment and low perceptions of their abilities from faculty, peers, and broadly the university/institution. For instance, Harmony, having spent only a short time in engineering courses, recalled feeling like people were a lot less

willing to listen to her or help her out. She anecdotally shared that when someone else was missing class during group work everyone would mark them as present and make sure they received notes, though when she was out sick no one reached out to her to fill her in on the work and showed an unwillingness to help her. She stated that these moments helped her realize her differences as a Black woman and was her first real-world experience of being treated differently as a Black person. Jerry similarly shared that he felt there was an initial distance between him and his peers and that it would take time for his peers to begin to feel comfortable around him. He also recalled an instance where he was in a group with other Black men and the professor mentioned to Jerry that a person in his group was being aggressive and that he also felt Jerry had an aggressive tone towards him, causing Jerry to feel falsely stereotyped by his professor.

Sean also shared his experiences with not feeling connected with engineering professors during his second and third year of his undergraduate studies and reflected on the underlying assumptions that race-based and needs-based scholarships had about students of color. He observed that scholarships geared towards students of color generally had a lower bar then those open to all students. He noted, “But a lot of time it seemed that it was an assumption that the standard for Black engineering students, to like to get into the college or get those scholarships was essentially lower than just the regular scholarships. And so that was something that didn’t always sit well with me.” [Sean, Male].

Given the shared connections to mistreatment and negative perceptions from faculty, peers, and at the institutional level within engineering, there was alignment with the quantitative findings regarding *moderate-high levels of ethnic stereotype threat*. In the quantitative results, Jerry and Harmony both had high mean levels for ethnic stereotype threat, but Sean had a strikingly low ethnic stereotype threat mean (See Profile 1 comparisons; Table 16). Students also

made important connections to their reasons for wanting to leave engineering or leaving early in Harmony's case. They noted that their experiences with low perceptions from faculty and mistreatment were not deciding factors for wanting to leave the field of engineering. Harmony mentioned that leaving engineering was due to the difficulty of the course work and Sean attributed his desire to pursue linguistics based on his passion for writing and teaching. One aspect of the quantitative findings that did not align with the qualitative findings for Profile 1 was *low gender stereotype threat.* Harmony made connections to the intersectional nature of her race and gender as a Black woman and experiences with stereotype threat, racism, and discrimination in engineering, which is contrary to low gender stereotype threat in the quantitative findings. Sean and Jerry, on the other hand, reported not personally experiencing gender stereotype threat and instead shared their thoughts about how it affects women in engineering. Sean shared the following reflection "Not any that are happening to me, because of being a man. But just noticing a lot of my women engineering friends who kind of get dismissed and when we do have group projects, and their voices kind of get overtaken by other men in the group." [Sean, Male]. The finding among Jerry and Sean generally supports *low gender stereotype threat* in this profile, and this is especially true given their low levels on gender stereotype threat in the quantitative findings.

Overcoming barriers through affinity spaces. The third theme in the data were related to shared experiences with overcoming barriers and resilience through affinity groups. In the previous section, I described the various experiences with racial and gender microaggressions, discrimination, and stereotypes threat that students in Profile 1 shared. They also shared connections to the ways they coped with those experiences and about the safe spaces they sought out (See thematic map; Figure 5). One connection I made between all three students was based

on their determination and resilience to persist in their majors despite being burdened with various “isms” at different levels. When asking how they overcame these barriers, students shared statements such as “you just have to keep your head up” [Jerry, Male]. Students in this profile also spoke at length about the various affinity groups, clubs, and sports that provided a sense of belonging and connection. For instance, Harmony spoke about finding value for being in spaces with other Black students and served on the e-board of a Black female organization on campus [name omitted for confidentiality]. She also was a part of the Advertising Association, but expressed initial concerns given the lack of diversity in that space.

> “I would say I definitely feel like I belong in [Black Female organization]. It feels a lot like just home. It feels like a comfortable environment. So, I love being in [Black Female organization]. As far as the Advertising Association, I felt like when I first had interest in it, I was really timid about going to the meetings and things like that because I didn’t really see too many other people of color at first. But eventually, I started meeting people of color outside of the Advertising Association who also were in advertising. And then eventually, we were going to the meetings together which just made it feel more comfortable for me.”

Similarly, Sean expressed his involvement in two separate affinity groups [names omitted for confidentiality]. He described these spaces as being more community oriented, welcoming, and being spaces where he could engage in his passions. As previously mentioned, Jerry was heavily involved in sports, which was not only the most salient part of his identity among other identities listed, but also served to bring him support and pride. He mentioned his sport as being a very White-centered space, but it being diverse in people's backgrounds and income levels.

One primary aim of this study is to understand persistence in engineering, and while

students in this profile were generally not choosing a path in engineering, both Jerry and Sean chose to stay in engineering for their undergraduate majors, while speaking of aspirations in doing something else. They suggested that the barriers they faced in engineering were not particularly deterring them from continuing in those paths, but it is possible that other informal spaces like sports and campus organizations provided a sense of community that they were not finding in their engineering courses, though this is my interpretation and not based on any actual connections they made to this. This sense of support and community may have contributed to students' resilience and determination to continue persisting in their respective majors.

Profile 2: Themes. Profile 2 (*Moderate-High Identities, Ethnic ST and Low Gender ST)* was quantitatively described as students who had a moderate-high engineering identity, moderate-high ethnic identity, moderate-high ethnic stereotype threat, but low gender stereotype threat and was also the largest profile among the three profiles (*n = 105*). During the original development of themes for Profile 2, I identified eight unique themes all based on patterns of responses from the three individuals in Profile 2. These themes were 1) engineering major persistence, for all but one medical student, 2) college centered-salient identities, 3) limited racial ethnic and racial identity salience, 4) exploratory interests in K-12, 5) alternative careers and pathways, both within and beyond STEM, 6) familial/friend/advisor influences towards engineering, 7) feelings of isolation, exclusion, and low belonging in engineering, and 8) peer and professor mistreatment and mistrust (Profile 2 initial themes are defined in Table 14). The final three themes identified were 1) college centered identities, 2) alternative and exploratory engineering/non-engineering pathways 3) and experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. See Figure 6 for the Thematic Map for Profile 2. To protect the identity of the participants, the pseudonyms used for the

individuals were Dante (M, Graduated), Sophie (F, Junior), Connie (F, Graduated), Denise (F, Graduated), Jeremy (M, Senior), Samantha (F, Senior), Brionna (F, Senior), and Latrice (F, Senior).

College centered identities. The first theme among the represented individuals from Profile 2 was based on a shared connection around having college centered identities (See thematic map; Figure 6). The analysis demonstrated that five out of eight students in this profile had salient what I am calling "college-centered identities," while three out of eight students had salient race and/or ethnicity and family-centered identities. For the college-centered identities, the students stated, "college student [Brionna, Male]," "student and brother/uncle" [Jeremy, Male], "researcher" [Denise, Female], "leader" [Samantha, Female] and "mentor" [Dante, male]. The other three students in this profile mentioned salient identities that centered around their race and ethnicity, as well as familial identities, which were "Black" [Sophie, Female], "Black woman and sister/friend/girlfriend" [Connie, Female], and Nigerian-American and daughter" [Latrice, Female].

Students in this profile were more likely to be classified as having moderate-high engineering identity, which shares connections to college-centered identities based on both forms of identity being academically focused. However, a college-centered identity, such as "student," does not provide overly clear connections to one's identification with engineering. There were also important connections to ethnic identity, given that those who endorsed "college-centered" identities, still highly identified with their ethnic identities, which is not explained qualitatively (See Profile 2 comparisons; Table 17). The profile comparisons suggested that Sophie and Latrice had the lowest levels of engineering identity, relative to all other students in this profile, and highly endorsed their race and/or ethnicity, above all other identities. It could be that Sophie

and Latrice's experiences with ethnic and gender stereotype threat (explained in the third theme) may be one reason for their low engineering identities and high ethnic identities.

Alternative and exploratory engineering/non-engineering pathways. The second theme among the individuals in this profile was related to their experiences with choosing engineering as a major and connections towards alternative pathways (both within and beyond engineering) that they had considered. When describing their trajectories into engineering from K-12 education, five out of the eight students shared similar stories about not knowing what path to pursue in college or aspiring to pursue non-engineering pathways. First, Dante described wanting to be an architect right out of high school. He shared the following statement*:*

> "I know when I graduated high school I wanted to be an architect. And this kind of is all, it is just kind of being very honest and transparent. So I didn't even know what an engineer was when I graduated high school. I knew I wanted, I kind of wanted to be an architect because I had seen, it was just like a passion of mine. But after talking to my advisor, she kind of convinced me of engineering, and I originally came in as a mechanical engineering student" [Dante, Male].

Similarly, Sophie, Latrice, Samantha, and Brionna all shared similar stories about having a variety of interests beyond STEM that they considered when choosing to do engineering. Brionna had interests in medicine, math, and science. She shared with me that she had confided in a friend about her indecisiveness about what path to take and her friend helped her make her decision to go into computer science. Similarly, Latrice commented that she had many interests and really loved fashion but did not think Fashion would be a stable career path. Upon talking to her friend, she influenced her to join the coding and robotics club and after some research learned she could "marry" her interests in writing, fashion, and art with computer science.

Samantha also shared her story about trying to make a decision about which pathway to choose:

> "So originally I wasn't sure what I wanted to do and I knew that I wanted to have something to do with a hands-on experience as a career as more of like a desk job I guess. So I found that with mechanical, it was a good major to fall back onto as a resource, because I had noted a lot of my family friends that majored in engineering were able to have different career paths that weren't strictly engineering. So I thought that that was more of a safety net I guess, of a major to have since I wasn't sure, instead of kind of sitting around taking classes of every single major until I found something that was a good fit." [Samantha, Female].

However, three out of the eight students shared a common thread around having early interests in STEM and that propelled them into an engineering major without similar reservations as the majority of students in this profile. For instance, Denise spoke about loving math and biology and found that by pursuing biosystems engineering she could apply both interests. While students shared a common thread around their major exploration, they also shared interests in the various career paths they were interested in taking, that were both engineering-related and non-engineering related. For instance, Dante spoke at length about wanting to only be in an engineering career for a short period of time while managing his side business full time, which is in financial literacy and crypto currency. He shared this reflection: "I think I could see myself in an engineering career. I honestly don't want to be in it. Like, even though I said like three years, I really want to say like five years max. But if I were going to be in an engineering role, I could see myself being more the manager type of role rather than being the super technical you know, by the book engineer." [Dante, Male]. Those that were considering staying in engineering-related careers also shared their connections around the variety of careers they would want to do. For

instance, Jeremy spoke about wanting to either pursue a career in game development, IT services, or joining the military.

At the time of this interview, most students had progressed into their junior/senior year or had already graduated. However, prior to the interviews, this profile had the most variability with represented first/second year and third/fourth year students. As such, this theme is interesting in relation to students' year in school. Interestingly, many students in this profile did not appear to start engineering with a clear path towards engineering in mind. Unlike students in Profile 3, where students had expressed interest in STEM during K-12 that impacted their decision to go into engineering, this was not really the case with at least five students in this profile. However, given that students in this profile still are persisting in engineering as a major may be indicative of growth in their engineering identities. Based on this observation, this theme may partially explain why students have moderate-high engineering identities.

Experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. The final theme among representative individuals from Profile 2 was based on shared connections on experiences with stereotype threat, discrimination, and racism. All students in this profile had personal experiences with forms of bias (e.g., experiences of racism), as well as anecdotes about bias happening to other peers of color and women of color. There were similar themes among the women in this profile, Connie, Brionna, Denise, Latrice, Samantha, and Sophie. One common thread among the women was feelings of isolation and incompetence when working in group work with men in engineering. For instance, Sophie, Denise, and Connie all shared a common story about how when working in a group work with other men they would rarely feel inclined to openly engage with them because the few times they did their ideas and opinions were disregarded as either wrong or flawed. Connie, who was the

one student among everyone else who switched majors from engineering to genetics, recalls these feelings of isolation as being one of the determining factors for switching majors. Relatedly, Samantha mentioned her feelings of incompetence in engineering based on her perception that she learned slower than her peers. She shared her experiences of not wanting to slow people down when working in groups or being perceived as the "girl who doesn't know anything." Brionna shared a powerful quote that encapsulated this theme and the experiences of the women of color in this profile:

> "It felt like because I was maybe the only Black woman in the class or whatever people just didn't draw to me or try to talk to me or include me in what they were doing. So, then it was like if I was in a group, it was because they needed someone or they kind of ran out of people to clique with, like I wasn't their first choice." [Brionna, Female].

Dante and Jeremy, the two men represented in this profile, also shared their experiences with stereotype threat, racism, and discrimination, and similarly to the women spoke about underrepresentation of Black men in engineering. For instance, Dante who was a senior at the time of the interview spoke about only having three Black friends who have persisted with him.

> "You know, was different. I really couldn't connect to, unless I was with other Black people. And then now I'm like, now that I'm about to graduate, I'm, there's only a couple of Black people. It's literally, there's only like three, no, there's only two other Black people that I know in my class that I'm about to graduate with. And I'm cool with both of them." [Dante, Male].

He also shared his general experiences with stereotype threat by saying that "I would say other people from other cultures don't really think of Black people as being smart… I used to think I was really slow and that I wouldn't make it" [Dante, Male]. Jeremy reflected on a racial

incident he experienced off campus where he was treated unfairly for being Black. While he shared this experience, he also explicitly said that at [University Name Blinded] he was not personally affected by stereotype threat, racism, and discrimination but that he witnessed it happening to others and around him. Like many others across the various profiles, he mentioned coping with these instances as "brushing it off" or "not letting it get to him."

