Unpacking Whiteness and Racialization in Engineering: A Multimodal Discourse Analysis of Social Media Posts

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Abstract

Social media platforms, as a contemporary medium for discourse, provide a rich source of data for understanding how the constructions about engineering identity manifest in the digital age. This study sought to examine this phenomenon by employing a multimodal discourse analysis of social media posts, particularly memes. Our goal was to critically analyze how the construction of engineering identity, often unintentionally, perpetuates an exclusionary framework that is difficult for individuals from diverse backgrounds to access, while simultaneously fostering a utopian idealization of engineering identities that are often harmful and unattainable. The analysis of data sheds light on the possible consequences of these identity constructions in social media spaces. The discourses created in social media often idealized a specific, often homogenous, engineering identity; thus, creating a hostile-like narrative toward minoritized populations and excluding individuals from diverse backgrounds who do not fit this idealized mold. Ultimately, the study seeks to describe the complexities of constructing an engineering identity in a world where whiteness has long been the norm and racialization is often ignored.

Introduction

Sociocultural theories have been instrumental in exploring how students interpret, navigate, and adapt to the unique culture of their future profession. Within engineering education, different studies have sought to describe the characteristics of an engineer and how these impact identifying with engineering encompassing not only their mannerisms and modes of thinking but also their attire and actions [1-5]. This research has also added to the scholarship on the factors contributing to feelings of alienation experienced by historically marginalized and minoritized students within engineering [4, 6-8]. In engineering, as in other disciplines, learning to become part of the group (i.e., becoming an engineer) is intertwined with identity formation because both are shaped and constructed through interpersonal interactions and the discourses that emerge from those interactions (i.e., ways of knowing, doing, and being, as well as the attitudes, behaviors, values, etc.) [9, 10]. As students engage with discourses associated with engineering, they gradually cultivate an engineering identity, allowing them to be recognized as members of the engineering community by their peers, mentors, and professors. Through the acquisition of language, practices, values, and beliefs inherent to engineering, students signal their assimilation into the social fabric of the engineering world and embrace its established norms and conventions.

Idealizations of engineering, or what an engineer should be, is an important aspect to explore in engineering education research because it often intersects with professional development [11-13], academic achievement [8, 14], and overall well-being among students [6, 12, 15]. In engineering, where cultural norms, values, and practices converge to shape a unique discourse, the process of identity formation becomes particularly significant. Marginalized students, including those coming from underrepresented racial and ethnic backgrounds, LGBTQ+ communities, and low-income households, often navigate complex dynamics of identity within

engineering spaces [6, 7, 16, 17]. The formation of one's engineering identity can profoundly impact marginalized students, influencing their sense of belonging, self-efficacy, and academic persistence. Moreover, the negotiation of multiple identities, including race, gender, sexuality, and socioeconomic status, within the predominantly white, middle and upper class, male, and Westernized focus of engineering, can pose significant challenges for marginalized students, leading to feelings of isolation, imposter syndrome, and alienation [2, 6, 15, 18]. Therefore, understanding the nuances of how discourses around identity formation in engineering are created and its differential impacts on marginalized students is crucial for challenging systemic inequities in engineering.

Nonetheless, it is important to investigate how discourses around engineering identity are constructed and informed through new digital forms of socialization since they are becoming more and more common; thus, influencing younger generations [19]. Social media platforms, as a contemporary medium for discourse, provide a rich source of data for understanding how engineering identity constructions manifest in the digital age. Social media posts facilitate the messaging of stereotypes [20] including gender stereotypes as well as shaping and regulating identities [21].

This study sought to examine the implications of this phenomenon by employing a multimodal discourse analysis [22, 23] of social media posts, particularly memes. Multimodality refers to the employment of different semiotic modes to produce and convey meaning. These modes include linguistic (oral, text), visual (images, colors), auditory, gestural, and spatial [23]. Memes are "units of popular culture that are circulated, imitated, and transformed by individual Internet users, creating a shared cultural experience in the process" [24]. Guided by the question, *how and in what ways are discourses about engineering and engineers formulated and represented in social media memes?*, this paper describes the different ways in which engineering may be constructed in online spaces. Our goal is to explain how the construction of engineering identity, often unintentionally, perpetuates an exclusionary framework that is difficult for individuals from diverse backgrounds to access, while simultaneously fostering a utopian idealization of engineering identities that are often harmful and unattainable. To this end, we employ a racionlinguistic lens [25-27] to analyze how these representations encompass not just gender but also linguistic and racial stereotyping depicting the "other" (i.e., the non-white, the non-heterosexual, the non-standard English speaker) as powerless, inadequate, or deficient.

Theoretical Framework

In this paper, we draw from Flores and Rosa [26] conceptualization of raciolinguistics to analyze how engineering is portrayed and communicated in social media memes, and the potential of these in influencing how discourses around engineering identity are constructed.
We pay particular attention to raciolinguistics because memes are not just humorous or entertaining images; they often reflect and reinforce societal norms, values and power dynamics, including those related to race and language. Flores and Rosa [26] introduced the concept of raciolinguistics, which indicates that language – in all of its forms – is used to construct race, and therefore influences how personal, ethnic, and professional identities are negotiated and used. Thus, the connection that exists between language use and racial and ethnic ideologies become the foundational elements that create societal hierarchies [28].

The construct of race within society is not solely defined by physical characteristics of individuals but is also shaped and sustained through linguistic patterns and cultural norms [25]. Rosa and Flores [28] re-introduced the idea of the "white listening subject" (and speaker) to challenge negative perceptions of racialized individuals, shifting attention to the listening and speaking behaviors of privileged white individuals who perceive non-white speech as deficient. Through this lens, they scrutinize how hegemonic discourse perpetuates the marginalization of racialized individuals, casting them as inherently deficient without possibility for change.

Within the theoretical framework of raciolinguistics, the preference for white perspectives also cultivates a white speaking subject that upholds idealized linguistic norms associated with whiteness, while concurrently positioning racialized individuals, particularly Black, Indigenous, and People of Color (BIPOC), as needing remediation or extra support, being inherently deficient, or deviant from the expected norm [27]. Conversely, when white speakers engage in similar discourse, it is deemed normal. Given that higher education (and engineering not being the exception) continues to be dominated by white males and a Eurocentric discourse [29], the effects and impact of racialized ideologies continue to be present in our institutions. In defining engineering as certain types of people [30-33], the language and other semiotic modes (e.g. images) used in memes can be a reflection of the racialized ideologies that continue to exist in engineering to exclude those that do not align with the norm.

