”Are You Sure You Know What You’re Talking About?”: Epistemic Injustice Exposed by Stereotype Threat in Engineering

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Abstract

Currently and historically, women are underrepresented in engineering. One possible explanation for this phenomenon is the masculine engineering culture that rewards the ideas and behaviors of men over women. Researchers have shown that women who display more masculine attributes tend to be more successful in engineering. The culture of engineering could be a major contributing factor to women’s underrepresentation due to these masculine values and norms not only at the social level but also at the deeper epistemological levels of knowledge formation and convention. Our main argument in this paper is that epistemic injustice toward women and their ways of knowing is a theoretical grounding that helps explain the unwelcoming engineering culture toward women and others outside the centered identities of the middle-class white heterosexual male majority, thereby supporting unearned privilege for some while simultaneously disadvantaging and possibly harming others.

Through the theoretical framework of epistemic injustice, we seek to contrast the philosophical underpinnings of women’s ways of knowing to the accepted ways of knowing within engineering. We posit that this incongruence in epistemology is a structural barrier to women’s engagement in engineering and can negatively impact women’s experiences during their engineering education. The purpose of this paper is to understand how stereotype threat provides evidence of systemic inequity as defined by epistemic injustice theory and illuminates engineering practices that sustain and perpetuate harm to women.

In this conceptual synthesis, we examine literature on epistemic injustice and stereotype threat in educational spaces to provide a foundation to operationalize the two theories. Then, we propose a visual model to illustrate the overlap between the phenomenon of stereotype threat and the theoretical framework of epistemic injustice. Stereotype threat examined through the lens of epistemic injustice offers an extemporaneous perspective on the epistemological interplay between culture and individual to tackle the long-standing problem of women’s underrepresentation in engineering.

Introduction

The origins of engineering in the US stem from mid-19th century universities, in which the first engineering societies began to form and establish values for the profession [1]–[5]. Because white, cisgender, heterosexual men were the population of individuals that had the most access to studying engineering in the 1850s, they established the culture and values of engineering based on their shared identities [6]. As a result, those values form the foundation of engineering today. A consequence of this culture has been the fact that engineering has often been described as a "chilly climate" for anyone with non-centered identities and especially women [7]–[10]. In fact, researchers have shown that women have diminished sense of belonging withing the standard engineering culture [11]. Additionally, those who display more masculine attributes tend to be more successful in engineering [12], [13]. These research findings highlight that the culture of engineering is a contributing factor to women's underrepresentation and repression through masculine values and norms at the social and deeper epistemological levels of knowledge formation and convention [12], [14], [15].

Slaton [16] connects identity with technical validity in STEM professions, stating that "in science and engineering the validity of findings at the bench derives from the experimenter, not the experiment; [just as] the reliability of a building material or industrial product is determined by the tester, not the test" [16, p. 175]. This understanding further adds evidence that meritocracy in engineering is a myth. Instead, individuals are often judged for who they are and their socially constructed identities rather than ability or how they perform as engineers. In a culture that privileges whiteness, maleness, straightness, ableism, etc., women enter engineering learning environments at a disadvantage based on their gender identity. In other words, women experience systemic repression in the white supremacist, patriarchal culture of engineering [17]. White supremacy, patriarchy, and colonization produce hidden epistemologies that form the foundation of engineering culture. While we acknowledge that these hidden epistemologies systematically marginalize women and gender-nonbinary people [18], [19], we choose to focus on women within the gender binary in this paper.

The repression of women in engineering has been explained in previous research highlighting stereotype threat. We posit that stereotype threat is an example of epistemic injustice, and the phenomenon reveals the systemic inequity that is embedded engineering culture. In this paper, we summarize recent literature on epistemic injustice and stereotype threat to show where they overlap and provide explanation for the experiences of women in engineering. Also, we propose a visual representation to illustrate how stereotype threat is one type of epistemic injustice. The epistemic injustice theoretical framework provides a tool to characterize the imbalance of experiences between men and women in engineering based on prejudices and stereotypes toward women that grant them limited power in engineering culture. We offer a call to action at the conclusion of this paper to create momentum around efforts to address women's repression and work toward equitable and inclusive practices in the field.

