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What Strategies do Diverse Women in Engineering Use to Cope with Situational Hidden Curriculum?

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Introduction

This work-in-progress paper explores strategies that diverse women engineers, considered to be part of a majority (White and Asian) or minoritized (Hispanic/Latino, Black/African American, Native Americans/Alaska Native) group in this field [1], used to respond to situational hidden curriculum. "Hidden curriculum (HC) refers to the unwritten, unofficial, and oftentimes unintended, assumptions, lessons, values, beliefs, attitudes, and perspectives not openly acknowledged in an environment" [2, p. 1] HC is messaged as positive or negative, but negative HC could result in undesired costs, such as attrition [2]-[3].

Previous researchers [4]–[7] have identified four predominant factors, (a) awareness, (b) emotions, (c) self-efficacy, and (d) self- advocacy, for how individuals recognize, react to, and respond to situational HC. However, there is limited previous research about what strategies women use to cope with situational HC, principally in engineering environments. Thus, in this study, we report on strategies that women engineers, including women engineers with intersectional identities, used to respond to barriers stemming from situational HC. We derived these strategies from our qualitative analysis of the written responses of participants to an administered and reliable survey instrument [2].

Literature review

Women in engineering

Women are still underrepresented in engineering and comprise only 23% of total bachelor's degrees awarded [8], whereas women of color earn only 6% of engineering bachelor's degrees [9]. In the workforce, 13% of engineers are women [9]. Thus, nearly half of women who graduate in engineering decide to leave [10]. Further, women of color comprise less than 3% of the engineering workforce post-graduation [11]. While most arguments for increasing representation of women in STEM are a result of national economic needs for global competitiveness [12], we argue that all gender identities belong in engineering. Diversity of thoughts, experiences, and backgrounds are widely linked to positive outcomes, such as greater innovation and collective intelligence of combined ideas in a group [11]. Furthermore, normalizing gender equity is essential to increase the representation of minoritized and intersectional identities in engineering [13]. Women bring several assets to engineering, which counteract the predominant values of male dominance in the field , such as individualism, fierce competition, technical obsession, territorialism, and aggressive self-promotion [13]–[15]. Further, individualist classroom and academic cultures, as well as a lack of engagement with other communities of engineering students, a lack of sense of belonging, and isolation, contribute to gender-diverse students' decisions to leave engineering [14], [16].

Along with experiencing underrepresentation and isolation in engineering, women face "chilly" climates that are rooted in tokenism, gender stereotyping, discrimination, and sexism [17]. Majority groups in engineering have failed to provide a culture where women feel like they belong [18]. Women's self-efficacy is influenced by external circumstances, and they are especially impacted by both the individualistic and competitive climate as well as sexism and discrimination in engineering [14], [19]. Women of color, in particular, experience gendered **and** racialized otherness, further contributing to hostile working environments and isolation [20].

Self-efficacy and its four sources

Self-efficacy refers to an individual's beliefs in their capabilities to plan and take action to achieve a particular outcome [21]. There are four major sources of self-efficacy [21]: (1) mastery experiences, (2) vicarious experiences, (3) social persuasions, and (4) physical and emotional states. ***Mastery experiences*** are the interpreted result of an individual's past performances, such as how a woman evaluates her self-efficacy in a course based upon the grades received for that class.***Vicarious experiences*** are where individuals observe others performing tasks, such as a woman undergraduate student observing a fellow woman undergraduate student ask a question in class. In situations where individuals have had little experience to gauge their competencies, vicarious experiences seen through the behavior of models are particularly influential [22]. ***Social persuasions*** are verbal messages and encouragement that help individuals exert the effortto maintain persistence to succeed, such as a student encouraging another student to persist in a difficult engineering course. Individuals also look to their ***physical and emotional states,*** such as stress or hope, as a source of information about their capabilities to a given task or situation. Women typically value positive vicarious experiences and social persuasions whereas men are more likely to value mastery experiences [19]. Negative verbal messages that transmit HC can act as social persuasions, negatively influencing women's beliefs about their competencies [19].

Hidden curriculum and self-efficacy in engineering

Hidden curriculum (HC) can be experienced and internalized at the institutional level (e.g., perceived or present biases in the curriculum, structures, and type of assignments) and interpersonal level (e.g., snubs, dismissive gestures, or seemingly innocent comments, jokes, or humor that are perceived by the recipient as harmful, inappropriate, or insulting) [5], [6], [22]–[24]. These types of negative HC can create an environment where women and other minoritized individuals are disparaged and belittled in engineering whereas positive HC can have the opposite effect [2].