Like in Profile 1, students in this profile shared similar stories around facing stereotype threat, racism, and discrimination in engineering and in other contexts (See thematic map; Figure 6). However, both Dante and Jeremy did not express being necessarily deterred from persisting in engineering because of these issues. Additionally, the women in this group, except for Connie, also did not express being deterred from engineering because of their experiences with stereotype threat, racism, and discrimination. Contrary to the qualitative evidence for Connie leaving engineering, her ethnic stereotype threat level was the lowest among all students in this profile. What I conclude from this is that, in her new major (genetics), Connie did not experience high levels of ethnic stereotype threat. Connie's low ethnic stereotype threat level also might suggest that while she was in engineering she might have been at greater risk of "threat" then at the time of the survey data collection (based on her qualitative reflections). In general, the individual reflections from the interview data, in addition to quantitative support, speaks to the *moderate-high levels of ethnic stereotype threat* (See Profile 2 comparisons: Table 17). Moderate-high levels of ethnic stereotype threat levels do not however provide support for low levels gender stereotype threat, as women spoke about their experiences as being Black women in an intersectional nature which suggests that both their race and/or ethnicity and gender were both affected in their journey. Low levels of gender stereotype threat were quantitatively supported by Dante and Jeremey, but the women on the other hand had higher levels of gender

stereotype threat (See Profile 2 comparisons: Table 17).

Profile 3: Themes. Profile 3 (*High Identities and Stereotype Threat*), quantitatively described as the "high all" profile that is classified as high engineering and ethnic identity and high ethnic-and-gender stereotype threat, was examined closely to better understand the patterns and themes in the qualitative data. I developed themes from the first-level codes based on the specificity of students' experiences in this profile (n = 4). During the original development of themes for Profile 3, I identified seven unique themes all based on patterns of responses from the four individuals in Profile 3. These themes were 1) defying the odds with engineering persistence, 2) paving the way for other women of color in engineering, 3) STEM and medicine interest, 4) African American/Black woman salient identity, 5) complexity in Race x Gender [intersectionality] for African American/Black women of color, 6) exposure to others' experiences with racism and discrimination 7) major changes within engineering, 8) low male peer expectations, 9) professor/TA exclusionary experiences, and 10) affinity spaces (Profile 3 initial themes are defined in Table 15). Based on the recommendations by Braun and Clarke (2006), I reflected on these original themes and engaged in a process of revision and refinement to develop three final themes. The three final themes were 1) STEM interest and persistence 2) salient identity as African American/Black woman and intersectional identities, 3) and experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students are described in the following sections (See Figure 7 for the Thematic Map for Profile 3). To protect the identity of the participants, the pseudonyms are Darlene (F, Senior), Shondra (F, Senior), Armani (F, Graduated), and Jasmin (F, Graduated), and this sub-sample was fully women.

STEM interest and persistence. The first theme identified was based on the shared interest and persistence in engineering and computer science. Within this profile, Armani and Jasmin had graduated with engineering-specific majors at the time of the interview, Darlene was pursing an engineering major, and Shondra was majoring in experience architecture and minoring in computer science. When asked why they chose to pursue engineering majors and minors, these four students spoke at length about their interests in STEM dating to their K-12 years. For instance, Darlene spoke about having an initial interest in pediatrics and medicine given that she wanted to work with children like her mother. In high school she joined an engineering club and loved the experience of doing things that were hands-on and interactive. Indeed, her two interests with pediatrics and engineering "married" when she learned about biomedical engineering, which led her to choose mechanical engineering given the fact that she could specialize in biomedical engineering. Similarly, Shondra and Armani both developed interests in web design/development, with Armani really liking math and problem solving since high school. Jasmin also developed an interest in engineering starting in 5th grade when she first became involved in robotics, and this shaped her decision to go into electrical engineering. While the students in this profile shared similar trajectories based on their interest in engineering and computer science, the majority (3/4) also shared similar interests for wanting to purse an engineering career. Shondra, for instance, described wanting to use her major in experience architecture and minor in computer science to pursue a career in either programming or cyber security, as she was going to be interning with an engineering firm, in the summer. Similarly, Darlene mentioned she was going to use her degree in civil engineering to work for a civil engineering design company and Armani was going to use her degree in computer science and minor in mathematics to work in software development.

Jasmin spoke at length about her future and shared that she was going to be pursuing a career in patent law after college and had interest in pursuing a law degree. Interestingly, she mentioned that to become a patent attorney you must also have a STEM degree. So, while she was taking a path outside of engineering, she is still using her engineering background to engage within the law sector. This was her reflection about her career plans:

> "So, I actually did a career shift, but not really - this is what I've been doing. So, I decided to go into the field of patent law. So, I'm applying to go to law school so I can become a patent attorney. And the reason I say it's not a huge change is because in order to get your patent - to become a patent attorney, you have to have a STEM degree. And so, a lot of the work that I'm doing now - it's a lot of electrical engineering aspects involved in learning about the new technologies that people are trying to get a patent on." [Jasmin, Female].

Relatedly, the women in this profile also spoke at length about how their role as Black women in engineering serves as a way of "paying it forward" to other women who look like them or defying the odds of who persists in engineering. Indeed, Darlene's shared that she feels like she is an advocate and has more empathy for people because of her race. Similarly, Shondra stated that being a woman of color and a designer connects her with other women of color: "me being a woman of color, but also like a designer in that aspect, it allows for other women of color who are engineers and designers to reach out to me" [Shondra, Female]. Jasmin spoke about defying the odds as a woman of color in engineering and described being an engineer as giving her a sense of freedom.

What is interesting about this profile, being the "high all" profile on both identities and both aspects of stereotype threat, is that I expected to have a group of individuals who strongly

identified with engineering. Indeed, all three women shared connections from a young age to engineering and STEM more broadly, and all, even Jasmin to an extent, had plans for using their engineering degrees to be in engineering-related careers. This is consistent with the quantitative findings that suggested the individuals in this profile had the highest level of engineering identity (*M = 4.01*). Darlene, Shondra, and Armani all had *high engineering identity scores,* and unsurprisingly Jasmin had the lowest engineering identity level but was still highly consistent with her interests in pursuing an engineering-related career (See Profile 3 comparisons: Table 18). There are also important connections to this theme and *high ethnic identities.* The women shared ways in which their race and ethnicity provides a source of pride and strength, as they are defying the odds by persisting in engineering. This is supported through the high-level scores on *ethnic identity* (See Profile 3 comparisons: Table 18) and is also further supported by the next theme which is *salient and intersectional identities.* Also, within the quantitative findings Profile 3 had a significantly higher mean score on engineering career intentions than Profile 1 where engineering identity was also visibly lower among Sean, Jerry, and Harmony. This also supports the quantitative findings given that the women in this profile had intentions of using their undergraduate training in engineering to pursue in a career in their respective domains.

Salient identity as African American/Black woman and intersectional identities. The next theme identified among the four women in Profile 3 was based on their ethnic and/or racial identity, and specifically about the shared connection among three out of four women discussing their race and/or ethnicity and gender as their most salient identity. One of the main questions of interest in the interview protocol was to understand the various parts of one's identity and to understand which parts were most salient to them and why. I was particularly interested in understanding if students strongly identified with their race, ethnicity, or academic domain and

why, given that this would help explain at least part of the profiles. The three individuals who named their racial or ethnic identity as being the most important to them were Darlene, Armani, and Shondra. Jasmin, on the other hand, selected being an aunt as her most salient identity, but made interesting connections to her race, which will also be discussed.

Darlene, Armani, and Shondra all chose different words to describe their shared salient identities. For instance, Darlene mentioned being African American or Black as her most salient identity, and while she did mention being a woman alongside also being a daughter, student, and advocate, she spoke to being Black separately from her womanhood. This speaks to the complexity of intersectionality given that individuals may not always perceive their race and gender as being inextricable in every moment. In other words, for Black women it's possible their race or gender are more or less equally relevant in some situations. This may be true when they are in engineering spaces where males are overrepresented and gender stereotypes surrounding incompetence of women in those fields may make gender salient when race or ethnicity is not. Indeed, Darlene said the following statement:

> " I would have to say like African American or Black is important to me. And I would say, last and most important because it affects multiple ways in how I interact kind of through life. With that said, I feel like I'm an advocate and I feel like I have that empathy for other people because of the background of my race, and I could just look at people's deficits. That's really important to me and I don't know, I feel like my race just has prepared me for different obstacles in life, as a student, as a woman, as I look other people, advocate for them and things of that nature"

However, Darlene later did make explicit ties to the intersectional nature of her identities as a Black woman. She mentions the following reflection: "So I feel like, you know, my race and

my gender kind of go hand in hand with each other, like I don't have that much representation with both" [Darlene, Female].

Armani and Shondra, on the other hand, mentioned being a Black woman and woman of color and their most salient identities. They both had similar reasoning for identifying most with their race and gender which was that being a Black woman/woman of color is something they both have to deal with every day. Shondra specifically stated, "I would say woman of color because as sucky as it is, it does play a vital role for me every day" [Shondra, Female]. While Jasmin selected aunt as her most salient identity, she also made some noteworthy connections to being a woman of color: "I feel like, as a woman - a black woman, you've got to prove yourself at every step, every second. It's just a lot that comes with it, a lot of microaggressions, a lot of racism, just a lot" [Jasmin, Female].

These four women that represented Profile 3 made important connections with their experiences as Black women or women of color and majority shared a thread around finding their race and/or ethnicity to be most important to them. Within this profile, students had high levels on all variables in the profile, and namely for this theme it supports my hypothesis about ethnic identity salience among representative individuals in this profile. While Jasmin did not identify her race or ethnicity as her most salient identity, there is evidence that it was still valuable for her among her other identities and a sister, daughter, and aunt.

Experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. The final theme was about the women's experiences with both gender and racial stereotype threat, discrimination, and racism. What is unique about this theme, in contrast with a similar theme found among Profile 1, was that the women spoke to these experiences through the lens of intersectionality or by speaking to their race and gender

simultaneously. Several sub themes are worth mentioning for this broader theme which include underrepresentation, low expectations, and mistreatment, and being "weeded out." In terms of underrepresentation, Shondra shared her experience about there being a lack of people who looked like her when she was still a computer science major. Jasmin also made a similar connection by saying, "I can count on my hand how many people - women of color that I've seen in the classrooms" [Jasmin, Female].

Another sub theme within this broader theme was about the shared experiences with professors and students having low expectations of them. Darlene recalled group work and how they made her feel like she did not know as much as them:

> "if you're in a group project or something and you're in a group with all guys, there are time when they try to speak over you or just kind of dismiss your ideas because you're a female and they don't think you're—necessarily, you're not good at math or she doesn't know, kind of 'mansplain', certain things to you, and it's like I know what I'm doing." [Darlene, Female]

Along the same lines, two of the four women experienced what is known as the "weed out" effect, which is historically about pushing out less "prepared and competent" students out of any given major but mostly within STEM. Both Shondra and Darlene had negative experiences with a professor and teaching assistant while seeking help. Specifically for Jasmin, she had an experience with one of her electrical engineering courses where she was having trouble understanding a set of concepts and her professor proceeded to tell her that she should change her major because by not understanding those ideas it wouldn't make sense for her to proceed. She shared how this created a lot of insecurity for her in that moment and did not feel supported in her engineering pursuits. Similarly, Shondra had a negative experience with a teaching

assistant where she was harmed by a statement made regarding her ability to be successful in an engineering course. She shared the following anecdote:

> " I went to the help, [name of center omitted], and I asked the teaching assistants in there and they were just like I'm not sure how you're going to understand this if—I mean I'm not sure how you're going to pass the class if you can't understand this, or something like that. It was just like I thought you guys were here to help, not to put someone down" [Shondra, Female].

Given that this was the "high all profile," it is interesting to think about how race and gender played an important role for the women represented from Profile 3, particularly as it related to their experiences facing racism, microaggressions, and stereotype threat from their peers and professors. This theme supported the quantitative findings related to *high ethnic and gender stereotype threat*, given the trend among all three women. One noteworthy observation however was Darlene's low gender stereotype threat level. In the theme related to salient identities I mentioned that Darlene originally did not make connections to being a Black woman as most salient but highlighted her race as most salient. This may explain why her gender stereotype threat was low, comparable to the other women. If someone does not find their gender to be as important to them, or cannot tease apart their racialized and gendered experiences, it may lead to feeling fewer negative effects related to their gender.

Brief Discussion

The main aims of this qualitative investigation were to identify the various patterns and trends in the data that could either provide support or contradict the quantitative findings. Quantitatively, I found patterns among individuals responses based on their mean levels of ethnic identity, engineering identity, ethnic stereotype threat, and gender stereotype threat. Specifically,

three unique profiles or groups of individuals best explained the quantitative data. The first profile, named the *Low Engineering, Gender ST and Moderate Ethnic* (Profile 1), had three representative individuals invited for interviews. The second profile, name the *Moderate-High Identities, Ethnic ST and Low Gender"* (Profile 2), had eight representative individuals invited for interviews. The final class, *High Identities and Stereotype Threat* (Profile 3) had four representative individuals invited for interviews. I conducted a thematic analysis for each profile, following recommendations from Braun and Clarke (2006). In this brief discussion, I primarily discuss the themes among the profiles and the connections to literature.

Among the individuals in Profile 1, Jerry, Harmony, and Sean, three themes were identified. The first theme was based on shared experiences around why they chose to pursue engineering in college and their future non-engineering related career plans. Indeed, their stories shared similarities about being heavily influenced, and perhaps even forced, into engineering majors despite having other passions and aspirations. Their families shared similar values for education and expectations for them to pursue a financially sustainable and reliable position like engineering. This may be explained by Marcia's (1993) theory of a foreclosed identity which is when individuals have strong ties to their identities but adopt other beliefs and values that are instilled by authority figures such as family and mentors. Relatedly, the interviewed students shared interests and passions for engaging in non-engineering related fields. Among Black families, and broadly low-income families or diverse racial groups, having their children obtain an education and secure a financially stable position is particularly important and even sometimes necessary for sustaining the family (Browne & Battle, 2018). While only Harmony decided to change her major and leave engineering, they all expressed interests and aspirations in pursuing non-engineering related careers and fields after college. This theme may partially

explain one of the primary differences of this profile from the other two profiles, which was a low engineering identity. All three students not only had salient identities that were not engineering specific, but strongly identified with the other aspects of their self that also mapped onto their future aspirations.