In the context of this paper, we use raciolinguistics to analyze multimodality in memes on the basis of (1) race representation, (2) cultural production, and (3) power dynamics. Memes frequently contain language, whether in the form of written text, symbols or images that depict a particular phenomenon or situation. Understanding how language is used within memes to create racial representation provides insights into broader societal attitudes and biases within engineering. For instance, engineering education research has shown that there is a non-acceptance of difference in engineering spaces and that engineering is both gender and race-free leading to a perception of homogeneity [31]. Conceptualizations of engineering as a culturally produced practice [34] portrayed in memes is also important. Engineering students acquire an understanding of recognizable patterns and behaviors, shaping both their perception of what engineering is, who engineers are, and what engineers do. These influence not only how students interpret their surroundings, but also guide their adoption of practices including acculturation to often toxic behaviors [35-37].

In addition, seeing the use of semiotic modes as a cultural production in engineering allows us to comprehend how engineering students construct their identities (both social and personal) [34]. This includes understanding how images and language are constructed, who it is intended for, and how it is received by different racial and linguistic communities. For example, Foor and Walden [38] described how engineering students recognized the hierarchical value of what constitutes engineering by identifying Industrial Engineering as a discipline that lacked prestige by calling it imaginary. This study also explored how the perceived lack of technical competence and rigor of Industrial Engineering was compounded with race and gender because it was seen as a *natural* (emphasis added) space for women and BIPOC [38].

Finally, using raciolinguistics to explore power dynamics contributes to uncovering power dynamics embedded within language and race relations [27]. Raciolinguistics provides a

framework to explore how certain racialized groups are represented and positioned in relation to others, as well as how language is used to reinforce existing power structures or challenge them [26, 27]. In the context of engineering, power dynamics are often created by the ways in which engineers assign value to discourses, practices, and behaviors. Faulkner [39] described that engineers learn to accept that technical expertise and broader skills (e.g., communication, empathy, etc.) are mutually exclusive in an effort to separate the meat (technical) from the fluff (social). Assigning a higher value to certain practices is also representative of a racial and gender divide that exists in engineering, where women and BIPOC receive backlash for the affective work they are often responsible for but is repeatedly discredited or deemed not remunerable; thus, framed as not valuable even when it is imposed on them [40]. Hence, a raciolinguistic analysis can uncover the ways in which memes reflect, challenge, or reproduce dominant discourses surrounding race and language, providing valuable insights into contemporary social and cultural dynamics. By applying a raciolinguistic framework to the analysis of social media memes, engineering education researchers can gain a deeper understanding of how language and race intersect in online spaces, contributing to broader discussions about identity, power, and representation in digital culture.

Positionality

The first author identifies as a first-generation, bilingual transfronterizo from a low-income community, Mexican American with a background in engineering. His academic and teaching endeavors aim to integrate social justice concerns into engineering education, especially by fostering critical awareness among engineers to address issues related to deficit ideologies and inequity. His research in engineering education also emphasizes the need to challenge prevailing narratives about what constitutes engineering and who does engineering. He approaches this study from a multidisciplinary lens that includes an analysis of racialized bodies in engineering, an exploration of engineering culture, and a critical perspective on engineering socialization. The second author is a Mexican born woman who immigrated to the U.S. in her early 20s to do graduate work in applied linguistics with transnational multilingual populations. She is approaching this study from a multidisciplinary lens to study identity which includes anthropological, linguistic, and engineering analyses. Her work in digital spaces has demonstrated that identities are co-constructed and negotiated even when engagement between individuals appears superficial such as seeing posts on a social media channel or blog.

As committed scholars advocating for racial justice, our overarching goal is to amplify the voices and perspectives of minoritized students, positioning them as knowledge holders and generators deserving recognition in our quest for educational equity within engineering. Our study challenges the idea that students inherently lack and need "fixing." Instead, we contend that portrayals of deficit mindsets, attitudes, stereotypes, whiteness and hypermasculinity in social media further sideline students and perpetuate flawed notions of success in engineering.

Context of the Study

This project focuses primarily on the portrayal of engineering identity(ies) in digital media spaces. Digital media spaces, as a contemporary medium for discourse, provide a rich source of data for understanding how these constructions manifest in the digital age. Research has shown

that social media posts, such as videos or memes, facilitate the messaging of stereotypes [20] including gender stereotypes as well as shaping and regulating identities [21]. Because the focus of this study is to examine how these digital media shapes and regulates these identities, this study will focus on one of the most widely used forms to transmit individual and collective identity information digitally: memes [41]. Memes are "units of popular culture that are circulated, imitated, and transformed by individual Internet users, creating a shared cultural experience in the process" [24]. Memes contribute to the co-construction of "the mindsets, forms of behavior, and actions of social groups" [41]. Thus, users are both expected to actively engage in identity construction while reinterpreting cultural elements that shape commonly shared norms, values, and behaviors in society, and of a particular sub-group of society. This expectation is because users engage in various actions regarding memes such as the intertextual use of referring to other memes, photos, images, and digital content produced for a specific purpose and repackage them for a different one. As Shifman [41] states, we are "in an era marked by 'network individualism,'" in which "people use memes to simultaneously express both their uniqueness and their connectivity" (p. 30). What this means is that individuals can develop and express their unique identities in relation and opposition to the identities of online groups.

Methodology

This study adopts a multimodal discourse analysis [22, 23] of memes to gain an understanding of how engineering identities are constructed generally and not as part of a specific group. This study focuses specifically on most popular, high quality, and accessible engineering memes found using those same words in a search query on Chrome browser. To prevent the search to be already curated to a specific set of memes, we decided to make an incognito search to gain only those memes gathered by Chrome crawler, which would represent only those memes that are not repeated, are popular or receive a high number of hits, and that are accessible and not behind a password protected site, and not those relevant to a particular user.

Data collection and analysis

After yielding the results, we downloaded all 500 images that were displayed in the "image" result tab. We first identified those that were memes and not other types of digital images such as mere screenshots of tweets, TikTok videos, or reels, for example. A characteristic of memes is that they are intended to be humorous, so they use images, videos, GIFs from current events, popular culture references, or images of mundane tasks, and they are often captioned to convey the humor. These intertextual images can get further re-purposed and change meaning, maintaining their structure. We also discarded repeated memes, which appeared in the same form to convey the same meaning in separate pages. Finally, we also discarded memes that were situated entirely in a context outside of the U.S. and very often in a language not widely spoken in the U.S. At the end, our corpus of memes included 314 total, which we uploaded to NVivo for analysis.

