



Intersectional Engineers: Diversity of Gender and Race Microaggressions and Their Effects in Engineering Education

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Abstract: Underrepresented minorities in engineering regularly experience subtle behaviors or statements that denigrate them on account of their race, ethnicity, gender, or other identity. Engineering students cite these behaviors, known as microaggressions, as reasons for having considered changing majors or leaving college altogether. Despite the recent research trend to foster a more racially, ethnically, and gender-inclusive engineering education and profession, previous research does not examine microaggressions in engineering using an intersectional lens. Without an intersectional perspective, intragroup diversity is overlooked, increasing the potential to reinforce broad racial and gender stereotypes. To measure the effects of microaggressions among engineering undergraduate students, the current study used an intersectional approach and collected data from a predominantly white institution (PWI) and from a historically black colleges and universities (HBCUs). The authors conducted individual semistructured interviews to examine the effects of microaggressions among 42 engineering undergraduate students, who can be categorized into seven intersectional identities—White women, African American men, African American women, Asian men, Asian women, Latino men, and Latina women. Results showed five macroeffects and two microeffects—(1) reduced self-belief (reduced self-efficacy and reduced self-esteem), (2) otherness, (3) racial/gender isolation, (4) stereotype threat, and (5) and empowered sense of self. Also, in this work, we make comparisons across intersectional identities. The data provide support for further study of microaggressions and their effects on intersectional identities. This research extends the intersectional approach to focus on engineering departments and colleges and provides information to engineering departments and university administrators concerning the experiences of minority undergraduates and offers academic leaders further information regarding issues surrounding minority student retention and persistence.

DOI: [10.1061/\(ASCE\)ME.1943-5479.0000889](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000889). © 2021 American Society of Civil Engineers.

Introduction

In 2016, according to the NSF (2019), approximately a quarter of the engineering bachelor's degrees earned in the United States were awarded to underrepresented minorities. An even lower representation is found in the construction industry workforce, with women constituting approximately ten percent and racial minorities constituting approximately eight percent (Bureau of Labor Statistics 2019). The representation of women in executive positions within the engineering field has been shown to be very low, with only 16%

of firms having more than 10% in leadership positions (Hickey and Cui 2020). Underrepresentation in the construction and engineering industry is the result of the low numbers of minorities in engineering education. In engineering in 2015, for example, only 4% of bachelor's degrees were awarded to African Americans, compared to the 65% that were awarded to Whites (Yoder 2017). In 2019, for every five engineering degree earners, only one was a woman (Appelhans et al. 2019).

Engineering programs' limited racial and gender diversity is often driven by the negative experiences that minority students experience at college. Two-thirds of minority students in engineering report being frequent targets of microaggressions (Williams et al. 2017; Yang and Carroll 2018). Microaggressions—subtle behaviors or statements that denigrate people because of their race, ethnicity, gender, or other underrepresented identities (Sue et al. 2007)—are experienced widely across multiple identities, including Latinx (Gutiérrez et al. 2019), African Americans (Lewis et al. 2016), and Asians (Ong et al. 2013). Microaggressions are clearly problematic. They can affect student academic performance and persistence (Smith 2009). They are acted out in three domains—verbal, nonverbal or behavioral, and environmental (Sue et al. 2008). Examples include statements like “Wow, your English is so good!” or behaviors like moving away from a person of color in a classroom to avoid sitting near them.

Research has repeatedly shown that minority students who encounter regular incidents of microaggressions experience negative outcomes (McGee and Martin 2011; Trytten et al. 2012). In fact, microaggressive behaviors and treatment motivate minority students to withdraw from engineering majors and professions (Fouad et al. 2017). Minority engineering students feel again and

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Note. This manuscript was submitted on June 25, 2020; approved on October 29, 2020; published online on January 22, 2021. Discussion period open until June 22, 2021; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Management in Engineering*, © ASCE, ISSN 0742-597X.

again that they must prove their intellectual value (McGee and Martin 2011); they struggle with racially ascribed assumptions of intelligence (Trytten et al. 2012); they may experience low social inclusion among their peers (Marra et al. 2009). Reduced inclusion is likely to lead not just to social isolation but to fewer opportunities to establish essential peer support networks (Tate and Linn 2005). Moreover, microaggressions have been documented to affect both the mental and physical health of minorities (Ong et al. 2013). Repeated microaggressions result in minorities feeling powerless and invisible (Sue et al. 2008).

While plenty of researchers have (Sue et al. 2008) documented the effects of microaggressions, this past work has primarily studied gender (e.g., experiences of women versus men) or racial (e.g., experiences of African Americans versus Whites) identities. Students' experiences, though, are determined by the intersection of multiple identities (Crenshaw 1989; Ro and Loya 2015). Hence, it is essential to identify microaggressions based on intersectionality. Intersectionality explains an individual's experiences of discriminatory treatment due to both race, gender, and/or other social positions (Crenshaw 1989). Because intersectionality considers the complexity of how identity is unique to both race, ethnicity, and gender features, adopting such a lens provides researchers a more accurate understanding of students' experiences with microaggressions and their effect. The intersectional lens reveals that an individual's identities are neither accumulative nor independent but actively interdependent (Cho et al. 2013). An Asian woman, for example, is simultaneously a woman, Asian, and a member of other social positions and identities. The sum of her experiences is not equal to that of Asian people plus the experiences of women. The interdependent nature of intersectionality is able to capture an individual's membership within multiple identities.