Engineering education researchers [2], [5], [6], [23]–[25] understand HC from a response pathway standpoint, which involves a person becoming aware of HC (awareness) and how to process it (emotions), recognizing that HC leads to discriminant motivations in an individual (self-efficacy), that influences a person's inclination to act on behalf of themselves (self-advocacy). Typically, scholars compare a person's self-perceptions of their efficacy in a domain or course and tie them to outcomes (e.g., grades, GPA), which is known as academic self-efficacy [26]. In our study, however, we gauge an individual's self-efficacy by how they challenge or cope with situational HC; this phenomenon is closely aligned with ***coping self-efficacy***, where a person adopts strategies to change stressful environments into more benign ones [27], such as when responding to situational HC in engineering.

Women in engineering cope differently to hostile and biased learning and working environments by: (1) leaving the environment, (2) rationalizing differential treatment, (3) modifying one's appearance or behavior to fit the environment, (4) limiting interactions with hostile individuals, and (5) communicating one's feelings and preferences to others [15]. In the profession, these engineers have also coped with the chilly climates of the field by using support from mentors, co-workers, and other members of their team [15]. Zeldin and Pajares [22] similarly found that STEM women were resistant to negative social persuasions and used strategies like ignoring negative messages directed toward them or disallowing negative

messages to deter them from their goals. However, Zeldin and Pajares's work did not explore the influence that intersectional identities [28], such as being a woman and person of color in engineering, can have on these coping strategies or how they may vary to a given situational HC. In addition, there is limited understanding of how these strategies are tied to personal resistance of the environment surrounding them. Our research aim is to expand our understanding of how diverse women cope with and address HC in both the engineering academy and workforce so that we can identify and share strategies to help other women push past HC. Thus, we ask this research question: *What strategies do diverse women in engineering use to cope with situational HC?*

Methods

This work-in-progress study is a smaller piece of a larger mixed-methods survey to determine participants' awareness, emotions, self-efficacy, and self-advocacy around HC [2]. For this work-in-progress study, we explored the qualitative written responses of women (n = 333) in engineering on a single item of the survey designed to gauge their qualitative self-efficacy response to situational HC. The situational HC explored for this study came from participants' responses to the following question: *"Please provide an example of a personal obstacle you overcame successfully in engineering, related to the hidden curriculum. Briefly explain what caused you to consider it a personal obstacle."* This item allowed us to relate women's individual development of self-beliefs [22] around HC, and crucially, their strategies to push past HC.

Data collection

The second author and colleagues distributed the validated and reliable survey in a two-stage sampling process. The first stage was a purposeful sampling [29] strategy where five institutionalliaisons hired under the grant (see Acknowledgement section) and representatives of the Southeast, Northeast, West, and Southwest regions of the United States, assisted the research team with recruiting of participants. The representatives shared a communication (approved by the IRB office of the home institution of the second author at the time of this study), along with the Qualtrics survey link and informed consent. The inclusion criteria were: (1) an ABET-accredited college of engineering in the United States and Puerto Rico, (2) students or faculty who are currently enrolled or employed in that college of engineering, (3) over the age of 18, and (4) U.S. citizen or permanent resident. The research team used this purposeful recruitment of these regions to oversample populations that are traditionally underrepresented in engineering (e.g., Latinx, Black). From this effort, the team collected 564 responses.

The second stage of recruitment involved a probabilistic sampling [28] to capture other regions of the U.S. For this, we used Qualtrics Panel services to recruit the remaining individuals for the study using the same sampling criteria above. From this sampling, we collected 420 responses. In total, from the two recruitment strategies, we collected 984 participant responses, and we paid all who completed the survey an Amazon gift card for the amount of $25. After removing duplicate response IDs, incomplete survey entries, or participants who did not meet the inclusion criteria, we reduced the sample number to 963 participants. The survey took an average of 20 minutes to complete, which we administered between Fall 2018 and Spring 2019. For this work, we report engineering women's responses (n = 333) only and are currently analyzing data for other non-binary groups.

Data analysis

We used an inductive approach to data analysis influenced by a case study methodology [30]. We characterized the cases as majority group (White and Asian) and minoritized group (Black, Hispanic/Latinx, Native American, etc.) women in engineering per recent statistics of women in engineering [1]. Participants replied to the survey qualitative question asking about how they have responded to the situational HC they have experienced in engineering. From participants' qualitative responses , we parsed participants' responses into who was the communicator of HC (e.g., professor, student, system), the source of the HC (whether institutional or interpersonal), the HC itself (e.g., personal costs of pursuing engineering- overt; sexism in engineering- covert), and what aspects of participants' intersectional identity were impacted (e.g., woman x Black x student). We also explored the strategies participants used to cope with the HC (e.g., asked for help, learned about other successful women in STEM). From the available responses, we removed duplicate responses (n = 5), and responses from participants who did not reply to most survey items (n = 9).