Positionality

The context of white supremacy and patriarchy in engineering impact each of the authors of this paper in unique, nuanced ways due to how the systems of power and oppression interact with our intersectional identities. To provide transparency in how we approach these concepts and to add context to this work, we have provided positionality statements for each author on the research team [20].

Author 1: I am a heterosexual, white woman raised by two working-class parents in a double-income household. Both parents are first-generation college graduates from the Midwest, and they raised me and my two siblings in Orange County, California. I graduated from a private, teaching-focused university in Texas with Bachelor's and Master's degrees in civil engineering with an emphasis on structural engineering. I also worked for three years as a structural engineer before going back to school and pursuing engineering education. My education and career in engineering took place in predominantly white, male settings. Because of the privilege I experience as a white person and the sheltering of experiences that my privilege offers, I have undergone a massive amount of learning to identify systems of oppression embedded in the culture that may limit others in the profession. My goal with my research is to explore norms in engineering to understand and identify systems of oppression embedded in the culture that may limit marginalized communities in the profession.

Author 2: I am a gay, white, able-bodied, cisgender man with tenure in Engineering Education. My work centers on the ways we create change in engineering environments to foster equity and inclusion. My research focuses on engineering graduate and undergraduate students' experiences to generate data-driven targets for change. At the time of data collection and writing, I also serve as the co-chair of my College's Diversity, Equity, and Inclusion committee. This committee is actively working to change faculty practice, as such this paper represents a process that is motivated by local need for implementation.

Author 3: I am a Black, female, same-sex loving engineering professor with strong beliefs around spirituality. I am a first-generation PhD in my family and was raised in a racially and economically segregated large city in the Midwest. My research agenda is to broaden participation in engineering. My previous research investigated the experiences of multiple marginalized groups including women of color and members of the LGBTQ spectrum. I typically take an intersectional approach to identity in research and I am passionate about giving voice to those often overlooked in the business of educating engineers in the U.S.

Theoretical and Conceptual Frameworks

We first present epistemic injustice as a theoretical framework to examine possible reasons for women's repression in engineering. We propose a conceptual framework of scales to illustrate the dynamic complexity of inequity produced by epistemic injustice. From this, we can understand the systemic context in which stereotype threat exists for women in engineering.

Theoretical Framework: Epistemic Injustice

The theory we offer to understand women's repression in engineering is epistemic injustice, defined as the phenomenon in which an individual receives unjust treatment based on negative perceptions of their capabilities as a knower [21]. Epistemic injustice originates from philosophy traditions, as it links injustice to the ontological and epistemological roots of a particular culture or power structure. In the traditions of philosophy, psychology, and education, epistemic injustice has been used to call out the exclusionary or marginalizing practices within cultural or institutional systems [22]–[24]. We note here that though the theory of epistemic injustice may be novel to the engineering education research community, women of color pioneered discussions and operationalizations of this theory alongside Black feminist thought outside engineering contexts [25]–[33]. Notably, Settles et al. [24] uses the term of "epistemic exclusion" to explain the devaluation of faculty of color at a research-focused predominantly white institution. Within engineering education research, epistemic injustice and similar theories

have come to the surface of discussion. Ross [34] calls on the computer science education community to align the epistemological values of the field with the actions of its members after experiencing the "abstract, covert" lack of belonging felt during the review process of the Special Interest Group in Computer Science Education (SIGCSE) conference in 2017 [34, p. 1]. Apart from epistemic injustice research, feminist theories and research broadly on women's repression in engineering is underdiscussed [35]. Women in engineering have experienced prejudice in many forms in part due to their gender identity and engineering's exclusionary culture toward women [35]–[37]. The epistemological underpinnings of the culture of engineering (i.e., white supremacist and patriarchal systems of oppression) connect to women's experiences of epistemic injustice [17]. In this paper, we deconstruct a particular instance of epistemic injustice: testimonial injustice. This form of injustice is defined as a type of epistemic injustice in which a "prejudice causes a hearer to give a deflated level of credibility to a speaker's word" [21, p. 1].