Literature Review

Recently, researchers in engineering have studied the development and maintenance of a more racially, ethnically, and gender diverse and inclusive engineering education and professions. For example, Hartman et al. (2019), who conducted a multi-year project examining campus inclusivity, found barriers for inclusion within the admission processes, the importance of mentoring first- and second-year students, and the interpersonal climate. Although early in their research, their research promises to identify additional strategies to provide an inclusive and diverse educational environment. Examining the impact of a larger proportion of female professors on ethical and social justice topics taught in engineering, Bielefeldt et al. (2018) found evidence that engineering instructors who were women and from underrepresented minorities incorporated more ethical topics like social justice or poverty into their curriculum. Enhanced inclusion of ethical consideration into engineering curriculums may raise student awareness of ethical issues and identify it as a fundamental issue for all engineers to consider. Although not researching the effects of microaggressions, this research highlights the importance of more retention and retention of female engineers and underrepresented minorities within engineering education. In a related study of diversity as an ethical concern, researchers compared undergraduate students' and professional engineers' perceptions of cultural diversity in the course curriculum, access to the engineering field, and the work environment. Students in the study believed it was more important to recruit more minority students to engineering programs than professional engineers (Chaudhury et al. 2019). This demonstrates student desire for greater knowledge and diversity within engineering education and the importance of continued research into the experiences of minorities across the

education and career spectrums. At the graduate level, researchers have examined impediments to African American male student's persistence within engineering education. There was evidence of negative race-based interactions with peers and faculty members impacting participant persistence (Burt et al. 2018). This research shows that negative race-based interactions continue to occur in graduate school for people of color and may reduce their persistence. In an interesting reversal of perspective, Eastman et al. (2019) examined White and male culture in terms of equity and privilege within engineering education. Using an instrumental case study design, the researchers followed a White male engineering doctoral student for four years to document changes in his beliefs surrounding equity and privilege. Classwork and research directly involving people of color resulted in the research subject becoming more aware of his privilege and internalized biases. This research emphasizes the importance of incorporating discussions of equity, privilege, and other social justice topics within engineering education. Beyond the classroom and examining gendered knowledge accessibility perceptions among professional engineers, Poleacovschi et al. (2020) found evidence that when women sought information from other women, they perceived higher accessibility than when women sought information from men. In fact, when men sought information from women, they perceived significantly lower accessibility than when women sought information from men. The variance in the perception of knowledge accessibility highlights the considerably unbalanced gender relations within the professional engineering environment. Additionally, researchers examined the demographic and motivating factors of women in engineering careers. They found that more single women reported a desire to remain in the engineering profession and that expressed interest in engineering led to higher satisfaction in their careers (Morello et al. 2018). Moreover, research on gender equity and relations in specific fields has been recently developing, such as Manesh et al. (2020), who conducted a spatial analysis of the gender wage gap within architecture, civil engineering, and construction. They found certain areas that had relatively lower gender wage gaps than others. In 2015, Maine was an outlier compared to its neighbors in that they have a low wage gap due to a labor shortage, thereby increasing the wages of women within the construction industry. From a similar field, Perrenoud et al. (2020) examined gender differences in managers' attraction in the electrical construction industry. They found that women identified having a career opportunity in the industry as the most commonly reported attraction factor to the electrical construction industry. Among men, the greatest proportion reported having family relationships within the field as an attraction factor. Finally, Shrestha et al. (2020) researched the wage distribution and employment by gender in the construction industry. They found very little change in the gender makeup of the number of those working in the construction engineering field between 2005 and 2014. They also found a smaller wage gap between men and women in traditionally unionized occupations such as steelworkers or electricians, but this was not the case in occupations that were not unionized. Despite this trend of researching the development and maintenance of a more racially, ethnically, and gender diverse and inclusive engineering education and professions, microaggression effects among undergraduates have not been the primary focus of recent research.

Research on the effects of microaggressions on minority identities has been conducted both outside and within the engineering field. From outside the engineering fields, for instance, Sue et al. (2008) researched racial microaggressions and how they affected the lives of African American individuals. They found that African Americans who were the targets of microaggressions felt powerless, invisible, and under pressure to be a representative for

all African Americans. Within engineering, Trytten et al. (2012) examined how pressures to adhere to the model minority stereotype impacted Asian engineering students. The model minority stereotype attached to Asian Americans includes expectations they are smart, hardworking, docile, submissive, and that they are naturally good at math and other hard sciences. The study's results indicated no academic record differences between Asian American students and students from other racial identities. However, the data revealed the considerable effort Asian American students exerted to meet academic expectations. Generally, studies have considered the effects of microaggressions on only one racial or gender identity. A few notable exceptions, such as Ro and Loya (2015), examined the intersectional effect of gender and race on learning outcomes for engineering students. The authors found interactive differences in self-assessed change in student learning skills like communication, leadership, and teamwork. Likewise, Camacho and Lord (2011) analyzed experiences of microaggressions among Asian, Latina, and White women within engineering education. They found the types of microaggression experiences differed between racial and ethnic groups. Despite this, the experiences fell into similar microaggression categories, interpersonal, institutional, and jokes.