The second theme, which I identified across all profiles, was negative perceptions and instances or racism, discrimination, and microaggressions from peers and faculty. All individuals shared their experiences facing differential treatment in engineering, and within this profile individuals spoke to the isolation they experience from peers and negative perceptions from professors. Interestingly, one student mentioned the negative messaging also sent by university structures that provide scholarships for Black students and students of color more broadly. He asserted that these scholarships are not equitable with less expectations and requirements compared to scholarships open to broader populations of students. This speaks to an equity issue, but also to a potential deficit notion that Black students, and students of color more broadly, should have an "easier" application process or less requirements for scholarships to be able to meet them. One could also argue that accessibility is important for those scholarships, and that is why they are potentially less challenging to apply to than broader university scholarships, but Sean's perception on the scholarships being less rigorous is noteworthy as this is his lived experience. These shared experiences based on differential treatment can be assessed through race permanence and speaks to the racialized and gendered mistreatment in engineering fields (Bell, 1992).

Also noteworthy is that I identified this theme across the other two profiles, providing alignment with the quantitative findings that students generally reported moderate-high levels of ethnic stereotype threat. Given that there was only one woman in this profile, the connections to

gender-specific stereotype threat, or gender-based discrimination and microaggressions, were limited but still relevant for Harmony. Indeed, she spoke at length about feeling isolated in engineering and like no students were willing to help her while she was still in the major. Additionally, Jerry and Sean self-reflected on the experiences of women in engineering and had interesting reflections on the type of negative treatment women face in engineering (e.g., being silenced in group work). This theme is supported by critical race theory which suggests that racism is embedded in the social fabric of our institutions, and in this context among engineering peers, faculty, and institutional structures (Bell, 1992; Crenshaw, 1991). In general, this theme and the prior theme (leaving engineering), provide potential explanations as to why individuals most likely to belong to Profile 1 reported low engineering identities, moderate-high ethnic stereotype threat, the moderate-low gender stereotype threat. Moreover, among the three students, they did not attribute "leaving engineering" or pursuing other passions due to negative experiences in engineering per se. For instance, Harmony chose to leave engineering because of her initial interests in pursuing a college degree where she could learn art and design. This further supports the low engineering identity findings.

The final theme for Profile 1 was based on shared connections for coping with instances of racism, discrimination, and stereotype threat. Their shared experiences for other passions and interests that provided community and belonging in ways that engineering did not. This finding is also supported by Critical Race Theory and specifically speaks to counterspaces that individuals may seek to experience community and belonging especially when facing racism and discrimination in other settings (Datnow & Cooper, 1997). While this speaks to the importance of affinity spaces for Black students in engineering, it also begs the question about what engineering could be doing to provide more race-and-gender based support for marginalized

students, and how they could potentially learn from affinity/counterspaces to create those environments within engineering. Indeed, students broadly described their experiences seeking affinity spaces, especially those with higher representation of women and other Black students (or students of color broadly). Interestingly, the affinity spaces mentioned (names/descriptions omitted for anonymity) were spaces that were generally more inclusive and supportive then their engineering courses. While it was not a focus of this dissertation and more study is needed, students spoke at length about their feelings of belonging being stronger in these affinity spaces compared to their engineering courses. It is indeed the case that affinity spaces are generally more inclusive of people's needs, hence the reason they choose to engage in those spaces to begin with. However, there is a disconnect between the treatment students receive in those affinity spaces and engineering (based on the shared qualitative stories) and there are affordances of understanding how to develop synergy among these spaces for persistence and achievement. Despite Harmony being the only student, whose salient identity was based on her race and gender, all students reflected on being Black men or women in engineering and seeking specific race-and-gender based affinity spaces, which may support the quantitative findings of moderate ethnic identity.

Profile 2, represented by Dante, Sophie, Connie, Denise, Jeremy, Samantha, Brionna, and Latrice, also had three final themes. The first theme was based on their shared college centered identities. Majority of students in this profile had salient identities that centered around the academy and their values within the academy, such as being a student, mentor, and leader (though not identified as engineering students or engineers per se). For the three other students who did not choose a college-specific identity, they spoke about their race, ethnicity, and gender as being most salient. The quantitative results for this profile on engineering identity were

moderate-high which is only partially supported by these qualitative findings, given that there are similarities that can draw from student identity to engineering identity, but not as easily for mentor and leader. Especially when considering the second theme about alternative and exploratory pathways that students took during K-12, these students may not have particularly strong connections to engineering though still value being a student, mentor, and learner. For ethnic identity, the Sophie, Connie, and Latrice all identified with their race or ethnicity and gender and spoke at length about being Black women in engineering. Given that other students in this network also mentioned their race or ethnicity and gender as parts of their identities, though not most salient, speaks to the relative support of ethnic identity being moderate-high among the individuals in this profile.

As previously mentioned, the second theme was related to alternative and exploratory pathways in engineering and non-engineering. The individuals in this network shared similar stories about how they came to pursue engineering while weighing a number of exploratory paths and interests. While I believe this is something that many students do as part of their developmental progression into college, I found it to be interesting the context of theme 1 and the conversations around that theme. Students spoke to engineering not being their first choice and weighing other options, which varies significantly from what students experienced in Profile 1 (where students have very low intentions and interests for pursuing engineering) and Profile 3 (where students had strong STEM interests in K-12 that impacted their decisions to pursue STEM) (described below). The alternative and exploratory pathway's theme was also supported by several students sharing their intentions to go into non-engineering pathways, though majority of students still expressed interest in engineering pathways. This theme speaks to the particular importance of alignment between parts of our identities, such that domain identities or the field

we choose to pursue should also align with other parts of our identities and our passions (Syed, 2010). There is also support along this theme for moderate-high engineering identities, as students did not share particularly high or low connections to engineering and academic identities.

The final theme, like in Profile 1, was related to experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. Particularly for the women in this group, they shared similar stories around feelings of isolation and low belonging in engineering courses, particularly as it related to feelings of incompetence and disengagement from group work. A common thread across all profiles was women's negative experiences with their male peers, given that they frequently experienced discrimination and microaggressions from them. Extant research has explored this idea, but often in the context of women in engineering broadly (Leaper, 2015). Women in this profile spoke to their intersectional identities as Black women and the potentially added affects that are based on both aspects of their identities. Importantly, they shared that their experiences did not necessarily deter them from pursuing or wanting to pursue engineering, but it is important to think about what psychological or emotional cost pursuing engineering may be for these women.

Profile 3, which was represented by Darlene, Shondra, Armani, and Jasmin, also had three final themes. Importantly, this profile was fully represented by women, unlike the first two profiles where it was mixed between men and women. The women interviewed in this profile were also primarily third and fourth year (or graduated) students, as they had advanced into their final few years in the time between the quantitative and qualitative data were collected. This may be due to sampling given that women are often more inclined to participate in research studies or given that women were more likely than men to be represented in this profile (relative to Profile

2) and less likely to be in Profile 1 (relative to Profile 3). However, these findings should be interpreted with caution given that the themes do not represent the full profile and the interview sub-sample did not include any men. The first theme was about their shared experiences with their initial interests to pursue STEM and/or engineering in college and as a career. Indeed, three out of four women in this group shared similar stories about loving math, science, medicine, and engineering at a young age. They also shared the specific jobs and companies they see themselves doing, such as cyber security and software development, as well as working for specific engineering companies and doing alterative engineering careers. Given that this profile was the "high all" profile, a high engineering identity may be particularly is supported, though it is important to note that an engineering identity was not most salient and this interpretation is based on their early and sustained interests in engineering relative to individuals in Profile 1 and 2. Indeed, women spoke at length to their race or ethnicity and gender being most important to their sense of self.

The second theme was related to the women identifying strongly with being a Black women or woman of color. It was interesting that in the profile where ethnic identity was highest, women shared that their ethnic identity was most salient to them, especially in the context of an engineering specific interview. They had shared reflections on their race and gender being prominent factors in their everyday life, and particular for their experiences within engineering as being underrepresented and experiencing differential treatment based on their identities. From an intersectionality perspective, women's race or ethnicity and gender was at play for these women and played a unique role in their experiences, relative to Black men interviewed in the various profiles. While I did not measure gender identity quantitatively, it was apparent that Black women had strong connections to their race *and* gender which provides

meaningful information that could not be teased apart quantitively.

Consistent with Profiles 1 and 2, the final theme was about women's experiences gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. Women spoke about their experiences with racial and gender "isms" and how this specifically related to underrepresentation, low expectations, and mistreatment, and being "weeded out." This "weed out" effect is important to consider in the context of critical race theory and structural oppression, as it speaks to the lack of structural support that leads women to be underrepresented and pushed out of fields like engineering and STEM more broadly.

There are important connections to the quantitative findings from the qualitative themes and patterns. One noteworthy pattern was based on the findings for engineering and ethnic stereotype threat. In general, there were consistent patterns among Profile 1 (*low engineering identity, moderate-high ethnic stereotype threat*) and the interviewed sub-sample. These students shared a thread around a desire to pursue non-engineering related career paths and even one student had left engineering all together. They all also had similar patterns among negative experiences with ethnic stereotype threat, which aligned with patterns found across Profiles 2 and 3. Profile 3 differed from Profile 1 in their descriptions of early and sustained interests in engineering and STEM, and clear connections to their ethnic identities, which was consistent with their *high ethnic and engineering identity* mean scores. One of the most striking and relevant findings across all the profiles were their shared experiences with ethnic stereotype threat, racism, and discrimination. It highlights broader institutional structures that are unsupportive of Black students in engineering and illuminates Bell's notion of race permanence in CRT (Bell, 1992).

Chapter 5:

Discussion

The present dissertation study employed an explanatory sequential mixed methods approach to study the experiences of Black men and women in engineering contexts, particularly those related to their identities and perceived stereotype threat, racism, and discrimination. Within a sequential mixed method design, the quantitative data collection and data analysis inform the qualitative data collection and analysis (Creswell & Creswell, 2017). In this study, I used a latent profile analysis to understand how engineering identity, ethnic identity, ethnic stereotype threat, and gender stereotype threat combined to predict engineering career intentions and GPA. Then, I sought out to qualitatively examine students' identities and experiences with stereotype threat, racism, and discrimination. I found support for three unique latent profiles (via quantitative analysis) and support for profile-specific themes through a thematic analysis (via qualitative analysis). I also engaged in data triangulation of the quantitative and qualitative data, which Denzin (1970, 1989) described as a ''dialectical process'' that serves to provide a more nuanced understanding of research findings, as well as to place contradicting findings in dialogue with one another. Within this discussion, I synthesize the findings of the quantitative profiles and qualitative themes along each profile, followed by a discussion of implications, future directions, limitations, and concluding thoughts.

Critical Race Theory and Educational Psychology

Before discussing the specific profiles, I first situate my work within critical perspectives on race. Within the field of educational psychology, there is a pressing call and need to use critical approaches to understand the lived experiences of students of color and diverse students more broadly (Usher, 2018). One instrumental discussion piece that sparked my desire to engage

in critical scholarship within educational psychology was Usher (2018), which was titled "*Acknowledging the Whiteness of Motivation Research: Seeking Cultural Relevance."* In this piece she discussed the history of race-related research in educational psychology and very bluntly acknowledged that it has been constructed by "White men doing research on White students in White-centric spaces" (p. 132). Usher contended that this lens and worldview led to misrepresentations and deficit-based perspectives of diverse students, noting that the field of educational psychology has much work to do in learning about the experiences of diverse students, particularly those from marginalized racial and ethnic backgrounds and women.

Critical Race Theory affords the critical lens called for by Usher (2018) as well as other researchers already taking a critical approach in their research (e.g., DeCuir-Gunby, 2020, Gray et al., 2018). In my dissertation, I also employed CRT as a critical lens and world view. My main priority in this work was to learn and document the experiences of Black students in engineering, without perpetuating false deficits and making cross-racial group comparisons. While this is only one step in the right direction, I believe it is an important one, as research that continues to compare Black students to a system of "Whiteness" only leads to potentially damaging and false conclusions. I must fully acknowledge that my work is not free of potential biases towards Black individuals, particularly given my training in psychology that has an anti-Black historical context (Phelps, 2015). Like many scholars trained in White institutions, being a woman of color does not dissolve me of all bias and I too am continuing to learn how to authentically engage in social justice research that seeks to advocate for diverse communities. Nonetheless, several CRT tenets were instrumental in shaping the approach of this work, namely those related to race permanence, voices of people of color, and intersectionality (Bell, 1992, 1995; Cook, 1990; Crenshaw, 1988, 2011; Delgado & Stefancic, 2012).

Bell (1992) theorized about the permanence of race, and indeed I found evidence both quantitively and qualitatively that illuminated race permanence in engineering contexts. I made these observations across all profiles and across both men and women, as ethnic stereotype threat and ethnicity identity were "never" classified as "low." The permanence of race stands in contrast to engineering identity and gender stereotype threat, which were low in Profiles 1 and Profile 2. Furthermore, in the qualitative analyses, the shared experience of stereotype threat, racism, and discrimination in engineering was one pattern that was found across all three groups. These findings align with Bell's (1992) notion of race permanence and speaks to a deep-rooted injustice faced by Black students in engineering.

My focus on specific race-and-gender constructs, and especially those that examine structural harm to Black students via stereotype threat, allowed me to center their experiences and voices, both quantitatively and qualitatively. A unique affordance of CRT is that it considers how race and racism intersect with various dimensions of a person's identity such as their ethnicity, gender, sexuality, and social class (Crenshaw, 2011). In terms of intersectionality, I focused on both aspects of gender and race to more broadly understand the structures and inequities within engineering for Black women. My findings, both quantitative and qualitative, provided support for the negative treatment that occurs at the intersection of race and gender for Black women. Notably, Black men also reported experiences at the intersection of race and gender such as being viewed as aggressors in academic spaces. This finding is supported by CRT and is worthy of further investigation, as Black men may be overlooked in engineering contexts given their "over-representation" as men comparable to Black women. However, Black men are also underrepresented in engineering fields, in contrast to their White and Asian male counterparts, and there is a need to understand the treatment of Black men in engineering given

the societal bias and discrimination towards Black men. Given the focus on intersectionality for Black women in this dissertation, this was not a central focus of my work, but highlighted an important future direction for further research.

Profile 1: Quantitative and Qualitative Synthesis

The first profile that I identified in the quantitative data, was Profile 1 (*Low Engineering, Gender ST and Moderate Ethnic*) characterized by students who experienced moderate-high ethnic stereotype threat, low gender stereotype threat, and simultaneously had a low engineering identity and moderate-high ethnic identity. Given that students' ethnic identities were moderate-high in this profile, moderate-high ethnic stereotype threat may have led students to de-identify with engineering based on its source of their experiences with bias (Erikson, 1968; Settles et al., 2009). Further, identity incongruence suggests that there are psychological costs associated with experiencing stereotype threat, such as leading individuals to de-identify or disengage with a domain (von Hippel et al., 2011). However, this was purely a speculation based on prior research, and qualitative data provided an alternative explanation for students' reports of low engineering identity.