The process of testimonial injustice takes place within a testimonial exchange, in which two individuals exchange information. Within this exchange, one individual takes the role of the hearer (receiving information), and the other takes the role of the speaker (giving information). For a productive testimonial exchange to take place, the hearer must believe some level of credibility from the speaker to determine the information as true and valuable [38]–[40]. In other words, the hearer must make a credibility judgement of the speaker. Sources the hearer can use to make this credibility judgement can come from "information about the speaker themself [including visible identities]…, information about how the speaker said what they did …, background knowledge on the content of the assertion …, and information about the structural features of the assertion" [38, p. 437]. Each of these sources offers opportunities for implicit biases to be used in credibility judgements. If the hearer judges the speaker as having less credibility than what the speaker legitimately has, the hearer offers a credibility deficit to the speaker; conversely, the judgement of more credibility from the hearer offers a credibility excess to the speaker. Any difference between credibility judgement from the hearer and legitimate credibility of the speaker presents an injustice done unto the speaker.

The collection of imbalances in credibility offered to speakers produces a field of deficits and excesses known as the credibility economy [21, p. 30]. Within the credibility economy between men and women, power plays a key role in the establishment of identity prejudice and stereotype. The engineering context offers identity power to men based on their hierarchal position above women within patriarchy. The identity power granted to men is enacted in engineering spaces to allow for credibility deficits allotted to women, producing testimonial injustice that can further inhibit women's performance and perpetuate negative identity prejudice and stereotypes about women. Epistemic injustice has far-reaching effects that can impact women's careers, self-esteem, and relationships, and these deleterious outcomes revolve around the identity power that distorts the credibility economy between men and women in engineering.

Conceptual Framework: The Scales

To show how testimonial injustice operates within a knowledge exchange, we offer a visualization of the phenomenon in Figure 1.