Microaggressions and Their Effects

The concept of microaggressions originated from research conducted in the late 1970s by Pierce et al. (1977). In this early form of the term, microaggressions were defined as "subtle, stunning, often automatic, and nonverbal insulting exchanges which are 'put-downs' (or insults) of blacks by offenders" (Pierce et al. 1977). Since this first use of the term, researchers have expanded its definition to include the study of gender, ethnicity, and other identities. Sue et al. (2007) defined microaggressions as subtle behaviors or statements that denigrate people because of their race, ethnicity, gender, or other identities. Perpetrators of microaggressions are often unaware of the impact their words have on those around them (Dovidio and Gaertner 2000). Individuals who experience these unintentional microaggressions report feeling paranoid about them; were they being too sensitive; did they mishear the person (Sue et al. 2008)? They give considerable time to pondering these questions, wondering if the exchange was even racially motivated (Holder et al. 2015).

Microaggressions negatively affect minority students in multiple spheres, including reduced academic performance, poorer mental, and physical health, and constrained social interactions (Forrest-Bank and Jenson 2015; Ong et al. 2013; Solorzano et al. 2000). Forrest-Bank and Jenson (2015) found a negative relationship between enduring racial microaggressions and academic self-efficacy for students of historically disadvantaged identities. The more microaggressions they experienced, the less they believe they could complete their academic mission. In fact, a young adult who experiences microaggressions is more likely to engage in substance abuse and entertain criminal intentions. Also, microaggressions can lead to reduced academic self-esteem (Forrest-Bank and Cuellar 2018). Undergraduate students who experience microaggressions have been known to perform worse academically (Solorzano et al. 2000). They may face varying cumulative effects that can lead to their dropping classes, changing majors, or even leaving college altogether. Some students may feel isolated when they are one of the few representatives of a race, ethnicity, or gender in a classroom or lab (Yosso et al. 2009). Those without a readily available social group among their peers report feeling alienated and isolated from their peers. Additionally, microaggression effects have been found to increase the frequency of physical symptoms like headaches, gastrointestinal distress, and other physical discomforts (Ong et al. 2013).

Intersectionality

Intersectionality refers to the interlocked identities of race, gender, and other social positions (Crenshaw 1989). Rather than a unidimensional identification of one identity (e.g., female or Asian), intersectionality incorporates cooccurring multidimensional identification (e.g., Asian female). In other words, intersectionality illustrates that within race or gender there are significant intragroup differences that affect how people are treated. Instead of observing all people of one race or gender as the same, intersectionality highlights the nuances within social identities and how they may influence one's lived experiences. For example, one individual can be a woman, White, a mother, an immigrant, and have a disability, thereby simultaneously inhabiting several interlinked social positions and identities. The location of this person's experiences as a disabled immigrant White mother affects her privilege and oppression based on others' expectations and stereotypes. Influenced by racism, sexism, classism, and homophobia, the various interacting social positions and identities encompass interrelated systems of power. As Crenshaw (1989, p. 1249) observed, "Intersectional subordination need not be intentionally produced; in fact, it is frequently the consequence of the imposition of one burden that interacts with preexisting vulnerabilities to create yet another dimension of disempowerment." Intersectionality illustrates that people experience society while inhabiting multiple inextricably bound identities (Morales 2014). In the past decade, intersectional research has grown more common within engineering and construction to reveal variations within gender and race. Several authors have explored intersectional identities of engineers, including those of diverse young women and their commitment and persistence to engineering (Bringer et al. 2006), the experiences of African American women and girls in engineering (Ireland et al. 2018), and the experiences of women of color in engineering (Johnson 2011).

While some of the previous research evaluated the effects of microaggressions in college settings, few of them discussed these effects in the context of engineering and none of them have examined the experiences of seven intersectional identities with an intersectional lens. This can be problematic, despite increases in diversity awareness and programs (Carter 2006). The current research addresses this gap and expands our knowledge of the effects of microaggressions for undergraduates across seven intersectional identities within the engineering and construction fields. Despite the rise of intersectional research, there is limited research on the intersectional effects of microaggressions on engineering undergraduate students. If microaggression effects are not examined from an intersectional approach, then experiential differences between identities remain concealed. This research explores the effects of microaggressions using an intersectional lens.

The body of research on diversity in engineering is expanding, but an intersectional examination of the effects of microaggressions on engineering education remains a persistent gap in the body of knowledge. Research on the effects of racial stereotypes on Asian American engineering undergraduates was conducted by Trytten et al. (2012), but this was not an examination of microaggressions and did not include any Latinx, White, or African American undergraduate engineering students. Camacho and Lord (2011) studied the experiences of microaggressions among Asian, Latina, and White women within engineering education, but this study did not include African Americans or men. Additionally, no previous research has used an intersectional approach to examining microaggression effects among undergraduate engineering students. This research examined the effects of microaggressions and was conducted at a predominantly White institution (PWI) and a historically

black college or university (HBCU). Participants included undergraduate engineering students whose various identities encompassed the following: White women, African American women, African American men, Asian men, Asian women, Latino men, and Latina women.