One of the themes that I found in my qualitative analyses centered on the reasons for pursuing and leaving engineering. Interestingly, students shared experiences about going into engineering because of familial influences such as receiving messaging about engineering being a stable field to pursue. Interestingly, Marcia (1993) theorized about a foreclosed identity which is when individuals have strong ties to their identities but adopt other beliefs and values that are instilled by authority figures such as family and mentors. Relatedly, the interviewed students shared interests and passions for engaging in non-engineering related fields. Indeed, one student switched out of engineering altogether and another planned to leave engineering immediately

after graduation. Based on these experiences, their low engineering identity may have been because they did not have intrinsic reasons for wanting to pursue engineering and would not necessarily find engineering to be important for their sense of self. It might also be the case that moderate-high ethnic stereotype threat did not impact their already low engineering identity, but instead buffered the potential negative effects of ethnic and gender stereotype threat to their ethnic identity (based on their moderate-high ethnic identities). Another support for this was that students in this profile attributed leaving engineering, or wanting to pursue alternative pathways, based on other interests and passions, and not necessarily experiencing bias in engineering. Harmony (who switched majors) shared the following reflection about persistence in engineering:

> INTERVIEWER: Good. And so have any of these experiences then negatively impacted your willingness to persist as an engineering student?
>
> HARMONY: Not particularly. I knew already, like engineering kind of wasn't what I was interested in. So these instances, just because at least for me, weren't as prominent of an issue, didn't really play much of an effect and wanting or not wanting to continue engineering.

Another theme I identified among these students was their shared experiences with low perceptions and negative treatment from faculty, peers, and the academic institution. Despite gender and the year in school students were in, they shared similar experiences with ethnic stereotype threat. Students shared unique stories that can be examined from an interpersonal perspective, through a gender and intersectionality lens, and institutional level. Students shared their experiences with peers and faculty, such as feeling unsupported and isolated by her male peers in group work, and among a male student being accused as acting "aggressively" by a

professor. Harmony, being the only woman interviewed in this profile, spoke to the intersections of race and gender in influencing how peers and faculty perceived and treated her, which misaligned with moderate-low gender stereotype threat but aligned with moderate-high ethnic stereotype threat. Another student spoke to the negative messaging shared by university structures about scholarships for Black students. He perceived these scholarships to be inequitable given the seemingly low expectations and requirements compared to broader university scholarships. This highlights the perceived inequity in rigor of scholarships, that arguably sends deficit messaging to Black students that they are less competent than their peers. These shared experiences based on differential treatment aligns with race permanence, as Bell (1992) suggested racism permeates our society and is embedded in the social fabric of our institutions, and in this context, among engineering peers, faculty, and institutional structures. The permeance of racism, discrimination, and stereotype threat in classroom structures, and throughout the institution, speak to a very pressing need to interrogate these systems for the success and retention of Black students.

The final theme I identified among students in Profile 1 was their shared connections for coping with instances of racism, discrimination, and stereotype threat through seeking affinity spaces where they could experience community and belonging. Some research has considered how coping with racial stereotype threat and other forms of bias is shared among students of color in STEM (e.g., Cole & Espinoza, 2008; Museus et al., 2011; McGee, 2016; Perna et al., 2009), and students in this profile shared ways in which they found community in both interest-based and race-and-gender affinity groups. CRT affirms that counter spaces and counter storytelling are forms of resistance to racism and discrimination (Datnow & Cooper, 2009). Indeed, Datnow and Cooper (2009) found that students sought out and developed their own

"Black spaces" where their racial identities could be affirmed, and they experienced support in the face of racial and gender barriers.

Another interesting aspect of this profile was that women were more likely than men to be represented in Profile 1, relative to Profile 2. This finding is interesting considering the moderate-low levels of gender stereotype threat in Profile 1. While I expected men to have lower gender stereotype threat in engineering, data for this profile suggest that women may also be experiencing moderate-low levels of gender stereotype threat. Considering that both men and women in this Profile also spoke to leaving engineering, it could be the case that they indeed experience lower levels of gender stereotype threat in their new majors or are less affected by it if they do not endorse engineering as important for their identity. Lewis and Sekaquaptewa (2016) stated that an individual needs to have domain identification to experience stereotype threat in that domain, which in this case could suggest why women who also have low engineering identities may experience low levels of gender stereotype threat in engineering. However, women were also less likely to be in Profile 1 relative to Profile 3 (which was the "high all" profile). In general, this aligned with hypotheses that women would be more likely to be in a class where both gender and ethnic stereotype threat were high, as intersectionality suggests that racial and gender oppression work synonymously for Black women, especially in fields like engineering where they are marginalized based on both their race and gender (Cole, 2009).

I also sought out to understand the likelihood of profile membership based on year in school considering introductory and advanced students as two separate groups. The reason for this is that in engineering majors at this respective university students are engineering "pre-majors" in their first two years and in the last two (+) years are admitted into the college and

taking higher division coursework. The quantitative findings suggested that third- and fourth-year students were more likely to be Profile 1, relative to Profile 3. The identity development literature notes that science identity decreases over time in college (Robinson et al., 2018) and ethnic identification may also decrease over time if one is experiencing frequent ethnic and gender stereotype threat (e.g., Tovar-Murray, 2012). This is interesting to consider in terms of these student's trajectory given that they may have had stronger connections to engineering at one point in time, however there is no way of knowing from this dissertation if identities indeed decreased over time given the cross-sectional nature of the study. In general, these findings point to the breadth of experiences that third- and fourth-year students have experienced with their identities and stereotype threat.

Another key quantitative research question was to understand how the profiles predicted both engineering-related career intentions and cumulative GPA. Profile 1 (*Low Engineering Identity, High Ethnic ST)* had the lowest career intentions mean score, which supports the idea that individuals who do not strongly identify with engineering may also not have intentions to pursue engineering related careers. This was also aligned with the three students' plans post-graduation. Two out of the three students had no plans to pursue an engineering-related career, and one student had not dismissed the possibility of pursuing an engineering career but was weighing other options like his passion for sports.

Profile 2: Quantitative and Qualitative Synthesis

Profile 2 labeled as *Moderate-High Identities, Ethnic ST and Low Gender ST* was characterized by students who had a moderate-high engineering identity, moderate-high ethnic identity, moderate-high ethnic stereotype threat, but low gender stereotype threat. The first two themes that I identified among representative students from this profile are interesting in the

context of moderate-high domain and ethnic identities, and moderate high ethnic stereotype threat. The students in this Profile described an exploratory journey in K-12 that eventually (mostly) led them to pursue engineering. Marcia (1993) expanded on Erikson's theory of identity by establishing four stages of identity development. One of the stages called moratorium is described as a period of "crisis and no commitment" where individuals engage in exploration of alternative pathways. From a college student development perspective, I would expect students in the transition from high school to college to engage in much exploring (Marcia, 1993), but this is also true for junior and senior year students who are transitioning into their careers.

Interestingly, students in this profile also endorsed what I called "college-centered identities" given that students broadly identified as college students or with their values within the academy such as being a mentor or leader. The quantitative findings suggested that third- and fourth-year students were more likely to be represented in Profile 1 (relative to Profile 3), which could explain potential exploration in their last two years as they transition into careers. This could also explain why they endorsed broad "college-specific" identities and not domain-specific identities, such as being an engineer or scientist. Indeed, Brionna (F, Senior) shared her experience related to this:

> "I think being a college student matters most to me because it's kind of what's going to lead me to my next identity. So, everything that I'm kind of gaining now as a college student as far as academically, just social experiences and everything, is kind of going to lead into my next identity in whatever career field I go into or whatever I choose to identify with next."

Among those individuals who did not endorse college-centered identities, three women strongly identified with being Black women and with their familial identities and daughters and

sisters. I think it is interesting to consider how for women with who highly identify with engineering as a domain and their ethnicity are potentially being protected or experiencing a buffered effect against potential negative effects of racial and gender stereotype threat (e.g., Wheeler & Petty, 2001, Constantine et al., 2006; Gonzales & Kim, 1997; Phinney, 2003; Rust et al., 2011). Although gender identity was low across this whole profile, it is apparent that the low gender stereotype threat was driven among men who were more represented in this profile, as men would likely be less likely to experience gender stereotype threat in a male-dominated field like engineering. Indeed, the women in this profile generally had higher gender and ethnic stereotype threat levels compared to men. Given that these individuals were experiencing moderate-high ethnic stereotype threat, and moderate-high gender stereotype threat for women, but persisting in engineering speaks to resilience.

The last theme, and like the one identified among students along all profiles, was related to experiencing gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. Among the six women in the qualitative sub-sample, feelings of isolation and low belonging in engineering courses was a shared thread among them. The women from Profile 2 who were interviewed also spoke to feelings of incompetence from working with groups of men in their engineering courses given that their voices and contributions were not often taken seriously or even considered all together. As suggested among those in Profile 1, race permanence speaks to the gross treatment and inequities Black women face in engineering courses (Bell, 1992). Indeed, a key element of social identity theory is that individuals' identities are shaped and *reinforced* by social groups, such as peers in courses or friendship groups (Erikson, 1968). While women are negotiating their identities and racialized and gendered experiences, peers and faculty have the power to negatively impact Black women in engineering

– which is a pressing issue in this work. While the individuals in this profile shared that these experiences did not necessarily deter them from pursuing or wanting to pursue engineering, it is still critical to consider the extra weight Black women are forced to carry as they navigate engineering fields. McGee and Bentley (2017) challenged the notion of resilience as being an overly simplified conclusion to the success of high achieving students in STEM and focused on the ways that Black women in STEM may also be facing anxiety, trauma, and other socioemotional pain such as racial battle fatigue.

Another interesting finding among the individuals in this profile, like in Profile 3 described next, was that students had high intentions to pursue an engineering-related career. Students shared their intentions to go into both engineering or non-engineering pathways and this speaks to the particular importance of alignment between parts of our identities, such that domain identities or the field we choose to pursue should also align with other parts of our identities and our passions (Syed, 2010). This was evidenced by students also having moderate-high engineering and ethnic identities. Unlike students from Profile 1 who had low engineering identities and low intentions to pursue engineering-related careers, these students had real intentions to continue in engineering and their experiences of ethnic and gender stereotype threat, particularly for women, have important implications for supporting students who are demonstrating resilience in the face of adversity.

Profile 3: Quantitative and Qualitative Synthesis

Profile 3 labeled as *High Identities and Stereotype Threat* was characterized by students who had a high engineering and ethnic identity and high ethnic-and-gender stereotype threat, also characterized as the "high all" profile. Notably, women were more likely to be in Profile 3 compared to Profile 2 (based on the quantitative analyses) and the qualitative sub-sample was

also fully represented by women. From an intersectional perspective of interlocking systems of oppression, and similarly to the women in Profile 2, Black women in this profile endorsed high levels of ethnic and engineering identities while simultaneously experiencing high levels of ethnic and gender stereotype threat. This pattern also aligns with past research that suggests endorsing positive identities, especially those related to race and gender, may buffer the negative effects of race and gender related stereotype threat or racism and discrimination (e.g., Martinez & Dukes, 1997; Wong et al., 2003). It may also be that case that individuals who have spent time exploring, understanding, and committing to their identities have developed a set of coping and resilience tools that enable them to remain "identified" in the face of racial and gender barriers, such as stereotype threat (Umaña-Taylor et al., 2004). However, it is also important to recognize that resilience may also be at a cost of other socioemotional experiences (McGee & Bentley, 2017). It also points to the "double discrimination," or multiple forms of suffering given that women experienced high levels of both ethnic and gender stereotype threat. It is interesting to also consider in the context of the theme that spoke to salient Black woman or woman of color identities.

The women shared important reflections about their race and gender being prominent factors in their everyday life, and especially within engineering contexts. This theme has important implications for intersectionality, given that within this profile women spoke to both their race and gender being confluent in their experiences with racism and discrimination. From a critical race perspective, this theme supports race permanence, intersectionality, and counternarratives of women of color. This pattern is important to consider in the context of the third theme, which was based on women's experiences gender and racial stereotype threat, discrimination, and racism from engineering faculty and students. Despite their negative

treatment in engineering, Black women not only persist in the major, but continue to be interested in engineering careers. A noteworthy experience Black women in my study faced was attempts to be "weeded out" of engineering by faculty. This "weed out" effect is important to consider in the context of critical race theory and structural oppression, as it speaks to a repeated experience faced by students of color in engineering (Libassi, 2018; Bell, 1992).

I think what is particularly striking about the intersectional nature of Black women's identities and high perceived ethnic and gender stereotype threat is their interest and persistence in STEM. Not only did these women have among the highest engineering identities quantitatively, but qualitatively spoke about having interests in STEM that were established in their K-12 education. In other words, these Black women have persisted in engineering and continued to love it, with also aspirations to continue in it, despite experiencing a lot of stereotype threat, racism, and discrimination. A framework that may help explain this is based on O'Conner's (1997) notion of a collective struggle between Black women in STEM. Ross et al. (2021) also recently found that Black women in engineering had a "resilient engineering identity" that led to their prolonged engagement and success in that domain.

The women in his profile were among the highest in their intentions to pursue engineering-related careers, and this was apparent based on their qualitative stories. The importance of engineering and their race or ethnicity for their sense of self has protected them amongst the repeated experiences of ethnic and gender stereotype threat, racism, and discrimination. While this could have served as a deterrent and reason for them leaving engineering and pursuing another major, they have persisted and demonstrated extreme resilience in the face of adversity. Not only does this demonstrate the importance of intersectionality to understand the experiences of Black women in engineering, but also brings

up the need to address inequities at the intersection of those experiences in engineering structures such as classrooms, internships and co-ops, and institutional messaging.