We employed a multimodal discourse analysis (MMDA) [22]. An MMDA approach explains that written language (any text or text-like form) is one of many semiotic resources or modes integral to the meaning making process, providing only a partial account of meaning requiring other modes (including linguistic such as oral language) to be given full attention when analyzing

meaning making. Additionally, an MMDA approach also centers the analysis of the affordances of each mode in terms of their rhetorical purpose, their selection, and design as well as their uptake or recognition by their audiences. MMDA pays attention to who is doing the semiotic work and how the work is being done [22]. What this means for the study of memes is that we needed to analyze each meme as a unit and not separate the analysis of the text from the images, colors, fonts, from each other. With regard to the images, we also needed to take into account the characteristics of the people represented (i.e., age, gender, ethnicity, skin color, clothing) as well as the environment and objects within the environment presented (i.e., an office with state of the art technology, a superhero solving a problem). We extended the MMDA approach by adding a raciolinguistic lens [25-27] to analyze how these representations encompass not just semiotic resources but also notions of gender, linguistic and racial stereotyping to depict the "other" (i.e., non-white heterosexual, standard English speaker male) as powerless, inadequate, or deficient. By employing a multimodal approach for the analysis and a raciolinguistic lens, we considered not only the textual content of posts but also the visual and interactive elements, acknowledging that identity construction in the digital age is a multifaceted endeavor.

We employed a two-cycle coding [42] to analyze each meme as a whole. For the first cycle coding, we applied descriptive coding to quickly assign labels to each meme to summarize in a word the topic related to engineering identity. To create a provisional descriptive code list, we read theoretical and empirical literature related to four areas: engineering identity [4-7, 12, 43], engineering ways of knowing, doing and being [31-33, 39, 44, 45], engineering workplaces [35, 39], and genderization, racialization and hypermasculinity in engineering [4, 11, 30, 35, 38, 39, 46, 47]. Based on these readings, we developed a provisional "start list" [48] of categories in these areas, but extrapolated the content to further divide them into main codes, and those main codes into four general areas with subcodes to identify more specific topics. We met twice to go through randomly selected memes and discussed whether the descriptive codes captured the essence of the literature or whether we needed to modify them or expand them to better represent the patterns we were observing in the data. After these meetings, we developed a modified list of codes (see Table 1). Table 1 contains a list of categories, codes, and subcodes utilized in the first cycle coding. The codes in italics were the initial codes in the "start list" based on previous research related to engineering cultures [31].

Using the modified codebook, we both independently coded the corpus of 314 memes and achieved about 87% agreement. For the second-cycle coding, we used pattern coding [48], which helped us, along with analytical memos, to look for patterns that would tie together the different data coded with descriptive codes. We both discussed these patterns that emerged from our data and selected specific memes to showcase how the persistence of whiteness and engineering culture is represented in social media.

Table 1. *Initial themes, parent codes and child codes obtained from data analysis*

Theme	**Parent Code**	**Child Code**
Engineering Cultures	• *Engineering way of thinking*	• Mathematical and scientific prowess • Apolitical • Objective • Neutral • Solving problems • Making things
	• *Engineering way of thinking*	• Difficult • Exclusive • Workaholism • Meritocracy
	• *Engineering way of being*	• Asocial • Logical • Practical • Socially conservative • Pragmatic • Non-emotionally demonstrative • White Eurocentric • Westernized ideologies • White English dominant
	• *Unacceptance of difference*	• Lack of social responsibility • Homogenic (no diversity) • Monolingual • Uncritical acceptance of authority • Rigidity (rigor) • Non-acceptance of other ways of knowing, doing and being
	• *Relationships to individuals*	• Being part of an inner group • Clique • Individual detachment
	• *Relationships to environment*	• Leadership (having answers) • Competitiveness • Self-sufficiency • Hierarchy in relation to other fields • Hierarchy in relation to other engineering disciplines • Making differences between engineering and technicians

Limitations

It is important to note that although women were represented in engineering-related memes at a relatively low number (15% of the whole dataset), we considered that the discussion of the treatment of women in engineering should be done separately and through a different lens to capture the nuances and intersectionalities that women face in a male-dominated field. Previous research in engineering education has described the ways in which women are often pushed out of engineering due to the toxic culture of engineering and a lack of understanding of their intersectionalities [36, 39, 49, 50]. We decided to address this issue further in a forthcoming publication that will specifically address the portrayal of women in engineering memes through a critical feminist perspective.

Additionally, rather than fixating our analysis on percentages or quantifying memes, our interest focused on examining how minoritized individuals were portrayed in engineering spaces. Simply quantifying these instances would oversimplify the issue and fail to address the underlying stereotypes that have been created in social media about engineering and engineers while simultaneously inadvertently perpetuating the stereotypes we sought to critique. Even if we were to quantify the number of memes, it would not accurately capture the breadth of discourse present in these memes, given that we only analyzed a limited sample of publicly available memes—314 out of potentially thousands—and may have missed those not readily accessible and visible to the individuals that actually consume them.

Results

Our analysis showed that raciolinguistic ideologies in social media memes of engineers and about engineering constructed the discipline as profoundly white, male dominated field where historically minoritized individuals in engineering (e.g., black, indigenous, people of color, women, individuals with disabilities, etc.) were constantly othered, mocked, and framed as incapable of doing engineering. Out of the 314 memes within the corpus, about 85% of the memes depicted white males, only 15% included women, and about 27% showed BIPOC individuals. The following sections describe qualitatively how memes depicted (1) racialization in engineering, (2) minoritized individuals as the punchline, and (3) hypermasculinity. We use representative examples to demonstrate what was observed and analyzed throughout the dataset after two rounds of coding using multimodal discourse analysis (MMDA) [22].

Racialization in engineering

Although the majority of the memes included white individuals (about 85% of them), when BIPOC individuals were portrayed they were framed as not demonstrating mathematical and scientific prowess, not being capable of performing well under stress, or simply as outsiders. Consider, for example, meme #139 (Figure 1) and meme #108 (Figure 2). Meme #139 depicts a black person changing their facial expressions from happiness to confusion when asked to solve a problem. On the other hand, meme #108 shows a white man giving thumbs up with a smug expression to exemplify intelligence and easy problem-solving.

Both memes have the same context. In both the individual is asked to perform a task that may not be related to what an engineer may do directly (i.e., turning on an electronic device or repairing it). However, the narrative is different to position one person as inept and the other as savvy. Meme #139 involves language that is active. "Turns on projects for teacher" states what the activity was – without having to be asked to perform the task (i.e., active in nature) – and that it is performed with no problem. On the other hand, meme #108 is passive because the person is being "asked" (i.e., "they are asked how to fix a fridge) to perform a task rather than actively showing what they can do. Similarly, Meme #139 has unique visual elements to highlight the punchline and inadequacy of the person: a close-up picture that centers the attention on the eyes and mouth drop, lack of body gestures and spatial surroundings making the joke about the person itself. While this may be perceived as an innocent joke at first glance [45], the fact is that the person of color is being positioned in a deficit-oriented perspective while the white individual is positioned as being savvy and capable.