Methods

The research used a consensual qualitative research (CQR) design to examine the experiences of microaggressions among women and minority undergraduate engineering students (Hill et al. 1997). Embedded within grounded theory, CQR incorporates a data-driven inductive qualitative research design (Glaser et al. 1968; Hill et al. 2005). Data were collected by interviews using a semistructured interview protocol designed to not limit participant responses. Throughout the research, a core research team worked together to limit bias from affecting the research process and aided in the identification of complexities and subtleties within the data. The analysis was conducted by a core group who independently analyzed the data and then met to present their findings to the research team. The goal of the discussions was to reach a consensus on the interpretation of the data. A benefit of the consensus analytical process was that every researcher independently examined the research and then presented their interpretations of the data to the group, thereby reducing issues of groupthink (Hill et al. 1997).

Participants and Research Sites

This research was a portion of a larger research project with a goal to examine engineering student experiences with gender and race microaggressions within and across two institutional contexts. The two institutions provide systematic consistency and variation across key variables. They are both land grant institutions that prioritize STEM education, have well respected engineering programs, and have a commitment to student body diversity. At the same time, the institutions vary in their location and racial majority. The HBCU is located in the Southeastern region of the United States and has an African American population majority. The PWI is located in the Midwestern region of the United States and has a White population majority. The two sites were selected to capture different microaggression effects while controlling for these key variables. The estimated size of the engineering student body at the HBCU was approximately 2,000 engineering students, and the student body at the PWI was approximately 7,600 engineering students. Included in the research participants were seven intersectional identities—White women, African American men, African American women, Asian men, Asian women, Latino men, and Latina women. These seven identities represented a substantial proportion of the racial, ethnic, and gender minority engineering undergraduate student bodies across both campuses (85% at the HBCU and 97% at the PWI). The researchers do not examine White men because this study focuses on the experiences of racial, ethnic, and gender minority engineering undergraduate students, and White men represent the majority of engineers and the most privileged group in American society (Liu et al. 2019). Consequently, White men are outside the scope of this study. Interestingly, while White men were interviewed as part of a larger study, they were unable to identify times when they experienced microaggressions. This preliminary finding corroborates with research on gender role conformity and barriers to observing White masculinity. People police and aggress White men when they do not conform to traditional racial and gender roles, but White males are not always aware of whether they are microaggressed (Eisler and Blalock 1991; Fischer and Good 1997; Moss-Racusin et al. 2010). This preliminary

finding in corroboration with previous research point to the diversity of intersectional identities in engineering and how they become constituted through microaggressions. Despite the interesting nature of microaggressions and White men, we contend that a focused examination of minority microaggressions is a substantial and worthwhile task. Not only are these populations (the seven identity groups studied here) underrepresented in engineering education, but engineering researchers have systematically overlooked the diversity within these gender and racial groups.

Data Collection

Using a convenience sampling method at both study locations, recruitment flyers were displayed in common areas of engineering departments and in public areas across both campuses. Potential participants contacted research team members for initial eligibility screening. This approach was supplemented by researchers using a snowball approach and direct recruitment by research team members. Previous research has shown the success of snowball sampling to reach marginalized groups (Cohen and Arieli 2011). Following initial contact with the research team, participants received an informed consent form and a short screening survey regarding their gender identity, racial identity, major, and age (they needed to be at least 18 years old). The screening survey ensured the participants were eligible for participation in the survey. Eligibility requirements were being at least 18 years old, an engineering undergraduate student, and being White, African American, Asian, or Latinx. After the initial screening survey, 42 participants were invited to take part in hour-long, semistructured interviews with trained researchers. Participants received a \$25 gift card as an incentive for participation. The sample included six White women, six African American men, six African American women, six Asian men, six Asian women, six Latino men, and six Latina women. All data collection procedures were reviewed for ethical compliance by the institutional review board (IRB) at the lead university in this study.

The interviews were semistructured and guided by an interview protocol with open-ended questions intended to elicit real-life examples of microaggressions and their effects and not constrain responses of the participants, but all participants were asked the same questions. Lasting for approximately one hour, interviews were conducted in a private setting with only the interviewer and participant. We strived to have the racial and ethnic identity of the interviewer match those of the participant. This approach provides a study's participants with an interviewer who may be able to understand their social position better than those from outside the identity (Ganga and Scott 2006). The interviewers included a White woman, an African American man, two African American women, and a Latino man. Throughout the interviews, participants often discussed the effects of experiencing microaggressions. Specifically, the interview protocol included three questions regarding the effect of negative experiences on academic self-efficacy, academic performance, and self-esteem. The interview closed with questions regarding whether they thought they would experience similar microaggressions in their careers as engineers. Specifically, they were asked if experiencing microaggressions made them question their choice of pursuing a career in engineering.

Analysis

The interviews were transcribed by a professional transcriber, and transcripts were checked for errors by two members of the research team proofreading the transcripts. The CQR consensus process involved a core group of six researchers who regularly returned

to the raw data to ensure consistency across the overarching macrocodes and associated microcodes. All researchers provided their input throughout the data collection and analysis processes. Using the CQR approach, the analysis took on an iterative style of evaluation with researchers first reading all transcripts to identify themes of microaggression effects. During biweekly meetings over a four-month period, the research team inductively characterized core themes within each interview and across all interviews. From these themes, analytical codes were developed and placed onto a coding matrix (Hutchison et al. 2010). All codes were then subject to support within the relevant literature and through several iterations, and a final literature-supported coding framework was produced (Bringer et al. 2006). The initial and subsequent coding frameworks were presented in biweekly meetings with the research team until consensus on a finalized framework was reached. This coding framework was then used to analyze the interview transcripts and analyzed independently by two coders using NVivo version 12. To ensure interrater reliability, the coders met weekly to identify and reach a consensus on how to address any needed changes on a random selection of interviews. The coders were one graduate student at the PWI and one tenure track professor at the PWI.