Limitations

This dissertation had noteworthy limitations. One limitation was based on the cross-sectional nature of this study. This line of work would benefit from a developmental perspective given that identity and stereotype threat are not static and shift over time and place (Carney, 2021). Nonetheless, the cross-sectional design and nature of this work provides important information about levels and types of identities, in addition to the ways in which ST, racism and discrimination are present and impact student. However, we do not know how identities may be shifting over time, especially in relation to experiences with ethnic and gender stereotype threat. Future work should extend the current study using a larger longitudinal sample of Black students in engineering.

Another limitation related to the study design was based on my process of masking and non-masking participant profile information. For instance, I (as the researcher and sole interviewer) was aware of students assigned profile membership when recruiting them for the interviews given that I needed to avoid saturation participation being from any given profile. As such, there was a potential for bias in this interviews themselves given that I may have had unconscious perceptions about any one student's experiences based on the profile they were likely to "fall into." In terms of the analysis, I was not aware of individuals profile membership when analyzing the data (for initial codes), but once again unmasked the data when it was time to analyze individuals within specific profiles and understand their shared experiences. Relatedly, I used the same interview questions for all students, regardless of their profile membership. An affordance of taking this approach was that students experiences could be understood based on

the same questions asked to all students and made comparisons easier. However, less profile specificity could be achieved based on a lack of detailed questions regarding the specifics of profile level outcomes.

Next, while I draw from intersectionality and critical race theory, it is important to note that I did not quantitatively measure gender identity in my latent profile analysis, which limits my ability to make conclusions based on this important aspect of the self. However, this was something I was able to understand more deeply through student stories, which added depth to the conversations around Black men and women's experiences (I use the man/women binary because no students identified as transgender or non-binary in this study).

Aligned with the first limitation, another way in which this study was limited was in the ability to make conclusions based on casual inferences and relations. All the interpretations provided in this work are interpretative, including those that were discussed in the qualitative work. Both latent profile analysis and reflexive thematic analysis are both exploratory and reflective methods for examining phenomena and the findings should not be interpreted using causal assumptions. Relatedly, I am also limited in my ability to make claims about the connections of the quantitative profiles and qualitative interviews given that they were conducted one year and four months apart. In fact, several students in the interview sub-sample had graduated and most students had progressed into their final years of their program. Given the potential for identities to shift overtime, and perceptions of stereotype threat and other bias to also shift, this should be considered when drawing conclusions from the data.

The final limitation was based on my sequential mixed methods design, namely QUANT → Qual which places a greater emphasis on the quantitative method and results than the qualitative information. Indeed, this study is framed in a way that the qualitative data were

intended to provide supplemental information to the quantitative profiles, and not necessarily vice versa. Recent conversations around this approach suggest that it serves the quantitative community by giving the qualitative portion a "secondary status" which also limits the interpretive foundation of qualitative research (Denzin & Lincoln, 2005; Howe, 2004). I agree that within this design, I made limited use of the qualitative data and experienced tensions around wanting to include other interesting information that was not particularly relevant for describing the profiles. For instance, I recognized interesting connections to mentors as playing an important role in students' lives and contributing to their persistence and success. However, given that this was not my focus and did not necessarily help contextualize the profiles, I did not systematically categorize experiences related to mentoring. I have intentions of drawing more conclusions from the qualitative data in future studies.

Implications

Prior research on STEM achievement, specifically in educational psychology, has often focused on the deficits of Black individuals in comparison to historically successful and well-represented individuals in STEM. This work has challenged me to consider how identity works in complex ways under the guise of stereotype threat and other forms of bias. Indeed, one of the most important findings of this work was the prominence of both ethnic and gender stereotype threat, as well as the presence of racism, discrimination, and microaggressions in the lives of Black students from this sample. The other important layer of this is based on the forms of resistance and resilience, many based on their identities, which have helped students succeed in engineering. Students were compelled to find safety and belonging in affinity groups, primarily outside of the college of engineering. Students needing to "leave" their place of knowledge production to find community and belonging points to a strong need for the college of

engineering, and engineering programs broadly, to consider how to create structures within engineering that can support diverse students. One example of this was based on shared experiences with the diversity office within the college of engineering as a source of support and belonging. To provide context, the diversity office serves as more than an affinity space (or safe space) for students of color, but also has faculty and staff that systematically provide guidance related to navigating academia, degree completion, and career support. There are a number of things we could learn from this space to support students experiencing high levels of racism, discrimination, and stereotype threat in engineering. There are specific implications for faculty and student development that can serve to actively challenge oppressive structures within engineering that contribute to anti-Black racism. Based on Bell's notion of race permanence, there needs to be a degree of the visibility and acknowledgment of the oppressive structures within engineering. For instance, it is important for faculty development and training to challenge individuals to deeply consider the effects of racism and discrimination in engineering. This also cannot be accomplished through a "checked box" approach where one training is sufficient. This model also applies to student development, such as the integration of an ethnic study component as part of engineering training, which would cover topics related to racism in STEM fields and ways to combat and protect students from diverse groups. In 2015, Lehr (2015) published scholarship on the idea of reimagining engineering education and how learning from arts, humanities, and social sciences we could challenge the traditional training of an engineer. This sparked the idea that a pathway where engineers were also trained to be more culturally responsive as part of their degree program could lead to a more culturally inclusive and welcoming space for students of diverse backgrounds.

From a systems-based theoretical perspective (e.g., Bronfenbrenner Ecological Theory; Bronfenbrenner, 1977), something cannot simply be done with the individual (e.g., professional development, critical curriculum requirements) to change to structures. Not only is racism endemic, but it is embedded in the systems in which we operate through policies and norms. As such, there are implications for university administrators and university policy makers. For instance, what messaging are universities sending to students of color by asking them to apply to obviously "less rigorous" applications for funding and scholarships? This was a point made by a student in the interviews and he suggested that something be done to create more equitable scholarship systems within the university. Similarly, what does it mean for a Black women or man to be the only person of color in an engineering course?

This work also pushed the bounds of stereotype threat literature, which has also primarily focused on the "internal feelings of oppression" to explore the ways in which actual discrimination, racism, and microaggressions have created inequities for individuals in engineering. Stereotype threat being a "threat in the air" has often been hard to untangle, but when coupled with actual discrimination and racism it provides a broader lens for understanding systemic inequities within engineering. The other layer of this is addressing stereotype threat across ethnicity and gender for both Black men and women, which allowed me to draw important conclusions. Gender stereotype threat was particularly high among women in this study and when coupled with ethnic stereotype threat are "double threats" to their success and well-being. Despite the resilience of high achieving women in this sample, this is still an urgent need to look within engineering, and STEM, to interrogate their structures that contribute to anti-Black racism.

Future Directions

There are numerous directions future work could take in this area of research, particularly within educational psychology fields and by drawing from critical perspectives. One question that continued to arise for me was based on the persistence of high achieving Black women in engineering. The findings in this dissertation pointed to the shared feelings of isolation and incompetence, via racism and discrimination, which in most cases did not lead students to leave engineering. The pending question is "at what cost is persistence in engineering for women who consistently receive bias in engineering?" There are possibly socioemotional reactions and mental health concerns that need to be addressed in this literature (McGee & Bentley, 2017). Another layer of this is the need to further understand the experiences of Black men in the context of engineering, as a focus on intersectionality in this study led to the primary understanding of Black women's experiences in this study and given that women's voices were more represented in the qualitative interviews. However, men were more likely to be represented in Profile 2 where gender stereotype threat was low which was not surprising as women are more likely to experience gender-based discrimination in STEM fields given their underrepresentation in those fields. However, we much also consider what this low score truly reflects the experiences of the Black men in this study or whether the low score is due to the way in which gender stereotype threat was measured. Indeed, within the qualitative interviews there were shared connections of Black men speaking to being perceived as aggressors and leading to the feeling ostracized in STEM and within the academy more broadly. One Black male student in Profile 2 spoke to his experience being a Black male presence on campus and shared the following reflection "it's like a lot of times I can literally feel like I'm a shadow. I'm just walking around, and people you know just walk around as if I'm not there a lot of times. I've felt

that many times being here." This reflection leads me to consider the unique experiences of being a Black men especially those situated in gender stereotypes, as the effects of stereotype threat may be different for Black men and men of color, though some literature has found that the salience of stereotype threat was similar for men and women for students of color broadly (e.g., Beasley, 2012). There are implications for considering this in future studies and extending our current theoretical understanding of stereotype threat as was originally conceptualized by Steele and Aronson (1995). There are also unique affordances of drawing from Critical Race Theory to extend our understanding of stereotype threat, especially coupled with broader experiences of bias such as racism and discrimination.

There is also an additional need to understand the complexity within identities. This study supported theories of identity that suggest identity formation is a developmental, yet complex process, and this study only examines one aspect of this. Future studies should consider how other important parts of the self for Black students, like familial identities, are important factors in one's persistence in STEM. There is a lot to be learned about family and mentors and the role they play in supporting student success, particularly in the context of high experiences of stereotype threat and other bias. Many individuals spoke to finding safety in their communities (e.g., familial safety, college affinity spaces); more research is needed to understand how these experiences are both part of one's identity and serve to enhance and support identities.

Moreover, there was a lack of an understanding of social class in this context of this study and is broadly under-analyzed in the context of the educational literature (Dixson &Rousseau, 2005). Interestingly, in this study only 33% of students were first-generation college students indicating that the majority of participants came from families and parents who had higher education learning experiences, with many coming from families with masters and

doctoral training. Not only does this have implications for the way the data should be interpreted, given the historical context of education for Black individuals, but provides important considerations for future studies. A few questions that arise for me from this work is how are identities and experiences with racism and discrimination in STEM interacting with one's social class? Are there ways we are also highlighting the deficits of Black parents, or parents of color, in the literature and how can we challenge this in the STEM education literature by critically considering social class? Indeed, McGee and Spencer (2015) urged education researchers to consider the ways in which we also highlight the deficits of parents and other key socializers of Black children, as being passive, disinterested and disengaged, and lacking effort in their children's education and well-being. There is also something to be learned from those experiences to help understand STEM persistence as well as to continue to challenge deficit notions of Black bodies.

Conclusion

Attending to the call in the field of educational psychology urging researchers to draw from critical perspectives in order to address STEM persistence among Black students (Usher, 2018; DeCuir-Gunby & Schutz, 2014; Matthews & Lopez, 2020), I focused my efforts in understanding how complex identities and perceived ethnic-and-gender stereotype threat I identified using profile analysis and the relations of these profiles to predictors and persistence and achievement outcomes. As such, I found evidence for three unique profiles, namely a low engineering identity, and moderate ethnic identity and ethnic stereotype threat profile (Class 1), a moderate-high engineering and ethnic identity but low gender stereotype threat profile (Class 2), and a "high all" profile that had high identities and high stereotype threat (Class 3). I also followed-up with a sub-sample of students to further contextualize their experiences with their

identities and stereotype threat, racism, and discrimination, which helped illuminate Black men and women's experiences in engineering. I learned extensively from the qualitative data, which allowed me to both confirm some patterns in the quantitative data and develop alternative interpretations based on student voices. This study has implications for the field of educational psychology and our integration of critical theories and perspectives to exclusively study the experiences of diverse students. There is a particular need to challenge the history of deficit framing within educational psychology and this study challenges this by focusing on the interplay of identities and structural harm in the form of stereotype threat and other bias. This study also contributes to the dialogue of understanding how to retain Black students in the academy without causing further harm to their identities and personhood. Indeed, students of color find themselves having to negotiate parts of their identities, or worse, are subjected to harm based on important parts of themselves to be an engineer. There is much to learn about how the field of engineering itself can be racially and gender inclusive, and work to challenge inner structures that serve to harm Black students every day.

APPENDICES

APPENDIX A:

Tables

Table 1:

Descriptive Statistics

Construct	N	Mean	Std. Dev.	Min.	Max.	Skewness	Std. Error	Kurtosis	Std. Error
Engineering ID	161	3.60	.82	1.44	5.00	- .76	.19	.27	.38
Ethnic Identity	159	4.04	.74	1.50	5.00	- .60	.19	.01	.38
Gender ST	169	2.76	1.20	1.00	5.00	.25	.19	-.71	.37
Ethnic ST	169	3.90	.87	1.50	5.00	- .35	.19	-.71	.37
Career Intentions	161	7.64	.23	1.00	10.00	-1.16	.19	.06	.38
GPA	168	2.64	.07	0.00	4.00	-1.70	.19	1.52	.37

Note. The scale ranges for engineering identity, ethnic identity, gender stereotype threat, and ethnic stereotype threat are 1-5 (1 = strongly disagree; 5 = strongly agree). The scale range for engineering career intentions is 1-10 (1 = "I definitely will not", 10 = "I definitely will"). The scale range for GPA is 0.00 to 4.00. ST = stereotype threat; ID = identity.

Table 2:

Intercorrelations among Measures

	Measure	n	1	2	3	4	5	6	7	8
1.	Engineering Identity	161	-							
2.	Ethnic Identity	159	.29***	-						
3.	Gender Stereotype Threat	169	.01	.18*	-					
4.	Ethnic Stereotype Threat	169	.04	.29***	.42***	-				
5.	Gender	170	-.13	.15	.69***	.29***	-			
6.	Year in School	170	-.20**	.71***	.10	-.01	.01	-		
7.	Career Intentions	161	.74***	.13	-.01	-.02	-.08	.14*	-	
8.	GPA	168	.05	.03	-.02	-.05	.15*	.16*	.15	-

Note. *p<.05,**p<.01, ***p<.001. Gender was dummy coded as 0 = male, 1 = female. Year in school was also dummy coded as 0 = first/second year and 1 = third/fourth year.

Table 3:

Fit Indices for Gender Stereotype Threat Invariance Model

	Model	χ^2 (df)	$\Delta\chi^2$	RMSEA	CFI	ΔCFI
Gender stereotype threat	Configural	99.91 (4)		.081	.992	
	Weak	113.25 (7)	13.34	.073	.991	.001
	Strong	124.35 (11)	11.10	.104	.874	.117
	Partial Strong	142.22 (3)	28.97	.037	.990	.001

Note. Significance tests of chi-square difference were performed, and all values were non-significant. Loadings and intercepts were constrained to be equal across groups on two out of the four indicator variables, as such partial measurement invariance was achieved.