Figure 1. Meme #139

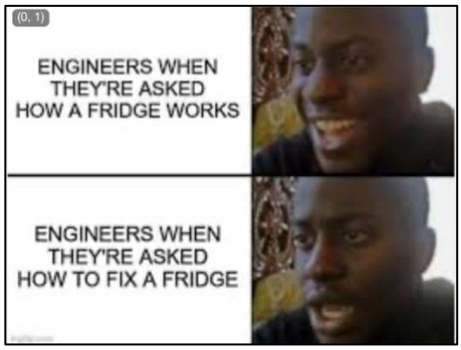

Figure 2. Meme #108

Positioning people of color as not having what it takes to do engineering was also portrayed in memes. For instance, Meme #167 (shown in Figure 3) displayed a still image of the film Forrest Gump where Bubba – Forrest Gump's friend while serving in Vietnam – exclaims that he wants to go home. The meme reads "20 minutes after engineering school," insinuating that the black individual (Bubba) could not continue to perform in engineering. A hyperbole stating 20 minutes is shown to exaggerate how difficult engineering is perceived to be, but also to show how quickly a person is giving up, and in this case it portrays a BIPOC individual perhaps as a way demonstrate they do not work hard enough to endure the difficult work of engineering or cannot stay in engineering [51, 52]. Contextually speaking, the phrase "I want to go home" shows that Bubba is giving up after just a few minutes of being exposed to engineering and not willing to prioritizing engineering. This characterization of "unfitness" of minoritized populations in engineering [53, 54] was a common trope found throughout the dataset analyzed for this paper. What is more, the scene presents a black person leaning on a white person (who does not seem to have any struggle) carrying him. This shows the power structures between white and BIPOC individuals in engineering spaces.

Figure 3. Meme #167

On the other hand, when white individuals were the front and center of the memes they were characterized as being amenable, adaptable, and deliberately chosen for engineering. That is the case of Meme #278 where a white individual is shown as if engineering chose him, something that was rarely the case for people of color portrayed in the memes. Instead, BIPOC individuals were portrayed as struggling, conflicted, and emotional. In the meme, the white individual is portrayed as someone that has been "chosen" to be an engineering from an early age while showing a "positive" attitude (demonstrated through the smile/smirk). The statement "the engineering life chose me" is passive indicating that the person had to go through no effort to belong in engineering as opposed to, for example, the black individual shown in Meme #167 (Figure 3). Although it may seem that often memes' images are selected randomly, it is important to recognize that consciously or unconsciously racialization plays a role in deciding the type of message that is being conveyed. Racial formation and race-making in America is still a process of "othering" [55], which was a constant throughout the dataset.

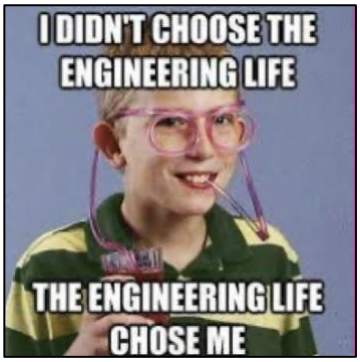

Figure 4. Meme #278

Moreover, white individuals in memes were shown as being successful even when the odds were not in their favor. For example, Meme # 356 (Figure 5) shows a cheerful white man being optimistic for getting a slightly higher score in an exam than the average. There are several aspects being described in this meme, such as the difficulty of engineering (demonstrated by the fact that everyone scored low in the test) [31, 52], the idea that engineers are not emotionally demonstrative (despite having failed a test)[31], and the framing of white individuals as being successful while the rest may be framed as failures [8, 39].

Figure 5. Meme #356

Racialization within memes was often manifested in the portrayal and perpetuation of stereotypes and caricatures of people of color and the use of tropes that positioned people of color as unfit or deficient, reinforcing and normalizing existing racial hierarchies and prejudices. Memes often centered around witty and confident white engineers, indicating that there is a predominance of whiteness in engineering [56]. Although the majority of memes centered around white individuals, when memes included minoritized populations, particularly people of color, they highlighted simplified and exaggerated representations that emphasized physical features, cultural traits, or perceived deficits associated with their racial or ethnic identity (e.g., not understanding what was being said, not confident, crying, not working hard). These representations ranged from subtle microaggressive messages to overtly deficit-oriented tropes (e.g., portraying people of color as lazy), serving to marginalize and dehumanize individuals based on their race or ethnicity. Thus, racialization in memes reflected broader societal attitudes and power dynamics within engineering spaces, highlighting the need for critical examination and challenging of such representations to foster greater awareness, empathy, and inclusivity.

Minoritized individuals as a punchline

Another theme that emerged from the data was how minoritized populations often serve as the "funny punchline" in memes to dehumanize and ridicule them, perpetuating harmful stereotypes and reinforcing societal biases. Minoritized populations such as people of color and individuals with visible and non-visible physical disabilities were often depicted in memes as incapable of pursuing engineering, their belonging in engineering spaces was questioned, and mocked when expressing interest in social concerns, including sustainability, that affect their own communities. For instance, Meme #320 (Figure 6) featured a known blind person (Ray Charles) struggling with an engineering problem on an exam, and alluding to his blindness through the use of the “funny punchline” (i.e., “I’m going to pretend I didn’t see that”). This representation reduces individuals with physical disabilities to objects of amusement, equating their disability to cognitive abilities and reinforcing the erroneous notion that they are inherently incapable of success in technical fields. Moreover, this particular meme has a double entendre given that the person is also a person of color and continues to be used as a “funny punchline.” This intersectionality is an aspect of engineering education research that needs to be more critically analyzed to eradicate preconceived notions of who is an engineer and who does engineering.

Figure 6. Meme #320

Moreover, Meme #89 (Figure 7) makes fun of a black individual's interest in sustainability and solar panels by portraying him as surprised and showing emotions (i.e., crying). This meme uses racialization and emotions as sources of humor, trivializing genuine concerns about environmental issues and sustainability within marginalized communities. By exploiting minorities as comedic fodder, these memes not only dehumanize individuals who express their emotions and social concerns but also used a racialized body to perpetuate the idea that "they may not know any better." This type of "humor" reflects that engineers follow orders uncritically, so they don't realize what may be basic facts until the end (i.e., that most solar panels are only 18% efficient). Also, this meme indicates that people of color possess flawed thinking or lack of critical thinking, which is depicted through a surprised black individual pictured as having illogical thinking.