Through the consensus process, the research team identified the following five macroeffects and two microeffects: reduced self-belief (reduced self-efficacy and reduced self-esteem), racial/gender isolation, otherness, stereotype threat, and an empowered sense of self. Table 1 presents the identified categories of effects, definitions, and support within the existing literature for inclusion in the study. First, academic self-beliefs or student characteristics that lead to academic persistence are comprised of self-efficacy and self-esteem (Walsh and Robinson-Kurpius 2016). Having a strong sense of self-belief has a strong relationship with academic success among undergraduates (Mattern and Shaw 2010). Coupled with prior academic knowledge, self-belief has been associated with increased math performance (Haikari et al. 2008). Moreover, having higher self-belief leads to greater persistence in academic environments (Gloria et al. 2005). Experiencing microaggressions can lead to reduced self-beliefs among minorities by affecting student motivation (Reynolds et al. 2010). Reduced self-esteem represents having a reduced self-value and perception of self-worth (Forrest-Bank and Cuellar 2018). Decreased self-efficacy represents the belief an individual can complete academic tasks or perform at certain levels necessary for academic success (Schunk and Pajares 2002). Self-efficacy has been shown to have a positive relationship with increased academic performance (Choi 2005). Second, racial/gender isolation or experiencing a lack of representation in peer groups can cause some intersectional identities to feel marginalized and unimportant (Yosso et al. 2009). Students may report feeling out of place and marginalized when faced with campus spaces with few who look like them (Museus and Park 2015). Racial isolation

limits the formation of peer support networks fundamental for academic success (Tate and Linn 2005). Third, otherness represents the social processes that both marginalize and perpetuate inequality across several axes of difference based on intersectional identities (Powell and Menendian 2018). Members of underrepresented groups feel as though they are on the outside of the society of the majority (Staszak 2009). Fourth, stereotype threat represents the pressures of worrying that negative stereotypes are accurate or maintaining positive stereotypes (Shapiro and Neuberg 2007). An individual considers their actions may be judged negatively by observers because of a negative stereotype about the individual's identity group. Racial and ethnic minorities and women may experience a diminishing effect when their performances are coupled with reminders of negative academic stereotypes associated with their race, ethnicity, gender, or other identity groups (Shapiro and Neuberg 2007; Steele 1997; Steele and Aronson 1995). Finally, an empowered sense of self occurs when people use negative experiences to increase their view of themselves (Sue et al. 2008). Some students find themselves feeling empowered by overcoming adversities or providing advocacy for other minorities (Espinosa 2011; Goodley 2000).

Results

Reduced self-efficacy refers to a reduced belief in an individual's ability to complete academic tasks necessary to attaining an engineering degree or career. White women, Latina women, and Asian women internalized statements by and treatment from peers regarding their engineering skills necessary to be an engineer. A White woman reported having White male students tell her that, in engineering, women were not as capable as men. She said she sometimes had internalized these beliefs and wondered if women may not have the skills to be engineers. Similarly, another White woman described being academically discouraged after male peers called attention to her being one of the few women who worked at her internship site. She said this made her question her abilities and skills to become an engineer. Women from all intersectional identities related to the effects of microaggressions from their male peers. An Asian woman stated that she regularly questioned her coding skills because of men telling her she was not as good at it as her male peers or that she was too pretty to be a skilled coder. Due to these experiences, she regularly doubted her ability to complete her duties as an engineer.

Students who spoke languages other than English—some Asian men, Asian women, Latino men, and Latina women—spoke of reduced self-efficacy. One Latina woman related that she sometimes felt inadequate because of the challenges represented by new English words. When White male peers questioned these students' ability to clearly communicate, they felt excluded from groups and

Table 1. Categories and subcategories of microaggression effects

Macro and micro effects	Justification	Definition
Academic self-beliefs	Reynolds et al. (2010)	Microaggressions can lead to reduced academic self-beliefs.
Reduced self-efficacy	Forrest-Bank and Jenson (2015)	Perceived lack of engineering skills: intersectional identities relate to feeling not being able to do math or complete a course of study.
Reduced self-esteem	Forrest-Bank and Cuellar (2018)	Having a reduced self-value and perception of self-worth as an engineer.
Racial/gender isolation	Museus and Park (2015)	Experiencing a lack of representation in peer-group causing some intersectional identities to feel marginalized and unimportant.
Otherness	Powell and Menendian (2018)	The social processes that both marginalize and perpetuate inequality across several axes of difference based on intersectional identities.
Stereotype threat	Shapiro and Neuberg (2007)	The pressures of disproving negative stereotypes or maintaining positive stereotypes.
Empowered sense of self	Sue et al. (2008)	Use of negative experiences to reflect onto those perpetrating and increase the personal view of themselves.

less able to form academic peer support networks. Not only were some intersectional identities left feeling a poor fit with their peer groups, but they also doubted their own intelligence. One Latina woman said she was less motivated to take part in classes after her peers told her to speak English.

There's definitely been times in classes that are harder because my English becomes a barrier. It does affect me sometimes because it scares me a lot to go talk to professors because I have a hard time communicating when it comes to new words that I just learned. I don't go to office hours because I'm scared of that.