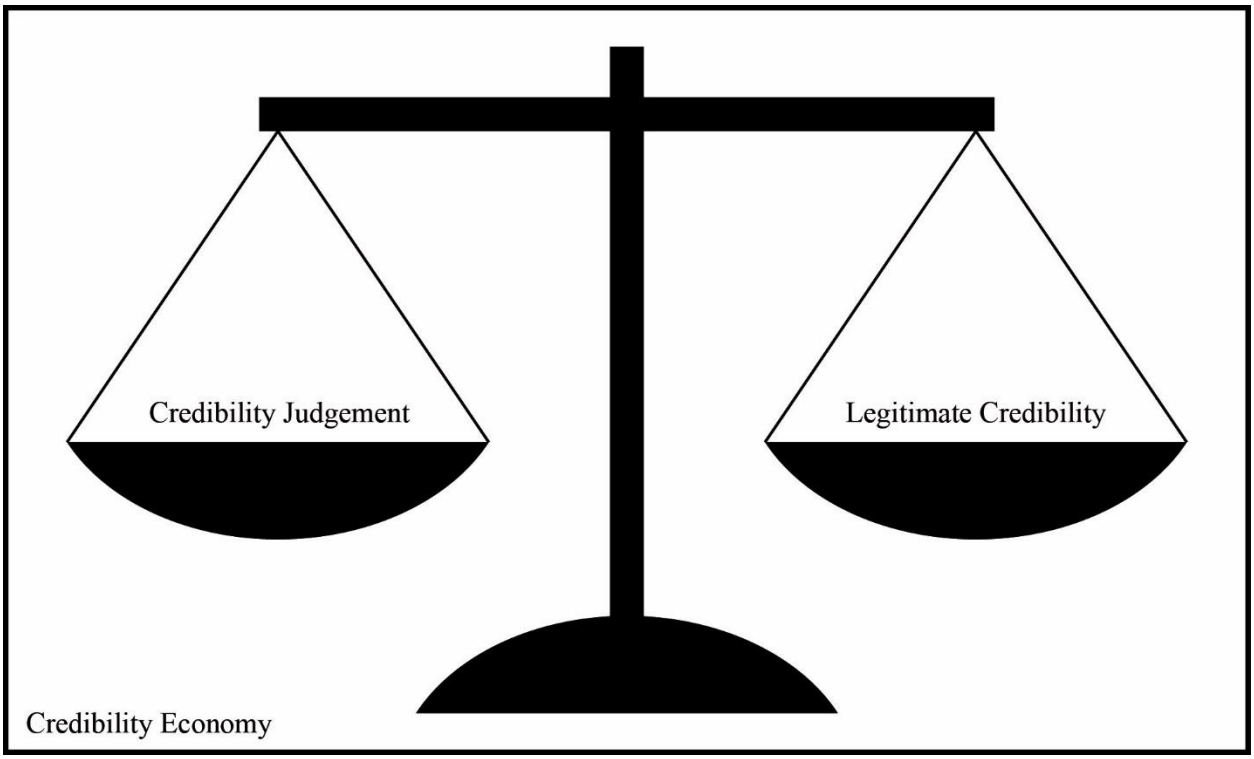


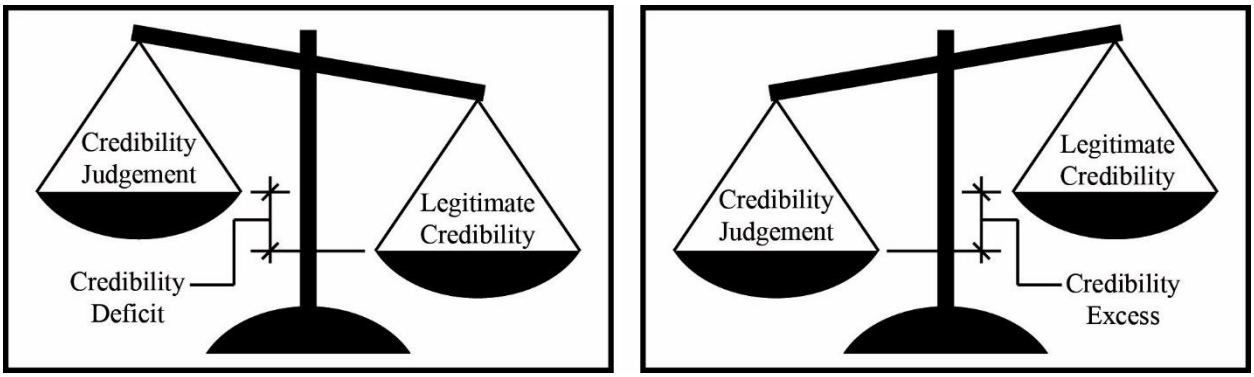
Figure 1: Visualization of epistemic injustice via the credibility economy

The scale in Figure 1 represents the process of a testimonial exchange between the hearer and the speaker. The weight on the left is the credibility judgement the hearer gives to the speaker, and the weight on the right is the legitimate credibility the speaker has regarding the information shared. If the scale leans to the right, this means the hearer judged the speaker as having less credibility than what is legitimate, which is an example of credibility deficit. Conversely, if the scale leans to the left, this means the hearer judged the speaker as having more credibility than what is legitimate, which is an example of credibility excess.

(a) *(b)*

Figure 2 shows the two cases of credibility deficit and excess.

The rectangle that encompasses the scale in Figure 1 represents the credibility economy, which is how credibility is distributed among individuals [38], often unevenly based on structural social contexts. Within the context of engineering, identity stereotypes surrounding race, gender, sexuality, socioeconomic status, disability, neurodivergence, etc. lead to prejudices that reveal themselves in the credibility economy. The hidden epistemologies in engineering provide the setting that supports identity prejudice against women via stereotypes that often degrade women's ability in technical fields [41], [42]. Moreover, we focus on the gender identity prejudice that allows men more identity power over women, which causes the testimonial injustice via credibility excess to men and deficit to women. Within the credibility economy, the power of men over women produces uneven scales that do not allow women to leverage their knowledge, thereby enacting systemic inequity for women in engineering.



(a) *(b)*

Figure 2: Visualization of (a) Credibility deficit and (b) Credibility excess.
Note: The scales are bounded by a box representing the credibility economy.

Epistemic Injustice Exposed by Stereotype Threat

After presenting epistemic injustice as a system of inequity in engineering, we summarize stereotype threat and view it as an indicator of epistemic injustice. With this understanding, we continue to widen the conversation of women's repression in engineering and reveal the systemic consequences of stereotype threat.