Figure 7. Meme #89

These harmful portrayals perpetuate deep-seated biases and stereotypes that undermine the abilities, intelligence, and value of minoritized individuals within the engineering field and broader society by using their bodies, concerns, and emotions as a punchline. Moreover, these memes also highlight the myth that minoritized individuals do not belong or are not inherently capable of occupying engineering spaces. Such representations not only reinforce systemic barriers to entry and advancement for marginalized groups in engineering but also contribute to the marginalization and erasure of their voices and experiences. By continuing to link deficit perspectives to minoritized individuals instead of highlighting their contributions and concerns, these portrayals perpetuate a harmful narrative that maintains inequality and limits opportunities to fully participate and thrive in engineering.

Hypermasculinity and Sexism

One of the themes that was captured in the analysis of the memes was the persistence of hypermasculinity and sexism in engineering. For example, meme #96 (Figure 8) alludes to the idea that sleeping with an engineer, as opposed to learning from or talking to one, will make a person smarter, juxtaposed with an image of Albert Einstein. This meme encapsulates the notion that intelligence is inherently associated with masculinity, particularly within the realm of engineering. Adding a layer of complexity to this meme is the fact that it positions women (or any potential partners of an engineer) as void of intelligence that is not inherent to them. By linking the idea of intellectual prowess to the persona of a renowned figure like Einstein, the meme reinforces the stereotype that male engineers possess superior intellect, thereby perpetuating a hypermasculine ideal grounded in intelligence and expertise (aside from whiteness and Eurocentricity).

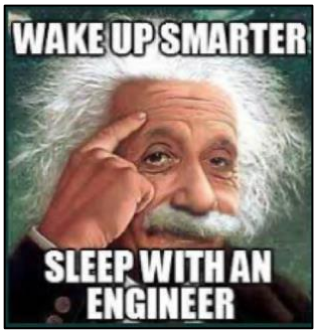

Figure 8. Meme #96

In addition, meme #38 (Figure 9) features an image of the superhero Iron Man alongside the phrase "do it like a mechanical engineer," positioning superheroes as symbols of hypermasculinity within engineering culture. By aligning the attributes of superheroes (i.e., muscular, extreme strength, womanizer, lack of emotions, calculating, rich, and tech savvy) with the characteristics of mechanical engineers, the meme reinforces the perception of engineering as a domain dominated by masculine strength and power. The portrayal of Iron Man, a quintessential symbol of masculinity and technological prowess, further underscores the association between engineering and hypermasculinity, perpetuating a narrative of male dominance and superiority. This may also convey the message that being a mechanical engineer is grandiose or that it can lead to grandiose things, and that any other engineering majors (e.g., civil, industrial) may fall short. Moreover, the image of Iron Man – shown as “ready to fight,” with his fist on the ground, showing power and a monotone expression – create the effect of being a savior and an individual bolstering power. Meme #59 (Figure 10) shows the same person who wears the Iron Man suit – Tony Stark – in the same light: with arms wide open as a sign of authority and command. This alternative form of portraying a superhero, has a similar effect of demonstrating hypermasculinity in engineering by using the images of individuals (predominantly white) whose character is representative of a superhuman showing power and authority (either by supernatural traits or by having above-average intelligence, being rich, and calculating). The message of hypermasculinity through superheroes is a compelling one, and one

that shows engineering as something that is done with force, violence, or destruction (i.e., collateral damage); thus, showing the underlying historical ties between engineering and white male dominance [45, 52].

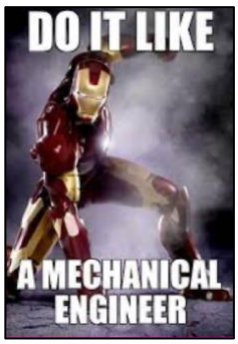

Figure 9. Meme #38

Figure 10. Meme #59

The memes were not only depicting hypermasculinity and the dominance of white males in engineering, but there was a blurred line between hypermasculinity and sexism in engineering. Meme #168 (Figure 11) in our examination of hypermasculinity highlights sexism, depicting males as successful engineers upon graduation while women are relegated to the role of homemakers or wives, and whose own success was dependent not on merit but on being married (to a man). The meme communicates that success of women is not measured by the same accomplishments as their male counterparts but in terms of fulfilling societal expectations (i.e., marriage). This portrayal reinforces traditional gender roles and stereotypes, positioning men as competent and successful in the professional sphere while women are depicted as secondary and subordinate. By portraying women as incapable in contrast to the successful and confident male engineers, the meme perpetuates a narrative of male superiority and female inferiority within the field of engineering. Moreover, this meme also assumes that within engineering spaces the norm is to be heteronormative and cisgender (i.e., no recognition of LGBTQ+ in engineering spaces).

Figure 11. Meme #168

Finally, hypermasculinity and whiteness was also often portrayed as being the norm in engineering and providing status. For example, meme # 59 (Figure 12) depicts a white man reminiscent of F. Scott Fitzgerald's The Great Gatsby (played in the film by Leonardo DiCaprio) with the message "you heard right girl… I am an engineer." Discursively, the use of the world girl to refer to a woman is a way to infantilize or juvenilize them and to position them as children who may need caring, education, mentorship and that are unable to care for themselves. This meme perpetuates the stereotype of the white male engineer as a successful and charismatic womanizer, reinforcing the association between engineering and hypermasculinity. By portraying the engineer as a figure of charm and allure, the meme contributes to the construction of a hypermasculine identity grounded in social and sexual dominance. The inclusion of such imagery further solidifies the stereotype of the white male engineer as the epitome of success and desirability, perpetuating a narrative of white male superiority within the field.

Figure 12. Meme #59

Discussion

It is important to note that our initial list of codes was developed based on the themes identified in existing literature. Our analysis focused on how the literature already described engineering identity, ways of knowing, doing and being, and those codes already provide an explanation of what is deemed desirable (e.g., hypercompetitive, masculine) and what is not (e.g., emotional, feminine, etc.) within engineering culture [5, 30, 31, 45, 49, 52]. What was striking during the analysis was that desirable characteristics in engineering were often represented by white and white-presenting individuals. And, contextually, there were few instances where desirable characteristics were depicted by BIPOC. However, this desirability demonstrated by BIPOC was often mocked or presented as a “punchline” for a joke related to inadequacy (e.g., cheating, not having a response readily available, laziness).