This student had heard her peers comment on her English, which impacted her willingness to speak with the instructor. She said she thought it reduced her ability to complete coursework and obtain necessary supplementary instruction. An Asian man had been mocked when he made English mistakes. Consequently, he spends time in engineering classes and labs making sure he uses the correct word rather than fully engaging in academic materials. Several Asian men and Asian women related similar experiences, and because of this treatment, they doubted their communication skills in classes or with instructors.

Reduced self-esteem represents having a reduced self-value and perception of self-worth. A Latino man spoke of sensing those around him disapproving of him and of having to work much harder than others to have his achievements recognized. He felt his peers would dismiss him as not as smart as them because of his appearance and accent, resulting in him not taking part in group work because he felt he had less to contribute. For some intersectional identities, this reduction in self-esteem led to questioning if they were worthy enough to complete an engineering degree. An African American woman said the following:

I think it had an impact on me like I may not be good enough for this major. I've tried to tell myself that if I were to get this degree, then I could also be part of this journey as an engineering major.

This student felt microaggressions, resulting in a lowered sense of academic worthiness. A Latina woman talked about how experiencing microaggressions regularly led to her finding herself often crying in the shower. She hoped that as she got older the negative experiences would not affect her as strongly as they do presently.

The microaggressions were not always verbal. An African American man discussed how his peers would not sit next to him, making him feel bad about himself. Another African American man reported that a White woman once refused to get into an elevator with him. This jarring experience made him feel very badly about himself.

In addition to nonverbal microaggressions, interactions with peers in classrooms were fraught with challenges. An Asian woman spoke of her initial experiences at the university. Her instructor directed students to introduce themselves to one another. When she turned and introduced herself to the male student sitting next to her, the man scarcely spoke to her. She introduced herself to a student sitting behind her, while the first student continued to ignore her but talked to the student she started talking to. After this experience, the participant was less confident about speaking to other students in classes. Similarly, a Latino man reported being ignored multiple times in group work, which made him think he was unworthy. After being regularly ignored, his self-confidence weakened and he spoke up less in class.

Racial/gender isolation—This represents experiencing a lack of representation in peer groups, causing some intersectional

identities to feel marginalized and unimportant. All intersectional identities reported feeling isolated when peers called their attention to the fact that they were the sole member of a minority group in a room full of White students or of male students. Some felt marginalized and out of place, such as a White woman who reported a professor joking that she was the only woman in the classroom. The experience made her feel conspicuous and embarrassed. Also, African American men, African American women, Latino men, and Latina women related they had experienced other students not wanting to sit near them or peers pointing out that they were the only person in the class not White or male. A Latina woman said,

I'm in a Physics lab, and there aren't assigned teams. If I show up first and sit down, no one else will sit down next to me. Then I have to go and add myself to a group. It's weird, and I know you didn't sit next to me because girls are stupid or she's brown.

This Latina woman felt insulted by her peers' unwillingness to sit by her. She clearly articulated common challenges for minorities taking part in required group work, which is common in engineering classes. White male students often attempted to avoid working in groups with those unlike themselves, particularly Latina women, Latino men, African American women, and African American men.

Otherness represents the social processes that both marginalize and perpetuate inequality across several axes of difference based on intersectional identities. After members of the majority group pointed out how intersectional identities differed from members of the dominant culture, the intersectional identities expressed feelings of otherness. Incidents that induced such feelings of otherness often concerned language, accents, and differences from the dominant culture being pointed out. Sometimes, this was communicated through joking that took on a mean tone. One Asian man related that a peer, whom he considered a friend, had called him "coronavirus" and then laughed. The experience served to remind him he was different from the dominant culture and left him feeling marginalized. Marginalization by those belonging to majority groups occurred with university staff. A Latino man recounted a White university staff member commenting on how well he spoke English and that she loved his accent. The experience made his Latino ethnicity apparent and made him feel uncomfortable because he was suddenly very conscious of his difference from the White staff member. Another Latino man related an incident that bothered him considerably while he was running for a student government position.

I was running in a student government election in the past, and my opponents were making this story of me being a rapist. It was completely false, but it was just something that they were perpetuating, even on social media, as well as on-campus, where they vandalized some of my posters and signs that were promoting me as a candidate and writing "rapist" on top of them.

Afterward, this participant felt consumed with thoughts of the incident and felt different from the dominant culture. He said he would not likely run for office again because of the incident, and he felt betrayed by the campus community.

Stereotype threat represents the pressures of worrying that negative stereotypes are accurate or maintaining positive stereotypes. Women from all intersectional identities remarked they invested considerable effort to disproving negative stereotypes about women in engineering. A White woman spoke of wanting to disprove the

stereotype that women do not have the skills or the ability to learn how to become an effective engineer. In addition to the stereotypes surrounding women in engineering, women of color experience additional stereotype threats, as was evident for several Latina women and African American women who put in a strong effort to disprove negative stereotypes concerning their racial, ethnic, or gender identities. One African American woman expressed frustration at having to work much harder than others to disprove negative stereotypes about her racial and gender identities, such as African American women possessing lower intelligence. A Latina woman said that her peers purported her scholarships were awarded because of her gender and ethnic identity. She said she and other scholarship awardees often spoke of hearing similar statements. She worked harder in all her classes to avoid giving her peers reason to perpetuate this negative stereotype.