Table 4:

Fit Indices for Different Latent Profile Solutions

# Of Profiles	Free parameters	BIC	Profile percentages	Profile sizes	Entropy	BLRT
1	8	1748.870		169		
2	13	1719.922	75.29%; 24.71%	131,33	.728	<.001
3	***18***	***1715.275***	***18.34%; 62.13%; 19.53%***	***31,105,33***	***.743***	***<.001***
4	23	1716.935	17.16%; 10.65%; 51.48%; 20.71%	29,18,87,35	.745	<.001
5	28	1722.326	11.83%; 15.97%; 46.15%; 10.06%; 12.98%	20,27,78,17, 27	.739	<.001

Note. BIC = Bayesian Information Criterion; BLRT = Bootstrap Likelihood Ratio Test; Bolded and italicized row indicates the selected profile solution.

Table 5:

Mean Comparisons of Engineering Identity, Ethnic Identity, Ethnic Stereotype (ST), and Gender Stereotype Threat (ST), and Outcomes by Profile

Variable	*Low Engineering, Gender ST and Moderate Ethnic (n = 31)*	*Moderate-High Identities, Ethnic ST and Low Gender (n = 105)*	*High Identities and Stereotype Threat (n = 33)*
Engineering Identity	2.38 (.26)$_a$	3.85 (.12)$_b$	4.01 (.13)$_b$
Ethnic Identity	3.68 (.20)$_a$	3.97 (.12)$_a$	4.55 (.10)$_b$
Ethnic Stereotype Threat	3.96 (.27)$_a$	3.62 (.11)$_a$	4.67 (.09)$_b$
Gender Stereotype Threat	2.97 (.22)$_b$	2.16 (.13)$_a$	4.33 (.23)$_c$
Engineering Identity	*z = -3.96*	*z = 3.67*	*z = 4.62*
Ethnic Identity	*z = -1.95*	*z = -0.83*	*z = 4.80*
Ethnic Stereotype Threat	*z = -0.44*	*z = -4.18*	*z = 6.55*
Gender Stereotype Threat	*z = -0.82*	*z = -7.62*	*z = 5.13*

Note. Profile variables presented as raw mean scores. Values in parentheses represent standard error values. Values with different subscripts in the same row represent significantly different values based on equality tests. Z-score values are italicized and represented below the means and standard errors for each construct.

Table 6:

Profile Comparisons of Engineering Identity, Ethnic Identity, Ethnic Stereotype, and Gender Stereotype Threat, and Predictors

		Gender				Yr in School			
Profiles	Profile Comparison	*b*	SE	p	OR	*b*	SE	p	OR
Profile 2: *Moderate-High Identities, Ethnic ST and Low Gender* VS Profile 1: *Low EGR, Gender ST and Moderate Ethnic*	Profile 2[a] vs. Profile 1	1.7	.70	**.02**	5.47	.65	.61	.29	1.91
Profile 2: *Moderate-High Identities, Ethnic ST and Low Gender* VS Profile 3: *High Identities and ST*	Profile 2[a] vs Profile 3	3.37	.68	**.01**	29.17	-1.96	.75	**.01**	.14
Profile 3: *High Identities and ST* VS Profile 1: *Low EGR, Gender ST and Moderate Ethnic*	Profile 3[a] vs Profile 1	-1.67	.74	**.02**	.19	2.61	.81	**.001**	13.62

Note. The Odds-Ration (OR) can be interpreted as the likelihood that a student will be in each group relative to the reference group (signaled by subscript a). OR values less than 1.00 indicate a lower likelihood of group membership relative to the reference group, and OR values greater than 1.00 indicate a greater likelihood. EGR is the abbreviation for engineering. Gender was dummy coded as 0 = male, 1 = female. Year in school was also dummy coded as 0 = first/second year and 1 = third/fourth year.

Table 7:

Mean Comparisons of Career Intentions and GPA by Profile

Variable	*Low Engineering, Gender ST and Moderate Ethnic (n = 31)*	*Moderate-High Identities, Ethnic ST and Low Gender (n = 105)*	*High Identities and Stereotype Threat (n = 33)*
Career Intentions	2.46_a (.78)	8.63_b (.04)	9.20_b (.35)
GPA	2.65_a (.16)	2.68_a (.10)	2.49_a (.19)

Note. Profile variables presented as raw mean scores. Values in parentheses represent standard error values. Outcome values with different subscripts in the same row represent significantly different values based on equality tests.

Table 8:

Sampling Grid

Variable												
Profiles	Profile 1 (N = 31)				Profile 2 (N = 105)				Profile 3 (N = 33)			
Gender	M	M	F	F	M	M	F	F	M	M	F	F
Yr in School (2020)	Fir/ Sec	Thir/ Four	Fir/ Sec	Thir/ Four	Fir/ Sec	Thir/ Four	Fir/ Sec	Thir/ Four	Fir/ Sec	Thir/ Four	Fir/ Sec	Thir/ Four
Profile sample size	n = 11	n = 9	n = 6	n = 5	n = 48	n = 30	n = 15	n = 12	n = 8	n = 3	n = 18	n = 4
Interview sample size	n = 1	n = 1	n = 1	n = 0	n = 2	n = 0	n = 3	n = 3	n = 0	n = 0	n = 0	n = 4

Note. Fir/Sec = first and second-year students; Thir/Four = third and fourth-year students; Yr = year.

Table 9:

Recruitment Grid

Study ID	Email	First Name	Profile	Gender	Year in School	Round 1	Round 2	Round 3
012345	Student1@gmail.com	Dante	1	M	First	1		
012346	Student2@gmail.com	Sophie	2	F	Third		1	
012347	Student3@gmail.com	Darlene	3	F	Third			1
012348	Student4@gmail.com	Jerry	1	M	Second	1		

Table 10:

Interview Participant Profile

Name	Year in school at time of survey	Year in school at time of interview	Gender	Major at time of interview	Class
Jerry	First Year	Third Year	Male	Computer Engineering	1
Harmony	Second Year	Fourth Year	Female	Creative Advertising	1
Sean	Fourth Year	Fourth Year	Male	Civil Engineering	1
Dante	Fourth Year	Graduated	Male	Electrical Engineering	2
Samantha	Third Year	Fourth Year	Female	Mechanical Engineering	2
Sophie	First Year	Third Year	Female	Computer Science	2
Brionna	Second Year	Fourth Year	Female	Computer Science	2
Latrice	Third Year	Fourth Year	Female	Computer Science	2
Connie	Second Year	Graduated	Female	Medicine	2
Jeremy	Third Year	Fourth Year	Male	Computer Science	2
Denise	Fourth Year	Graduated	Female	Biosystems Engineering	2
Darlene	Third Year	Fourth Year	Female	Civil Engineering	3
Shondra	Fourth Year	Fourth Year	Female	Architecture	3
Armani	Fourth Year	Graduated	Female	Computer Science	3
Jasmin	Fourth Year	Graduated	Female	Electrical Engineering	3

Table 11:

Braun and Clarke's (2006) six phases of thematic analysis

Phases	Description of process
1. Becoming familiar with the data	Transcription of the data, data cleaning, reading the data, writing down initial memos.
2. Development of initial codes	Systematically coding interesting features of the data across the entire data set and collating data relevant to each code.
3. Initial development of themes	Ordering codes into potential themes by gathering data that is relevant to each potential theme.
4. Reviewing potential themes	Reviewing themes work in relation to the coded excerpts (Level 1) and the entire data set (Level 2); generating a thematic map of the analysis.
5. Defining and naming themes	Refinement to the specifics of each theme through ongoing analysis and understanding big picture or overall story; generating definitions and names for each theme.
6. Producing written report	Writing up the report consists of relevant and compelling quotes that connect back to the literature and research questions

Table 12:

Initial Coding Grid

Code Name	**Code Definition**	**Coded excerpt**
General Identities	Self-identifying categories that come to mind when asked the question "how do you identify yourself" e.g., ethnicity, race, gender, sexuality, familial	He self-identified as someone who is a mentor, a fraternity brother, and a leader.
Salient identities	The parts of one's identity that are most important to them	"I think - I would say researcher. I would say that's what matters most…"
Intersectionality	A lived experience, particularly for women of color, when two or more identities work in combination	"I feel like sometimes they like come together in some ways because I can't ex—I can't really just like think of anything like oh just because I was a woman, this person didn't listen to me. I feel like it was like a mixture of the two or whatever."
Peer stereotypes/micro aggressions/discri mination	Experiences of racism, discrimination, microaggressions among peers	"One time I was doing like problems, and everybody couldn't figure out the problem and I was like oh, I found it and they were like, "No, you looked it up."

Table 12 (cont'd)

Professor stereotypes/micro aggressions/discri mination	Experiences of racism, discrimination, microaggressions among faculty	"And he was like, he said something about one of the other group members and said that this other guy was like being, was being aggressive or something, which wasn't exactly true. So that was kind of a weird experience where it was like okay, apparently, I shouldn't work with other black men because if there's too many of us together it's like seen as somewhat of a threat or an issue, and that kind of sucks."
Stereotype threat beliefs	Perceptions of how peers, faculty, and broadly the institution perceives them, specifically when viewed in a negative light	"I think there was me and four or five other black guys and one Chinese guy, and he kind of, he, he—I felt like he treated our group a little bit unfairly. I feel like he judged us a little bit harshly, and I don't think that that's something that would have happened if I was in a group with students who didn't look like me"
Black/African American/African in Engineering	Speaking to what it means to be Black/African American/African in engineering	"Sometimes I'm the only Black person in the class."
Black/African American/African man in Engineering	Speaking to what it means to be Black/African American/African **man** in engineering	"So, I feel like I have to carry myself a little bit differently, like I have to almost seem like, like make myself seem almost like harmless so that people are like a little bit, like they'll let their guard down you know?"
Black/African American/African woman in Engineering	Speaking to what it means to be Black/African American/African **woman** in engineering	"Like nothing that really deterred me, but of course if you're in a group project or something and you're in a group with all guys, there are time when they try to speak over you or just kind of dismiss your ideas because you're a female and they don't think you're—necessarily, you're not good at math or she doesn't know, kind of man slang, certain things to you, and it's like I know what I'm doing"

Table 12 (cont'd)

Coping with discrimination, stereotypes, racism	Coping mechanisms for instances of discrimination, stereotypes, and racism	"I feel like I pretty much just brush it off. I don't ever like approach anybody directly, like you said, something that I did not like. I usually just brush it off, because you can't change people that quickly."
Leaving engineering/non-engineering experience	The unique experiences of those who have left engineering and specifically what they benefited from or lost by leaving	"And my group was very, wasn't very kind. There were two women and one white woman. And I kind of felt like everything I said was consistently being pushed to the side or I would say something and the other woman kind of would say the same thing, and they'd listen to her over me. It was consistently that over time. But I would say that kind of reflected in a lot of different areas. But that kind of was like, hm. So yeah, that was kind of something that factored in my decision to switch."
Belonging	Experiences of belonging or not belonging in Engineering	"So, I did phenomenal in all the intro to engineering classes. Well, it wasn't the greatest thing. It was more so, like I didn't feel welcome. I didn't feel comfortable. Sometimes I felt very isolated."
Persistence	Experiences of persistence and future goals	"So currently, I just accepted an offer with Marathon down in Texas."
Interest in Engineering or STEM	General interest in STEM or engineering at any point	"I feel like my brain is just wired to be an engineer to some extent."
Family and first-generation college student experience	Speaking to the first-generation college student experience -- readiness, preparedness, resources and expectations from family/friends	"And I didn't have people in my corner to kind of even talk to about that. I couldn't talk to my family about it, because I'm supposed to be the example of you know, already."

Table 13:

Initial Themes and Definitions for Profile 1

Theme	Definition
High family expectations/influences, and	Shared experiences around family having high expectations for their future and playing a role in their academic pathways
Loss of STEM interest	Loss of STEM interest early on or having other interests and passions that were not STEM-related
Endorsing many relevant non-engineering identities	Speaking to saliency of non-engineering identities such as religion and sports
Coping strategies for dealing with stereotype threat microaggressions, discrimination	Shared connections for dealing with stereotype threat, racism, discrimination
Low perceptions from professors, students, and institution	Low expectations from professors, students, and broadly the institution, especially as it relates to development of certain group-based scholarships
Overcoming barriers: institutional, faculty, and peers	Connections to determination, resilience, and persistence for overcoming barriers, such as saying “you gotta keep your head up”
Gender underrepresentation in engineering	Marginalized in engineering, as experienced by the female in the sample. Men made impactful reflections of gender stereotypes, discrimination, etc.
Racial underrepresentation in engineering	Shared experiences with being marginalized in engineering based on their gender

Table 14:

Initial Themes and Definitions for Profile 2

Theme	Definition
Engineering persistence	Shared persistence and interests in engineering as a class
College-centered salient identities	Shared identities around college specific factors (e.g., being a student)
Limited racial ethnic and racial identity salience	Shared connections to their racial and ethnic identity – as not particularly salient
Exploratory interests in K-12	Shared experiences with weighing many interests when selecting a college major
Alternative careers and pathways, both within and beyond STEM	Interest in pursuing pathways both within and outside of STEM
Familial/friend/advisor influences towards engineering	Shared experiences with having friends and family influence their decisions to pursue engineering
Feelings of isolation, exclusion, and low belonging in engineering	Shared experiences about feeling isolated and like they don't belong in engineering
Peer and professor mistreatment and mistrust	Being mistreated in engineering courses from professors and teaching assistants

Table 15:

Initial Themes and Definitions for Profile 3

Theme	Definition
Defying the odds with engineering persistence	Speaking to resilience and enduring a path/journey that isn't always easy to get through
Paving the way for other women of color in engineering	Paying it forward and being a role model for aspiring women of color engineering students
STEM and medicine interest	Shared experiences with an early STEM or medicine interest
African American/Black woman salient identity	Share saliency with being African American/Black women
Complexity in intersectionality	Making sense of how race and gender, or being a woman of color, has shaped experiences in engineering contexts
Exposure to others' experiences with racism and discrimination	Seeing the impacts of racism and discrimination happening to others
Major changes within engineering	Pattern of changing majors among women in this Class both within and outside of engineering
Low male peer expectations	Perceptions from male peers in classes that were about them having less abilities
Professor/TA exclusionary experiences	Being mistreated in engineering courses from professors and teaching assistants
Affinity spaces	Shared experiences with safe spaces that provided community, support, and belonging

Table 16:

Profile 1 Comparisons Across Profile Variables

	Overall Profile Means	Harmony	Jerry	Sean
Engineering Identity	2.38	1.78	2.33	2.00
Ethnic Identity	3.68	3.50	2.17	4.67
Ethnic Stereotype Threat	3.96	4.00	4.50	1.50
Gender Stereotype Threat	2.97	4.00	1.25	1.50

Note. All scale ranges are 1-5 (1 = strongly disagree, 5 = strongly agree).