The multimodal discourse analysis (MMDA) of the memes collected for this study demonstrates that a complex set of discursive and semiotic practices are embedded in these memes. The memes themselves are also complex in the messages portrayed through images and text. For example, racialization in memes about engineering was not only about ascribing racial meaning to bodies, but also to expressions, emotions, and what could be taught of as inherent characteristics [55]. Omi and Winant [55] argued that race is a fundamental piece of racial formation in the United States, and engineering is not the exception [57, 58]. The memes show how images and text can be used to “otherize” minoritized populations while providing meaning

and significance to who is at a higher status and who is outside those socially constructed boundaries. In creating these hierarchies, society has also created language to describe who is on top and who is on the bottom, thus showing that language – a form of communicating ideas – is also racialized and used to establish/form/show hierarchies to render some able, successful, valuable and others indispensable and invisible [26-28].

These memes also operationalize mindsets and ideologies about who is an engineer, who does engineering, and what is engineering. For instance, the memes showed that the white race and whiteness have been constructed as the "master category" (i.e., the dominant category) [55] and that it operates as the default. Whiteness is, in other words, the baseline used to categorize individuals but also the default for how society should operate, and in this case how engineering operates. It is this conceptualization of the white race as a master category that continues to maintain white supremacy in the U.S. while simultaneously reproducing inequalities, class stratifications, rights and privileges, or access to resources [29, 59, 60].

In addition, racialization within memes underscores the pervasive impact of stereotypes and caricatures on perceptions of minoritized populations within engineering spaces. Common tropes being perpetuated in memes, which eventually become part of the discourse in engineering spaces, portray women and people of color are not fit to pursue engineering [5, 8, 31, 35, 57], unable to endure the difficulty of engineering [8, 31, 45, 52], or too emotionally demonstrative. When minoritized populations are depicted in memes, they are often portrayed through simplified and exaggerated representations that emphasize perceived deficits associated with their racial or ethnic identity, which is the result of historical and consistent oppressive structures and deficit ideologies within engineering [51, 61, 62]. On the other hand, there is a predominance of memes featuring witty and confident white male engineers, which not only reflects the overrepresentation of whiteness within the field but also perpetuates racial hierarchies and hypermasculinity [35, 63].

In examining memes through a raciolinguistic lens, we can discern significant insights into how race representation and power dynamics intersect within engineering spaces. Memes, as multimodal forms of communication, often contain language, symbols, and images that reflect and perpetuate societal attitudes and biases [21]. Language contributes to the construction of racial representation [27], offering a window into prevailing ideologies within engineering. Moreover, memes also serve as cultural artifacts [24, 41] that contribute to the construction of engineering identities, both social and personal. For example, the memes presented in this paper show that within the world of engineering there are particular attitudes, behaviors, and discourses in general that are accepted, rarely contested, and fully embraced such as being competitive, self-sufficient, workaholic, and cisgender among others [30, 31, 45, 64-66]. By analyzing the language and imagery embedded in memes, we can discern how engineering students negotiate and construct their identities within the discipline. For instance, the devaluation of certain engineering disciplines or social concerns, such as sustainability or climate change, underscores how cultural discourses within engineering intersect with perceptions of prestige and technical competence.

Conclusion and Implications

This research contributes to an expanding effort in engineering education to explore the ways in which discourses in engineering are created, adopted, and perpetuated. This work is also a valuable starting point for educators to spark change in their educational environments. For instance, in terms of raising awareness, educators can begin to bring attention to the issues discussed in this paper and challenge current dominant discourses that prevent the creation of more welcoming spaces and engineering narratives. Educators can discuss the prevalence of such memes in online spaces and the impact on the perception of engineering, what is engineering, how engineering is done, and who does engineering. By highlighting the problem, educators can start a conversation about why these stereotypes and depictions are harmful and how they lead to unequal access to engineering.

In addition, establishing spaces for these conversations is important if the goal of engineering is to truly become a conduit to innovation and service to society. Establishing safe spaces where students – future engineers – feel comfortable discussing sensitive topics like stereotypes, discrimination, and destructive cultures is crucial for a profession that is intended to "hold paramount the safety, health, and welfare of the public in the performance of their professional duties" [67, p. 14]. Educators can incorporate the analysis of discourses evident in memes into their curriculum, treating them as cultural artifacts worthy of critical examination. By analyzing memes within the context of broader social and historical narratives, students can gain insights into how stereotypes are constructed, perpetuated, and challenged. Moreover, students can gain an appreciation for the roles that engineers play in creating a narrative that may go against the tenets of the profession. Encouraging critical thinking skills can empower students to deconstruct and challenge harmful stereotypes present in online content in enacted through the work they do out in the world [44, 68].

Moreover, as educational spaces change, it is important for engineering students to engage in productive ways with media literacy. Incorporating media literacy education into the engineering curriculum to help students navigate and critically evaluate online content and the consumption of online information, including memes, is fundamental for the development of critically conscious engineers [69, 70]. By teaching students to be discerning consumers of digital media, educators can empower them to recognize and challenge different forms of online communication. Allowing students to actively participate in (re)shaping the narrative surrounding engineering and the work of engineers through media literacy education, educators can foster a sense of agency and ownership over their own (engineering) representation.

Raciolinguistics also offers a framework to unpack power dynamics inherent within language and race relations, shedding light on how racialized groups are positioned and represented within engineering discourse. By analyzing the ways in which language is used to assign value to discourses, practices, and behaviors, we can uncover how power structures are reinforced or challenged within engineering spaces. In essence, a raciolinguistic analysis of memes provides a nuanced understanding of how language and race intersect within engineering culture, offering valuable insights into contemporary social and cultural dynamics. These examples uncover the forms in which racialization is also often constructed and show how pervasive is the notion of "othering" and creating a monolithic and unachievable identity of engineering that it is harmful

even to the people that it represents the most. By critically examining the discourses embedded within memes, engineering education researchers can contribute to broader discussions about identity, power, and representation in digital spaces, ultimately working towards fostering greater inclusivity and equity within the field.

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References

[1] B. M. Capobianco, B. F. French, and H. A. Diefes-Du, "Engineering identity development among pre-adolescent learners," *Journal of Engineering Education,* vol. 101, no. 4, pp. 698-716, 2012.

[2] A. T. Danielsson, A. J. Gonsalves, E. Silfver, and M. Berge, "The pride and joy of engineering? The identity work of male working-class engineering students," *Engineering Studies,* vol. 11, no. 3, pp. 172-195, 2019.

[3] G. L. Downey and J. C. Lucena, "Knowledge and professional identity in engineering: code-switching and the metrics of progress," *History and Technology,* vol. 20, no. 4, pp. 393-420, 2004.

[4] K. L. Tonso, *On the outskirts of engineering: Learning identity, gender, and power via engineering practice*. Rotterdam: Sense Publishers, 2007.