Asian men and Asian women often experienced the converse—pressure to maintain positive stereotypes of higher ascribed intelligence and academic performance. One Asian man said, “Quite simply, I look Asian, so [my peers] judge me and have a high expectation of me. I don’t really want to disappoint them. So, I work real hard for it.” This student worked harder than he would have otherwise to the stereotype of the highly intelligent Asian. He said the increased effort made him feel as though his efforts were carrying the grades of the group.

An *empowered sense of self* is when people use negative experiences to increase their view of themselves. African American men, African American women, Asian men, Asian women, Latino men, and Latina women reported feeling empowered by experiencing microaggressions. These intersectional identities did not internalize microaggressions and instead shielded themselves from feeling the effects of microaggressions. They used microaggression experiences to strengthen themselves. The following statement from an African American woman encapsulates much of what many intersectional identities reported:

Strangely enough, it motivates me to do better. It’s like when someone tries to tell you what you can’t do, or you’re limited to this because you’re a female. So, I say, “No, I can do whatever I want to do.” It’s taking a negative experience and turning it into a positive one.

This woman felt that these negative experiences made her feel stronger and empowered because she knew they were not true; she knew that she was a hardworking person.

Comparison across Intersectional Identities

In this section, we discuss each effect and the two intersectional identities that most commonly experienced them. Frequencies refer

to the number of codes that each intersectional identity reported. We calculated these frequencies by dividing the number of codes reported by each intersectional identity and dividing it by the total codes reported by all intersectional groups. Table 2 presents the frequencies of microaggression effects experienced by each intersectional group.

Latina women experienced (33%) reduced self-efficacy at the highest rates due to microaggressions concerning language and being nonnative English speakers. Latina women said they had been told not to speak their native language because others assumed they were unable to speak English fluently. In the behavior of majority identities, their academic capabilities were tied to their perceived ability to speak English. Additionally, there seemed to be an undercurrent of associating foreignness with a lack of proficiency in engineering skills. Some members of the majority identities believed those from outside of the United States are not as capable as those from within the country. At the same time, African American women and White women experienced the same frequency of reduced self-efficacy (17%), though the reasons differed. Some African American women had been told that they did not “look like” engineers. The underlying message of these statements was that people of color were not as intelligent as White people and that women were not as good as men at math and other engineering skills. African American women had been told they were not smart enough to be adept at math and other engineering-related skills because not only were they a woman but they were also African American. White women were told women made poor engineers. Although similar in effect, the difference highlights the intersectional nature of microaggressions.

Latino men (33%) and Latina women (33%) frequently experienced the effect of otherness. These were primarily conveyed through a veil of jokes or backhanded compliments. Many Latino men spoke about being the butt of jokes about them being in construction engineering simply because they were Latino or that they spoke English *so* well or that their accents were hardly noticeable. Latina women were subject to similar comments. Mean-spirited jokes and comments made to both Latino men and Latina women ensured the recipients were conscious of them being outside the dominant culture. This self-consciousness made some think twice before speaking their native language in public or approaching peers in academic settings.

Latina women (31%) and Latino men (28%) frequently experienced reduced self-esteem as an effect of microaggressions when they were ignored or were targets of negative comments. Latino men expressed feeling socially excluded by their peers by having their efforts ignored. Latino men struggled to form an identity as an engineer because of regular experiences of microaggressions. Similarly, Latina women worried about what their peers thought of them because of negative interactions with them. Several Latina

Table 2. Percentage of microaggression effects by identity

Macroeffects and micro effects	White women	African American men	African American women	Asian men	Asian women	Latino men	Latina women	Total number of quotes per code
Reduced self-beliefs								
Reduced self-efficacy	17%	8%	17%	8%	13%	4%	33%	24
Reduced self-esteem	6%	9%	6%	16%	3%	28%	31%	32
Otherness	7%	0%	0%	13%	13%	33%	33%	15
Racial/gender isolation	16%	10%	13%	3%	26%	23%	10%	31
Stereotype threat	14%	0%	7%	21%	29%	7%	21%	28
Empowered sense of self	0%	21%	26%	11%	11%	16%	16%	19
Total number of quotes per identity	16	12	17	18	24	27	35	149

Note: Percentages reflect row totals.

women stated that after experiencing a microaggression they felt worse about their general worth. Both Latino men and Latina men discussed feeling worse about themselves following a rejection within a group work situation. Some said they thought this was because they were a person of color in a predominantly White field; some of their peers may elect to work with partners who look like themselves, thus hurting the Latino's self-esteem.

Asian women (26%) and Latino men (23%) frequently experienced racial/gender isolation that was problematic for many intersectional identities. Some felt isolated because they were often the only representative of their identity in the room. In addition, sometimes their peers pointed this out to them. Some felt isolated because other students avoided sitting with them or working in their groups. Asian women had to face peers not just as a racial minority but as a gender minority.

Most frequently experienced among Asian women (29%) and Asian men (21%) was stereotype threat. This was experienced through a pressure to uphold the model minority stereotype—Asians being good at math and generally superior students. Culturally, Asian students are under greater pressure (from peers and families) to maintain these stereotypes because they may benefit a group that may otherwise be discounted.