Stereotype Threat

The hidden epistemologies in engineering create the environment to trigger stereotype threat for women. Stereotype threat is a psychological condition that disrupts cognitive activity based on a fear of being judged by or reinforcing negative perceptions of one or more marginalized identity [43], [44]. We operationalize this definition in the current synthesis based on the social psychology tradition, and within the context of higher education research. Engineering education research on stereotype threat highlights the structural nature of this phenomenon and how individual beliefs have little effect on the outcomes or impact of stereotype threat [45]–[47]. Bell et al. [41] emphasize that stereotype threat is not a belief that is internalized by the individual. In fact, one can fully disagree with the stereotype and still experience the effects of that stereotype threat. This is because stereotype threat is based on structural power dynamics from prejudices embedded at the cultural level of a community.

On a systemic level, stereotype threat exists in any system comprised of gender and/or racial disparities paired with a belief that these disparities exist because of perceptions of deficits within the socially constructed genders or races themselves "rather than systemic inequalities" [42, p. 33]. Engineering holds up the widely-held and equally false belief of meritocracy [16], in which skill or merit determine success rather than unacknowledged bias or prejudice. As a result, in research that neglects feminist theories and contexts of systemic oppression, women's underrepresentation is often explained through a lens that women do not have the knowledge capabilities to achieve in the field of engineering [41], [48], [49] rather than discussing the constant undercutting of women's credibility in these spaces. The hidden epistemologies in engineering produce stereotype threat for women and people of color in the field [17].

For women in engineering as well as STEM more broadly, multiple studies have captured stereotype threat through ideas about math performance or other perceived disparities in knowledge credibility [41], [42], [44], [45], [50]. Stereotype threat toward women create

dynamics of visibility or invisibility, which can simultaneously over-emphasize women for their gender and devalue women for their occupational competence [42]. Jones, Ruff, and Paretti [45] give further insight into the stereotypes that further separate men and women in engineering. The study shows that men were more likely to hold negative stereotypes of women's abilities as engineers. Though the study concluded that the population of women researched did not show signs of stereotype threat in their own ability self-perceptions, the undermining of their abilities as engineers from the men in the study show the stereotype against women upheld by men in this engineering context.

All instances of inaccurate perceptions of women's competence in this research are injustices toward women, and their effects ripple throughout the culture of engineering. Ireland et al. [51] explains how Black women in STEM educational contexts can experience "imposed definitions" of their identities and the expectations associated with them [51, p. 234]. Ong, Smith, and Ko [52] present examples of women of color seeking counterspaces to combat the isolation experienced either in response to or to avoid "confirming others' potential negative stereotypes of women and students of color as being intellectually inferior" [52, p. 217]. Regardless of individual beliefs, stereotypes are powerful oppressive tools to marginalize disadvantaged communities and perpetuate the disparities of opportunities and resources handed out by privilege. Stereotype threat is a systemic issue that causes injustice to all individuals subject to its rules.

Stereotype Threat as Evidence of Epistemic Injustice

Within the visualization of scales in Figure 1, stereotype threat is embedded as a form of epistemic injustice. The cultural foundations in engineering establish inequity in the credibility economy that contribute to epistemic injustice. Stereotype threat acknowledges the imbalanced nature of the credibility economy and the potential injustice that can take place when one is judged incorrectly on their legitimate credibility. The credibility judgement made by the hearer (weight on the left side of the scale) is the same judgement that is threatened by the systemic stereotypes that permeate a culture. Therefore, testimonial exchanges that convey credibility imbalances contribute to the phenomenon of stereotype threat in engineering culture.

Our conceptualization of stereotype threat as evidence of epistemic injustice is possible because of the nature of stereotype threat, as it stems from systemically and culturally upheld beliefs that form stereotypes and affect women's performance competence in academic spaces. As a result, stereotype threat can attack women's knowledge credibility. The stereotype threat in the air [43], [53] toward women in engineering is epistemic injustice based on the gender identity prejudice that men carry more identity power than women. This epistemic injustice results in the continual repression of women in engineering based on the unevenness of scales in the credibility economy. The repression endures despite many efforts to increase retention and recruitment of women in engineering [54]. This paper shows the underlying cultural imbalances in the credibility economy of engineering that will continue to place women at a disadvantage. This uneven culture of engineering undermines diversity, equity, and inclusion (DEI) efforts, and these credibility imbalances must be addressed before we can evidence of our desired outcomes.