[5] K. L. Tonso, "Teams that work: Campus culture, engineer identity, and social interactions," *Journal of engineering education,* vol. 95, no. 1, pp. 25-37, 2006.

[6] K. J. Jensen and K. J. Cross, "Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion," *Journal of Engineering Education,* vol. 110, no. 2, pp. 371-392, 2021.

[7] R. A. Revelo and N. Stepin, "Within-Group Differences of Engineering Identity for Latinx Engineering Students," in *2018 IEEE Frontiers in Education Conference (FIE)*, San Jose, CA, 2018: IEEE, pp. 1-5.

[8] C. E. Foor, S. E. Walden, and D. A. Trytten, "“I wish that I belonged more in this whole engineering group:” Achieving individual diversity," *Journal of Engineering Education,* vol. 96, no. 2, pp. 103-115, 2007.

[9] C. Convertino and A. Monarrez, "Storylines in figured worlds: Understanding diverse college students’ decision to major in computer science," *Journal of Diversity in Higher Education,* 2020.

[10] D. Holland, W. Lachicotte Jr, D. Skinner, and C. Cain, *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press, 1998.

[11] E. A. Cech, "Engineers and engineeresses? Self-conceptions and the development of gendered professional identities," *Sociological Perspectives,* vol. 58, no. 1, pp. 56-77, 2015.
[12] A. Esquinca and J. A. Mejia, "Latinx Engineering Students: A Critical Multimodal Analysis of Professional Identity Texts," in *Encyclopedia of critical understandings of Latinx and global education*, vol. 5, Y. Medina and M. Machado-Casas Eds. Leiden, The Netherlands: Brill, 2022, pp. 332-354.
[13] I. Villanueva, T. Carothers, M. Di Stefano, and M. Khan, "“There Is Never a Break”: The Hidden Curriculum of Professionalization for Engineering Faculty," *Education Sciences,* vol. 8, no. 157, pp. 1-21, 2018.
[14] National Academies of Sciences, Engineering, and Medicine, *English learners in STEM subjects: Transforming classrooms, schools, and lives*. Washington, D.C.: National Academies Press, 2018.
[15] B. E. Hughes, "“Managing by not managing”: How gay engineering students manage sexual orientation identity," *Journal of College Student Development,* vol. 58, no. 3, pp. 385-401, 2017, doi: 10.1353/csd.2017.0029.
[16] S. L. Rodriguez, C. Lu, and D. Ramirez, "Creating a Conceptual Framework for Computing Identity Development for Latina Undergraduate Students," in *An Asset-Based Approach to Advancing Latina Students in STEM*: Routledge, 2020, pp. 25-39.
[17] J. R. Morelock, "A systematic literature review of engineering identity: definitions, factors, and interventions affecting development, and means of measurement," *European journal of engineering education,* vol. 42, no. 6, pp. 1240-1262, 2017.
[18] K. L. Meyers, M. W. Ohland, A. L. Pawley, S. E. Silliman, and K. A. Smith, "Factors relating to engineering identity," *Global Journal of Engineering Education,* vol. 14, no. 1, pp. 119-131, 2012.
[19] B. Keles, N. McCrae, and A. Grealish, "A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents," *International journal of adolescence and youth,* vol. 25, no. 1, pp. 79-93, 2020.
[20] K. Dobson and I. Knezevic, "“Ain’t Nobody Got Time for That!”: Framing and stereotyping in legacy and social media," *Canadian Journal of Communication,* vol. 43, no. 3, pp. 381-397, 2018.
[21] J. Drakett, B. Rickett, K. Day, and K. Milnes, "Old jokes, new media–Online sexism and constructions of gender in Internet memes," *Feminism & psychology,* vol. 28, no. 1, pp. 109-127, 2018.
[22] G. Kress and J. Bezemer, "Multimodal discourse analysis," in *The Routledge handbook of discourse analysis*, J. P. Gee and M. Handford Eds.: Routledge, 2023, pp. 139-155.
[23] G. R. Kress, *Multimodality: A social semiotic approach to contemporary communication*. London: Taylor & Francis, 2010.
[24] L. Shifman, "Memes in a digital world: Reconciling with a conceptual troublemaker," *Journal of computer-mediated communication,* vol. 18, no. 3, pp. 362-377, 2013.
[25] H. S. Alim, J. R. Rickford, and A. F. Ball, Eds. *Raciolinguistics: How language shapes our ideas about race*. New York, NY: Oxford University Press, 2016.
[26] N. L. Flores and J. Rosa, "Undoing appropriateness: Raciolinguistic ideologies and language diversity in education," *Harvard Educational Review,* vol. 85, no. 2, pp. 149-171, 2015.

[27] J. Rosa, *Looking like a language, sounding like a race: Raciolinguistic ideologies and the learning of Latinidad*. New York, NY: Oxford University Press, 2019.
[28] J. Rosa and N. Flores, "Unsettling race and language: Toward a raciolinguistic perspective," *Language in society,* vol. 46, no. 5, pp. 621-647, 2017.
[29] N. L. Cabrera, "Exposing whiteness in higher education: White male college students minimizing racism, claiming victimization, and recreating white supremacy," *Race Ethnicity and Education,* vol. 17, no. 1, pp. 30-55, 2014.
[30] W. Faulkner, "Dualisms, hierarchies and gender in engineering," *Social studies of science,* vol. 30, no. 5, pp. 759-792, 2000.
[31] E. Godfrey and L. Parker, "Mapping the cultural landscape in engineering education," *Journal of Engineering Education,* vol. 99, no. 1, pp. 5-22, 2010.
[32] A. L. Pawley, "Engineering faculty drawing the line: A taxonomy of boundary work in academic engineering," *Engineering Studies,* vol. 4, no. 2, pp. 145-169, 2012.
[33] A. L. Pawley, "Universalized narratives: Patterns in how faculty members define "engineering"," *Journal of Engineering Education,* vol. 98, no. 4, pp. 309-319, 2009.
[34] R. Jenkins, *Social identity*. Routledge, 2014.
[35] S. Hacker, *Pleasure, power and technology: Some tales of gender, engineering, and the cooperative workplace*. Routledge, 2017.
[36] K. J. Cross and M. C. Paretti, "African American males' Experiences on multiracial student teams in engineering," *Journal of Women and Minorities in Science and Engineering,* vol. 26, no. 4, 2020.
[37] A. Gonsalves, E. Silfver, A. Danielsson, and M. Berge, ""It's not my dream, actually": students' identity work across figured worlds of construction engineering in Sweden," *International Journal of STEM education,* vol. 6, no. 1, pp. 1-17, 2019.
[38] C. E. Foor and S. E. Walden, "" Imaginary engineering" or" re-imagined engineering": negotiating gendered identities in the borderland of a college of engineering," *NWSA journal,* pp. 41-64, 2009.
[39] W. Faulkner, "Nuts and Bolts and People' Gender-Troubled Engineering Identities," *Social studies of science,* vol. 37, no. 3, pp. 331-356, 2007.
[40] D. A. Chen, J. A. Mejia, and S. Breslin, "Navigating equity work in engineering: contradicting messages encountered by minority faculty," *Digital Creativity,* vol. 30, no. 4, pp. 329-344, 2019.
[41] L. Shifman, *Memes in digital culture* (The MIT Press essential knowledge series). Cambridge, Massachusetts: The MIT Press, 2014.
[42] J. Saldaña, *The coding manual for qualitative researchers*, 2nd ed. Thousand Oaks, CA: SAGE, 2015.
[43] S. L. Rodriguez, E. E. Doran, M. Sissel, and N. Estes, "Becoming la ingeniera: Examining the engineering identity development of undergraduate Latina students," *Journal of Latinos and Education,* pp. 1-20, 2019.
[44] E. A. Cech, "The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices," in *Engineering Education for Social Justice*, J. Lucena Ed. Dordrecht: Springer, 2013, pp. 67-84.
[45] D. Riley, *Engineering and Social Justice: Synthesis Lectures on Engineers, Technology, and Society*. San Rafael, CA: Morgan and Claypool, 2008.