Finally, African American women (26%) and African American men (21%) frequently experienced an empowered sense of self. These participants were able to use negativity from others to reflect positively on themselves. African American men and African American women were much more likely than other intersectional identities to not only deflect negative interactions but to use the interaction to bolster a belief in themselves. The effect of an empowered sense of self among undergraduate engineering students may be more apparent in these intersectional identities because of selection effects. Students unable to react this way may not persist in the college environment.

Discussion

In an environment where only a quarter of engineering bachelor's degrees are earned by minorities, universities need answers to why their graduates not more diverse (NSF 2019). Most minority students in engineering report experiencing microaggressions, and this has affected their academic performance and persistence (Williams et al. 2017; Yang and Carroll 2018). Using an intersectional perspective on the analysis of the effects of microaggressions on undergraduate engineering students provided a rich data source that simultaneously accounted for racial/ethnic and gender differences. Using this perspective, this study found reduced self-esteem, racial/gender isolation, and stereotype threat as the most experienced effects of microaggressions. Latina women and Latino men reported reduced self-esteem more commonly than the other intersectional identities included in the sample. This could have been due to contemporary issues surrounding the federal administration making undocumented immigrants a forefront issue. Comments from political administrative leaders that Latinx immigrants being violent and taking jobs from American citizens were reflected throughout several interviews with Latinx men and women. At the same time, Asian women and Latino men reported racial/gender isolation more than any other intersectional identity. The main difference between these two identities was that Asian women felt isolated both by race and gender whereas Latino men felt only isolated by race. This highlights the importance of taking an intersectional perspective to capture these differences between intersectional identities. Finally, Asian women and Asian men reported stereotype threat more commonly than other intersectional identities.

These two intersectional identities receive substantial pressure from family, peers, and society in general to maintain expectations of the model minority stereotypes.

In contrast to the many negative effects of microaggressions, we saw an empowered sense of self for African American women and African American men. These intersectional identities were able to locate the negative experiences with the aggressors rather than internalizing and accepting fault. They used negative experiences to empower themselves that differs from others in the study. Not surprisingly, this was the only positive effect of experiencing microaggressions and further exploration of the mechanisms of how some individuals can navigate regular negative interactions with others and using this to empower themselves rather than internalizing the negativity.

This study has some limitations that should be noted and provides opportunities for future research directions. First, despite substantial efforts being made to minimize researcher biases through the CQR approach, unknown researcher biases may still exist. Future research could include a replication of this research at another university to capture the effects of microaggressions at other institutions and geographies. Additionally, as with other qualitative research, results cannot be generalized beyond the experiences of those interviewed (White women, African American women, African American men, Asian men, Asian women, Latino men, and Latina women) and the locations (a Midwestern PWI and a Southeastern HBCU) conducted. However, we argue that the use of subjective experiences reported by participants provides a rich narrative unable to be documented by many quantitative methodologies. Finally, the data collected in this study represent only cross-sectionally data obtained in interviews. A longitudinal research design may document the changing effects of microaggressions over the academic career of engineering undergraduate students. Future research could take a longitudinal design to investigate if temporal variability is present in the effects of microaggressions.

Conclusion

As a discipline, engineering fields lag behind other professions in their diversity and inclusion of women and minorities. Despite a growing proportion of women obtaining degrees in other disciplines, some engineering majors have persistently low percentages of women earning degrees. Similar patterns exist for racial and ethnic minorities, with two-thirds of engineering bachelor's degrees being awarded to White students. The imbalance leads to a low representation of women and minorities in engineering professions. Recently, there has been increased research conducted on the development and maintenance of more racially, ethnically, and gender diverse and inclusive engineering education and professions. This trend promises to provide information to university administrators, department heads, and industry leaders to recruit and maintain a vibrant and diverse student body and workforce. The body of research on diversity in engineering is expanding, but an intersectional examination of the effects of microaggressions on engineering education remains a persistent gap in the body of knowledge.

This research examined the effects of microaggressions among undergraduate engineering students in the context of two universities to address this gap. The results showed differences in the effects of microaggressions between intersectional identities. The effects of microaggressions reach across all aspects of the engineering field from the classroom to the field. Several participants related they had previously considered changing their majors due to experiences of microaggressions. Undergraduate engineering students

may not persist in their major or in their field following graduation if they continue to experience microaggressions. Many potential engineers who would otherwise be a good fit for the engineering professions may pass on the opportunity to learn engineering skills and to provide unique perspectives because of their perceived hostile environment. For the engineering field to better incorporate a diverse workforce, issues surrounding microaggressions and similar behavior must be aggressively reduced and eliminated for the good of the field. This research encourages engineering departments to incorporate training emphasizing the effects of microaggressions on students rather than more direct forms of discrimination. Follow-up research intends to extend the examination of the effects of microaggressions on student persistence and identify strategies to reduce the incidence of these experiences. Microaggressions experiences contribute to a negative environment among women and minorities across engineering fields. This environment may lead to lower persistence among some students contributing to the perpetuation of a less diverse engineering workforce. Ultimately, the goals of the research are to eliminate microaggression experiences and the negative effects on the learning environments among women and racial and ethnic minorities.

Data Availability Statement

All data, models, or codes generated or used during the study are proprietary or confidential in nature and may only be provided with restrictions (e.g., anonymized data).

Acknowledgments

This material is based in part on work supported by a National Science Foundation Grant Nos. 1828172 and 1828559. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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