Consequences of Stereotype Threat: The Credibility Gap

We show in the short summary of epistemic injustice and stereotype threat that women in engineering are epistemically repressed because of the imbalanced gender identity scales in the credibility economy. Moreover, women of color experience additional unfair credibility deficits

based on their intersectional identities of race and gender (i.e., the double bind as defined by Shirley Malcom [55]). With the understanding of multiple scales operating at once within the credibility economy based on identity salience in a testimonial exchange, we can visualize the accumulation of deficits or excesses given to different groups of shared identities in engineering. As a result, certain groups who have received credibility deficits on a systemic level have a wealth of untapped credibility they have been kept from expressing. These groups have non-centered identities including women, people of color, people with disabilities, neurodivergent people, people on the LGBTQ+ spectrum, and those whose marginalized identities intersect.

Conversely, those who have received credibility excess by virtue of whiteness, maleness, ableism, socioeconomic advantages, etc. have a credibility debt, in which more credibility has been offered to them than they possess. This credibility debt contributes to social domination and the erasure of non-white and Indigenous cultures, knowledge, and communities by rewriting the dominant narrative through a painfully narrow lens. The groups with privileged identities should consider bending that privilege that it may benefit more than just themselves. The disparity between those with untapped credibility and those with credibility debts we term the credibility gap, in which knowledge remains inaccessible and ignored. Epistemic injustice has been committed on a systemic level to entire communities within engineering, and we must take action to redesign these scales if the field is to progress toward liberating women from repression and allow their full participation in STEM disciplines.

Call to Action: Balance the Scales

To balance the scales, those in credibility debts must listen, support, and provide space for the groups that have been denied the acknowledgement and legitimacy of their untapped credibility. Efforts to balance the scales appear in calls for anti-racism [56], [57], womanism [58], [59], queering STEM [60]–[62], and many more DEI efforts [63]–[65]. In addition to these efforts, we call for changes toward epistemic equity through pedagogical intervention. Women cannot be liberated to learn freely without the expulsion of the fear of being wrong and potentially representing the whole of women in engineering badly (i.e., stereotype threat against women). The approach of stereotype threat as a form of epistemic injustice allows for pedagogical intervention that directly promotes epistemic justice in learning environments. De Bie et al. [66] offer pedagogical techniques that foster epistemic equity through bolstering students' confidence and "comfort sharing and contributing what and how they know," which combats the fear that stereotype threat produces in marginalized populations like women [66, p. 36].

To address the epistemological foundations of engineering, researchers have looked to other models of education, such as Indigenous ways of knowing [67] and Endarkened feminist epistemologies [68]. These non-centered ways of knowing must be valued as legitimate knowledge rather than discredited, which challenges how engineers define knowledge (i.e., engineering epistemology). For example, Indigenous epistemologies recognize the bond between knowledge and responsibility [69], which incorporates the ethical considerations of the modern world into the process of learning and retaining new knowledge. This convergence of knowledge and responsibility to others and the earth rewrite the field of engineering through a decolonized, non-Eurocentric lens, and it balances the scales of credibility by offering freedom from prejudice that privileges whiteness, maleness, ableism, heterosexuality, etc. With this liberation, we can ensure women and those with non-centered identities have space to thrive and contribute to the betterment of this world, as is a long-standing tenant of the engineering profession [1].

Conclusion

Epistemic injustice is a system of inequity that perpetuates an exclusionary culture to women based on their perceived knowledge credibility. The purpose of this paper is to consider stereotype threat in engineering as a type of epistemic injustice, thereby highlighting the phenomenon's epistemological consequences that support and perpetuate practices that are harmful to women. To accomplish this, we provided a short summary of recent literature on the theories of stereotype threat and epistemic injustice to provide a foundation of our argument for the paper while focusing specifically on stereotype threat in engineering. Then, we proposed a visual model to illustrate the complex relationship between the concepts. We offered scales within a credibility economy to explain the injustice of one's inaccurate credibility judgement toward another based on identity prejudice implicit in the dominant culture. Engineering currently offers a culture that does not allow women access to expressing their own credibility while creating credibility debts for those with excesses of credibility. We conclude this paper with a call to action to balance the scales of the credibility economy in engineering. Many members of the engineering education research community are already working toward this goal, and our collective support and participation can eradicate the epistemic injustices toward women in engineering.

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