[46] K. Ness, "Constructing masculinity in the building trades:‘Most jobs in the construction industry can be done by women’," *Gender, work & organization,* vol. 19, no. 6, pp. 654-676, 2012.
[47] A. E. Slaton, "Meritocracy, technocracy, democracy: Understandings of racial and gender equity in American engineering education," in *International perspectives on engineering education*, A. E. Slaton Ed. Cham, Switzerland: Springer, 2015, pp. 171-189.
[48] M. B. Miles, A. M. Huberman, and J. Saldaña, *Qualitative data analysis: A methods sourcebook*. Sage publications, 2018.
[49] K. L. Tonso, "The impact of cultural norms on women," *Journal of Engineering Education,* vol. 85, no. 3, pp. 217-225, 1996.
[50] S. Hacker, *Pleasure, power and technology: Some tales of gender, engineering, and the cooperative workplace*. London: Routledge, 2017.
[51] A. E. Slaton, *Race, rigor, and selectivity in US engineering: The history of an occupational color line*. Harvard University Press, 2010.
[52] D. Riley, "Rigor/Us: Building boundaries and disciplining diversity with standards of merit," *Engineering Studies,* vol. 9, no. 3, pp. 249-265, 2017.
[53] E. O. McGee, D. M. Griffith, and S. L. Houston, "“I know I have to work twice as hard and hope that makes me good enough”: Exploring the stress and strain of Black doctoral students in engineering and computing," *Teachers College Record,* vol. 121, no. 4, pp. 1-38, 2019.
[54] B. A. Burt, K. L. Williams, and W. A. Smith, "Into the storm: Ecological and sociological impediments to Black males’ persistence in engineering graduate programs," *American Educational Research Journal,* vol. 55, no. 5, pp. 965-1006, 2018, doi: 10.3102/0002831218763587.
[55] M. Omi and H. Winant, *Racial formation in the United States*. Routledge, 2014.
[56] A. L. Pawley, "Shifting the “Default”: The Case for Making Diversity the Expected Condition for Engineering Education and Making Whiteness and Maleness Visible," *Journal of Engineering Education,* vol. 106, no. 4, pp. 531-533, 2017.
[57] J. A. Mejia, R. A. Revelo, and A. L. Pawley, "Thinking about racism in engineering education in new ways [Commentary]," *IEEE Technology and Society Magazine,* vol. 39, no. 4, pp. 18-27, 2020.
[58] A. L. Pawley, J. A. Mejia, and R. A. Revelo, "Translating Theory on Color-blind Racism to an Engineering Education Context: Illustrations from the Field of Engineering Educationresearch with underrepresented populations," in *ASEE Annual Conference and Exposition*, Salt Lake City, 2018, vol. 2018.
[59] R. D. Reason and N. J. Evans, "The complicated realities of Whiteness: From color blind to racially cognizant," *New Directions for Student Services,* vol. 2007, no. 120, pp. 67-75, 2007.
[60] Z. Leonardo, *Race, whiteness, and education*. Routledge, 2009.
[61] R. R. Valencia, *Dismantling contemporary deficit thinking: Educational thought and practice*. Routledge, 2010.
[62] M. Menchaca, "Early racist discourses: Roots of deficit thinking," in *The evolution of deficit thinking: Educational thought and practice*, R. R. Valencia Ed., (The Stanford Series on Education and Public Policy. London: Falmer, 1997, pp. 13-40.

[63] K. J. Cross, "Racism is the manifestation of White supremacy and antiracism is the answer," *Journal of Engineering Education,* vol. 109, no. 4, pp. 625-628, 2020, doi: https://doi.org/10.1002/jee.20362.
[64] E. A. Cech, "Engineering's systemic marginalization and devaluation of students and professionals with disabilities," in *2021 ASEE Virtual Annual Conference Content Access*, 2021.
[65] E. A. Cech and W. R. Rothwell, "LGBTQ inequality in engineering education," *Journal of Engineering Education,* vol. 107, no. 4, pp. 583-610, 2018, doi: 10.1002/jee.20239.
[66] E. Cech and T. Waidzunas, "Systemic inequalities for LGBTQ professionals in STEM," *Science advances,* vol. 7, no. 3, p. eabe0933, 2021.
[67] E. The National Society of Professional, "NSPE Code of Ethics for engineers," *JOM,* vol. 45, no. 4, pp. 14-16, 1993/04/01 1993, doi: 10.1007/BF03223280.
[68] J. A. Leydens and J. C. Lucena, *Engineering justice: Transforming engineering education and practice*. Hoboken, NJ: John Wiley & Sons, 2017.
[69] J. A. Mejia and R. A. Revelo, "Critical literacies in practice: Deconstructing engineering through an engineering and social justice course," in *Literacies of Design: Studies of Equity and Imagination in Engineering and Making*, A. Wilson-Lopez, E. Tucker-Raymond, A. Esquinca, and J. A. Mejia Eds. West Lafayette, IN: Purdue University Press, 2022, pp. 244-259.
[70] J. Mejia, R. Revelo, I. Villanueva, and J. Mejia, "Critical Theoretical Frameworks in Engineering Education: An Anti-Deficit and Liberative Approach," *Education Sciences,* vol. 8, no. 158, pp. 1-13, 2018.