Table 17:

Profile 2 Comparisons Across Profile Variables

	Overall Profile Means	Dante	Sophie	Connie	Denise	Jeremy	Samantha	Brionna	Latrice
Engineering Identity	3.85	4.33	3.00	4.00	4.89	3.89	4.00	4.00	3.33
Ethnic Identity	3.97	4.50	3.50	4.00	5.00	4.16	4.00	4.00	4.33
Ethnic Stereotype Threat	3.62	5.00	3.25	2.75	3.50	4.00	3.00	4.00	3.00
Gender Stereotype Threat	2.16	2.25	3.25	3.25	3.50	1.75	3.00	4.00	3.00

Note. All scale ranges are 1-5 (1 = strongly disagree, 5 = strongly agree).

Table 18:

Profile 3 Comparisons Across Profile Variables

	Overall Profile Means	Darlene	Shondra	Armani	Jasmin
Engineering Identity	4.01	3.67	3.89	3.78	3.00
Ethnic Identity	4.55	4.17	5.00	5.00	5.00
Ethnic Stereotype Threat	4.67	4.00	5.00	5.00	4.75
Gender Stereotype Threat	4.33	1.75	4.00	5.00	4.24

Note. All scale ranges are 1-5 (1 = strongly disagree, 5 = strongly agree).

APPENDIX B:

Figures

Figure 1:

Schematic of an Explanatory Mixed Methods Design

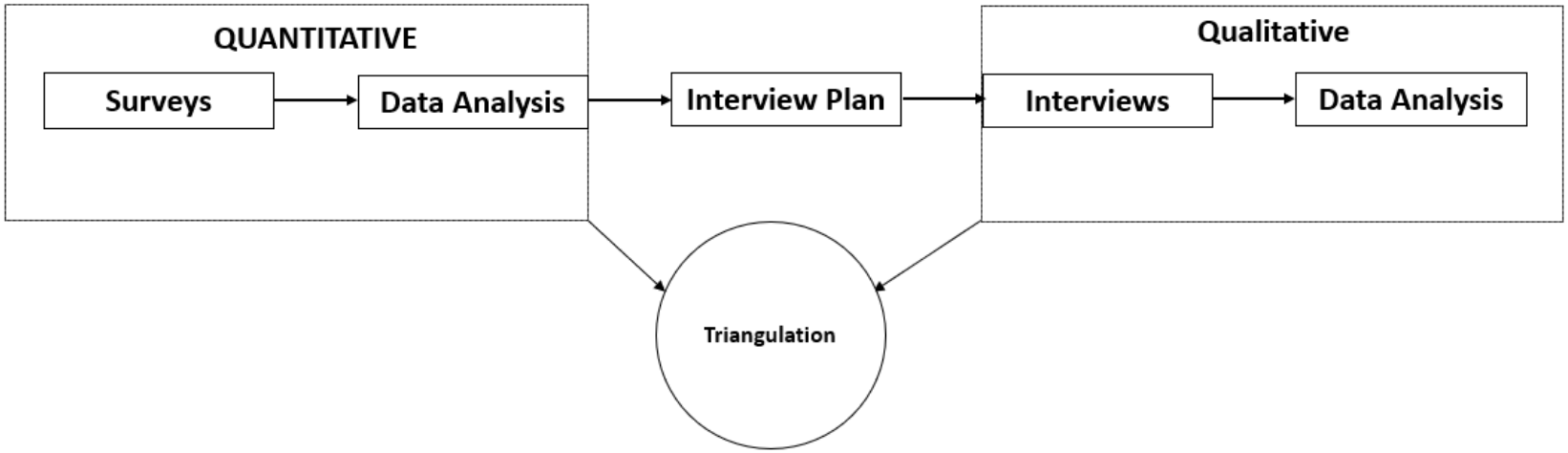


Figure 2:

Latent Profile Analysis Structural Equation Model

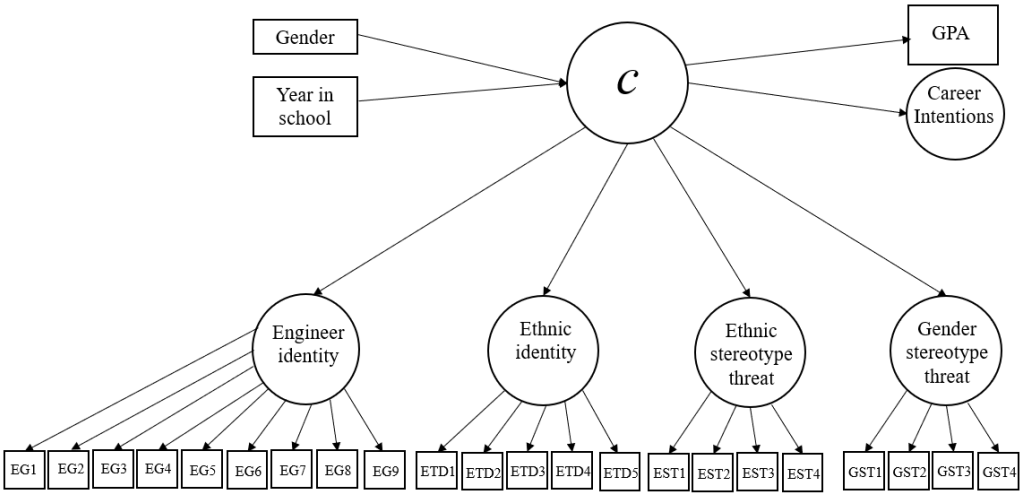


Figure 3:

Raw Values of Identity and Stereotype Threat Profiles

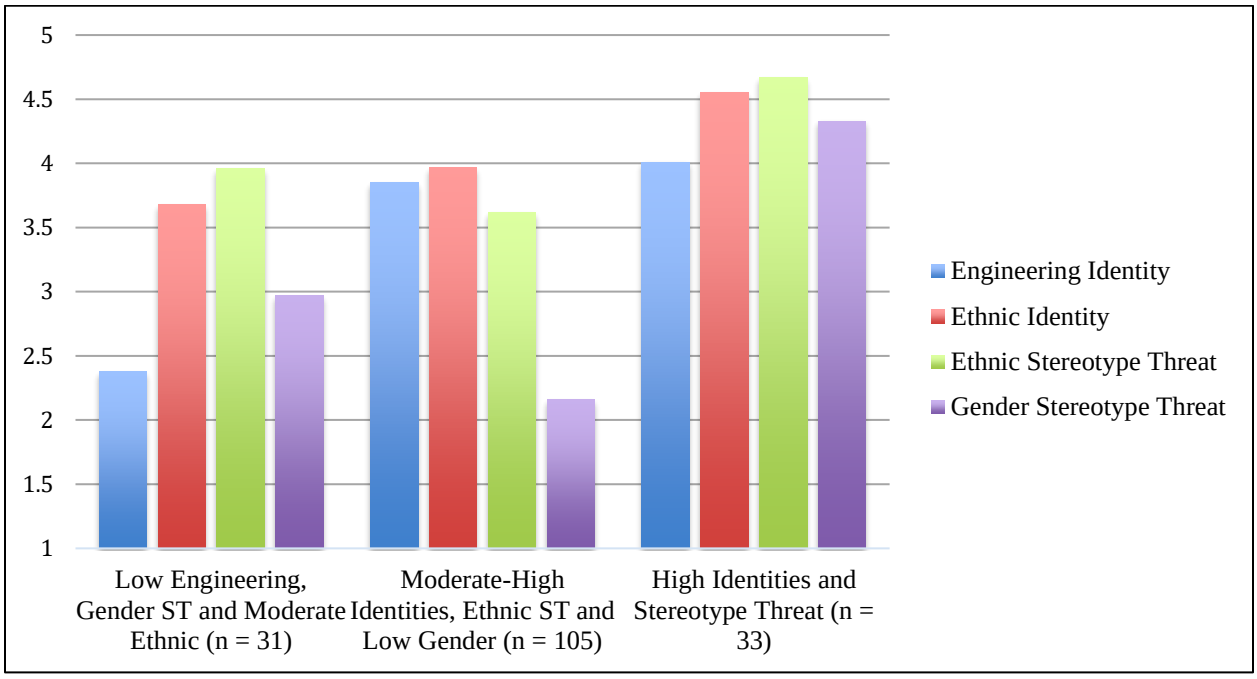


Figure 4:

Profile Networks

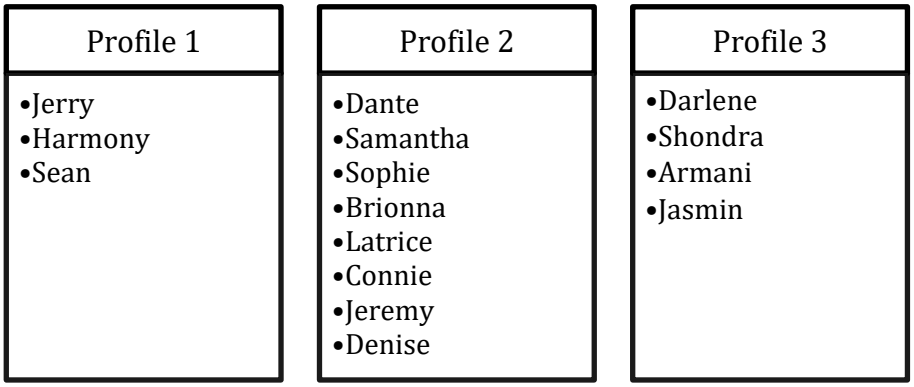


Figure 5:

Profile 1 Thematic Map

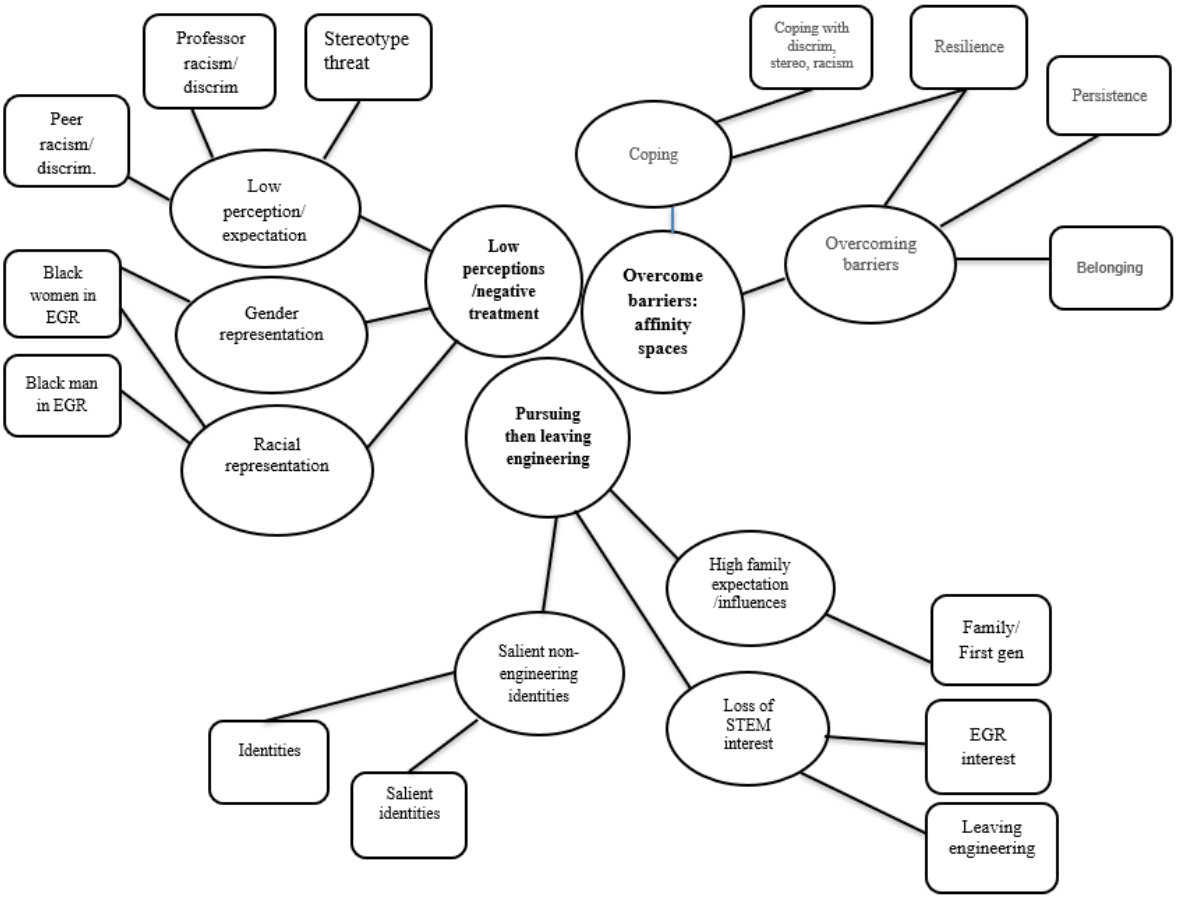


Figure 6:

Profile 2 Thematic Map

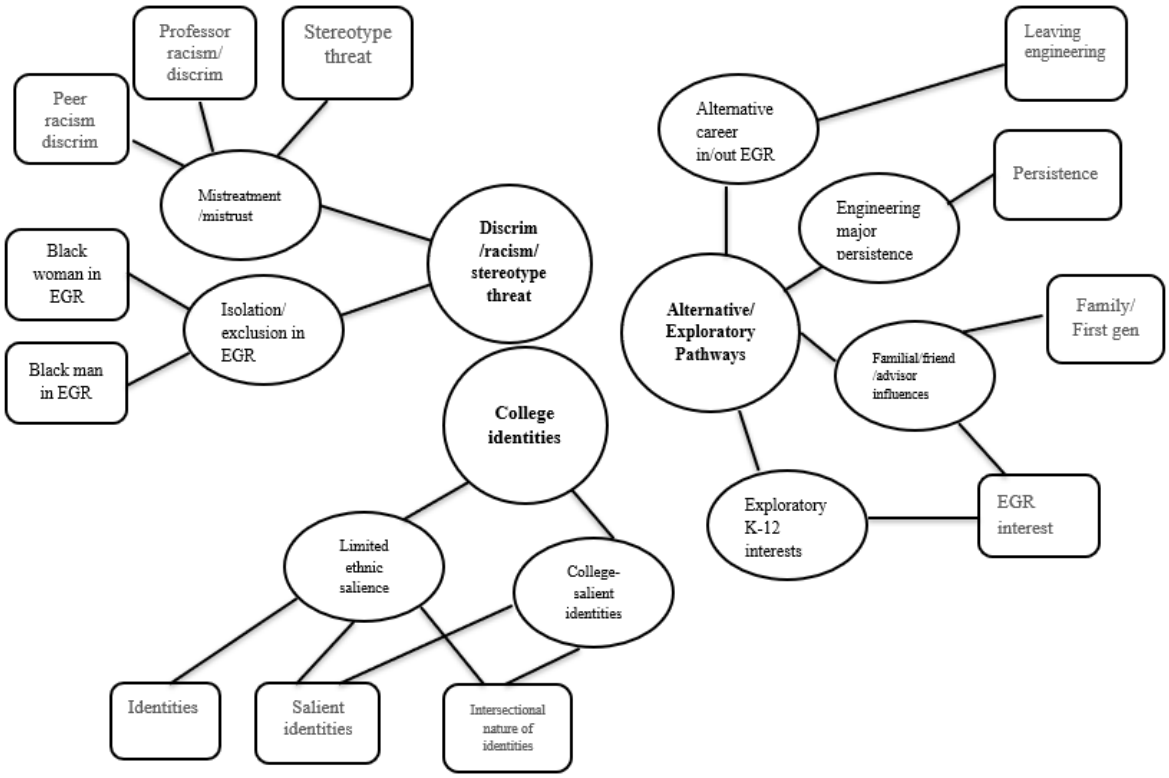
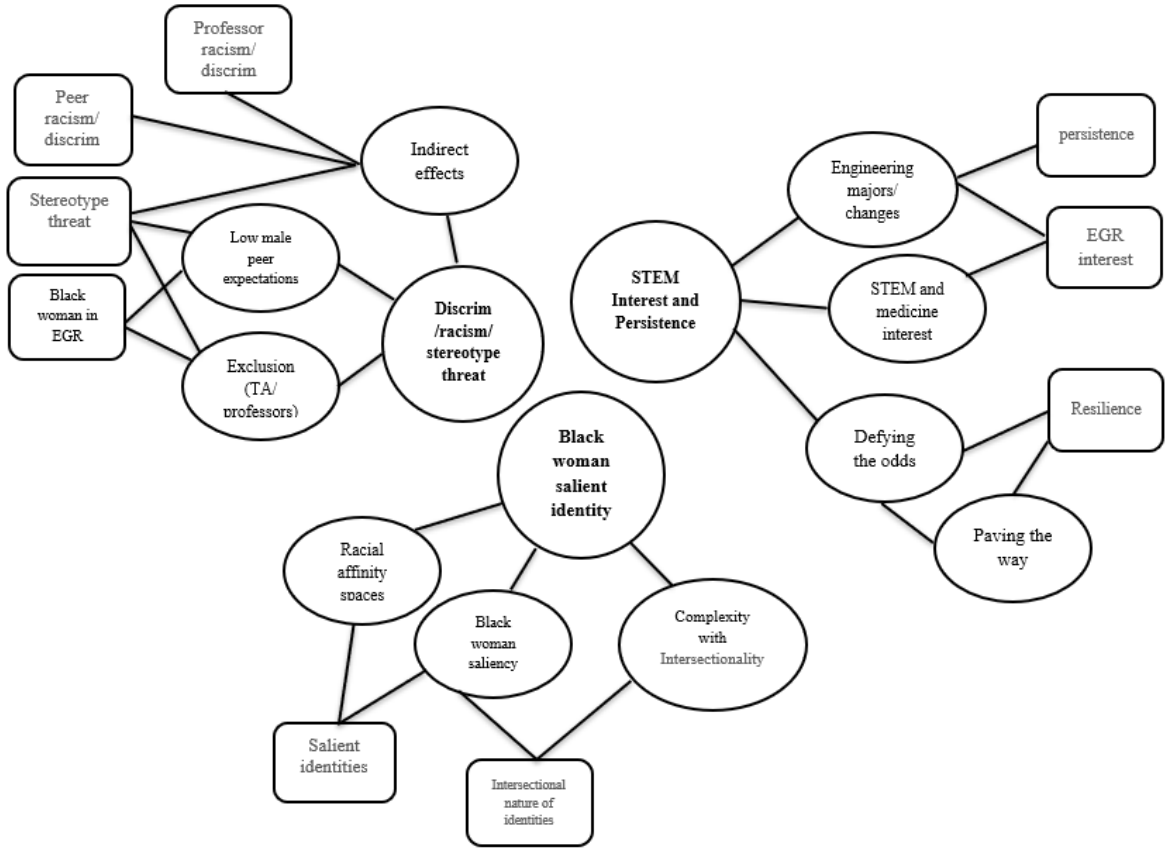


Figure 7:

Profile 3 Thematic Map



APPENDIX C:

Study Instruments

Survey Measures

Engineering Identity (*adapted from Pugh et al., 2009, [+]adapted from Estrada et al., 2011)
*I can imagine myself being involved in an engineering related career.
*Being involved in engineering is a key part of who I am.
*I consider myself an engineering person.
*I can see myself doing engineering in the future.
[+]I have a strong sense of belonging to the community of engineers
[+]I derive great personal satisfaction from being part of a team of engineers.
[+]I have come to think of myself as an 'engineer.'
[+]I feel like I belong in the field of engineering.
[+]The daily work of an engineer is appealing to me.

Ethnic Identity (Phinney, 1992; *+affirmation/belonging & *achievement factors denoted below*)
*I have spent time trying to find out more about my ethnic group such as its history, traditions, and customs.
+I have a strong sense of belonging to my own ethnic group.
*I understand pretty well what my ethnic group membership means to me.
*I have often done things that will help me understand my ethnic group background better.
+I feel a strong attachment towards my own ethnic group.

Ethnic Stereotype Threat (Steele, James, & Barnett, 2002) ***How often do you feel that because of your <u>ethnicity</u>...***
Some people believe that you have less ability.
If you are not better than average, people will assume that you are limited.
If you do poorly on a test, people will assume that it is because of your ethnicity.
People of your ethnicity face unfair evaluations because of their ethnicity.

Gender Stereotype Threat (Steele, James, & Barnett, 2002) ***How often do you feel that because of your <u>gender</u>…***
Some people believe that you have less ability.
If you are not better than average, people will assume that you are limited.
If you do poorly on a test, people will assume that it is because of your gender.
People of your gender face unfair evaluations because of their gender.

Interview Protocol

Section 1: ***Introduction and Educational History***

1. Tell me a bit about yourself.
    a. **Probes:** Where are you from? What is your major?
    b. Probe if not mentioned: Can you tell me a bit about your educational journey/experience, such as what type of schooling you had and what your interests in K-12 were?
2. What role, if any, did your family play in your decision to go to [University Name Blinded]?
3. Why did you decide to pursue engineering as a major in college?
4. **If not engineering:** Why did you *initially* decide to pursue engineering as a major? Why did you decide to then pursue [insert major here] as a major?
    i. Probe: If at all, how did your family play a role in this decision?
    ii. Probe: Is anyone in your family an engineer and what type of engineer? How, if at all, did they impact your decision to pursue engineering?
    iii. Probe: Who, if anyone, impacted your decision to pursue engineering as a major? And why?

5. How would you describe yourself in terms of your race? What about your ethnicity? Lastly, how would you describe yourself in terms of your gender? [**important note**: this will help me use the appropriate racial/ethnic description for each individual and to specify their gender correctly]

Section 2: ***Multiple Identities and Intersectionality***

**Important note* match the example of Michelle or Michael based on gender of student being interviewed*

For the next few questions, I would like to ask you about your identities or your thoughts about who you are. Identity is made up of multiple parts. For some people their identities are related to their personal characteristics such as their race, ethnic background, gender, or background. Other people identify more with other roles they play in their life like being a community leader, athlete, or brother/sister, and for others it's a combination of both. For example, a hypothetical person *Michael/Michelle* is a student in the College of Natural Science. When asked, "How do you identify," Michael/Michelle said that she/he identified as a woman/man/transgender, musician, a science student, and a daughter/son.

1. How would you respond to the question: how do you identify yourself?
    a. **Probe:** if you're having trouble thinking of parts of one's identity, how would you describe yourself to other people?
2. Which of the identities you mentioned matter most to you? Why?

3. What is it like to be a [mention all salient identities, e.g., mixed, bi-sexual woman] and an ____ (field; engineering, chemistry, english) student?
    a. **(For non-egr students)** What **was it** like to be a [mention all salient identities, e.g., mixed, bi-sexual woman] and an engineering student?
    b. **Probe:** In what ways do these identities compete with one another or are in cooperation?
    c. **Probe:** You focused on your experiences as a [fill in the blank], but you identified [fill in the blank] as also being important. Would you like to say more about that?
    d. **Probe if engineering identity is not mentioned:** What does being an engineer mean to you?
4. Can you recall any specific experiences at [University Name Blinded] that have shaped your identities?
    a. **Probe:** think about those with friends, in classes, in informal spaces like sports, organizations, and Greek life.

Section 3: ***Experiences of Stereotype Threat, Microaggressions, Discrimination***

1. Tell me about your experience as a Black [man or woman or non-binary] in an engineering major *[OR OTHER MAJOR]* at Michigan State University?
2. If any, can you discuss your experiences with *racial/ethnic* stereotypes, microaggressions, and discrimination in engineering?
3. Similarly, if any, can you discuss your experiences with *gender* stereotypes, microaggressions, and discrimination in engineering?
4. If at all, how have you handled being faced with stereotypes, microaggressions, and discrimination in engineering?
5. Have any of these experiences negatively impacted your willingness to persist as an engineering student?
6. What words would you use to characterize your engineering experience as a Black/African American man/woman/non-binary? What words would you use to characterize yourself as a student (or previous student) in engineering?
    a. Why did you select those words?

Leaving Engineering (Only for people who have left engineering)

7. Why did you make the decision to leave the College of Engineering?
    a. **Probe:** Was there a specific turning point for you or have you always felt like engineering/computer science was not the correct path for you?
    b. Can you briefly compare and contrast your old major in engineering versus your new major?

Section 4: ***Belonging/Overcoming Barriers and Affinity Spaces***

1. In what ways do you feel like you belong in engineering? Why?
2. In what ways do you feel like you don't belong in engineering? Why?
3. Have you participated in any extracurricular experiences while in college?
    a. If yes, then: What extracurriculars were they and why did you choose to participate in them?
    b. If no, then: Is this out of a lack of interest or are there specific barriers that have presented you from participating?
4. **If mentioned being involved in extracurricular activities:** You previously mentioned that you were involved in formal and informal spaces outside of your coursework, can you briefly mention why you chose to become involved in those activities?
    a. How are those spaces different then your engineering courses and labs?
    b. How would you describe your feelings of belonging in those informal spaces? Is that any different than your feelings of belonging in your engineering courses and labs?
5. **If mentioned not being involved in extracurricular activities:** You previously mentioned that you were not involved in formal and informal spaces outside of your engineering coursework. Why have you chosen not to participate in any formal and informal organizations and spaces?
6. What barriers, if any, did you face while pursuing engineering?
    a. **IF MENTIONED BARRIERS TO SUCCESS:** What type of support did you receive that helped you overcome your obstacles in pursuing your degree? You can think of personal, financial, and social support as some examples.

Section 5: ***Career and Future Self***

1. What are your career plans for after graduation?
    a. Probe: how does a *career in X* align with your goals in life?
2. Do you consider yourself someone that can be in an engineering career? Why or why not?
3. Has your image of yourself as an engineer changed from when you started at [University Name Blinded] until now? If so, how so? If not, what has remained the same?
4. **IF left engineering:** Even though you decided not to pursue an engineering career, do you think of yourself as someone that could have pursued this path? Why or why not?
5. If you could provide some words of advice to an incoming Black/African American male or female [match to participant] in engineering OR your major, what would it be?
6. Is there anything else you would like to add about anything we discussed today?

DEBRIEF AND THANK. END.

Study Instruments

Email invitation and confirmation templates.

Dear <Name>,

We are inviting you to participate in an interview to help [Anonymous Department] better understand students' experiences in engineering at [Anonymous] University. Your input will help us improve academic and social support experiences for future engineering and computer science students. We are interested in your responses even if you did not major in an engineering/computer science degree. The interview will take about **an hour of your time and be conducted via Zoom**. You will receive a **$50 Amazon gift card** for participating.

Please fill out this Doodle poll [Link Here] to pick an available time slot or copy/paste the link below into your browser. There are limited spaces, so please respond as early as possible to confirm your space.

If you have questions about the research project, you may contact me at liraamal@msu.edu.

Copy/paste this link into your browser: [Link]

Sincerely,
Krystal Lira
Graduate Research Assistant

Dear <Name>,

Thank you for your willingness to participate in an interview. The interview will take place **[DATE AND TIME]** and you will receive a **$50 Amazon gift card** for participating. Please click on this consent form [Link Here] which will take you to the consent form for the study. Please read it carefully and print a copy for your records.

The interview will be conducted online through Zoom. The link to the online interview is included below.

Zoom link: [Link Here]
Password: [Link Here]

For the interview, please go to a quiet location where you know you won't be disturbed, and the internet connection is strong. We also ask that you use a device with a working camera and use a headset with microphone, if possible. We recommend using a computer or tablet for the interview; however, you can also use a phone with the zoom mobile app, if needed.

Please do not hesitate to contact me if you have problems accessing Zoom, if you will be late, or if you need to reschedule. If you need to contact me, it is best to call or text me at 323-895-3790 or email me directly at liraamal@msu.edu

I look forward to meeting you!

Sincerely,
Krystal Lira
Graduate Research Assistant

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