The first author performed topical coding [31] to identify HC communicators, receivers, examples of HC and used in-vivo coding [29] in Microsoft Excel to identify strategy(-ies) participants used to cope with or address HC along with code definitions with example quotes to a codebook. The entire process was discussed and iterated at length with the second author. Participants' responses that did not have a specific example of HC (n = 122) or did not discuss who communicated the HC (n = 121), and responses that did not have a strategy for overcoming the HC (n = 179), were excluded. From the original group of participants (n = 333), less than half of participants (n = 154) had a codable communicator, receiver, issue, and strategy. From this sample of participants, 65 of their strategies were organized into 10 categories using Microsoft OneNote. The categories were divided into three themes. Even though we also coded for the communicators and receivers of HC, the aspect of a woman's identity the HC impacted, and the HC itself, these will not be discussed here but will be included in another publication seeking to integrate these findings with the quantitative items from the survey. Due to page limits in this work-in-progress study, we opted to include strategies used by women by engineering role (faculty, student, employer, etc.) in future work. Thus, we only present strategies women engineers communicated in their writing when they were asked to expand upon a situational HC they had to overcome in engineering.

Demographics

Out of the participants who shared a strategy (n = 154), the majority were 18-29-years-old (n = 121, 79%) (Table 1: Demographic characteristics of participants). Because we intentionally oversampled at some institutions, minoritized groups (n = 69, 45%) were more represented in this sample than is typical in engineering. Most of the participants did not consider themselves to be first-generation college students (n = 108, 70%) or non-traditional college students (n = 113, 73%). Most women in this study were either first and second year (n = 35, 25%), or third year or greater (n = 88, 57%), undergraduate students. The most common engineering concentrations representing these participants were environmental engineering (n = 29, 19%) and computer/electrical/electronics engineering (n = 23, 15%).

Table 1: Demographic characteristics of participants

Demographic	*n*	%
Age		
18-29	121	79

30-39	14	9
40-49	12	8
50-59	6	4
60+	1	<1
Race and Ethnicity		
Majority group	85	55
Minoritized* group	69	45
First generation college student		
Yes	45	29
Not sure	1	1
No	108	70
Non-traditional undergraduate student		
Yes	40	26
Not sure	1	1
No	113	73
Academic rank/role		
Undergraduate student	123	80
Graduate student/Post bachelor's degree	11	7
Academic advisor/Adjunct professor/Lecturer	5	3
Assistant/Associate/Full professor	15	10
Engineering concentration		
Architectural Engineering	7	5
Aerospace/Automotive/Mechanical Engineering	19	12
Biological/Biomedical Engineering	16	10
Chemical/Petroleum/Materials Engineering	25	16
Civil/Highway/Construction Engineering	22	14
Computer/Electrical/Electronics Engineering	23	15
Engineering Education	1	1
Environmental Engineering	29	19
Industrial/Process Engineering	11	7
Nuclear Engineering	1	1

* *Minoritized* was used to refer to racial and ethnic groups of women who have been historically excluded from engineering, specifically Black and Hispanic/Latina/Chicana women [1]. While there were no Hawaiian Native, AlaskaNative, or Native American participants in this study, we recognize they too are minoritized.

Positionality

The first author is a White, cis-gender woman, science, and engineering education researcher who has research experience focused on amplifying the voices and assets of minoritized people in engineering. She has a transformative worldview [32] and acknowledges

that systemic racism, sexism, and classism permeate higher education policies. These –isms percolate into interpersonal interactions between peers, instructors, and administrators within that realm and vice-versa. Her worldview influenced the analysis and the interpretation of the findings, and it allowed her to interrogate the social reality of women experiencing HC.

The second author is a Latinx, cis-gender woman, first-generation college student and engineer, and science and engineering education researcher. The second author has a critical pragmatic worldview [29] that recognizes the need to consider outcomes with processes, about how contextual inequalities are situated in power [31]-[32] and how strategies for change may require a plurality of methods [32]-[33]. As such, HC may represent a different epistemology and reality by all, and contextualizing each space is critical to our liberation from oppressive systems and epistemologies.

Results

By categorizing the reexamining participants' (n = 154) strategies, we saw a distinction in how women approached the HC they faced. Women engineers either felt efficacious by displaying outward measures, such as speaking directly to a peer about an issue or taking inward measures like developing mental resistance and self-assurance. Most participants (n = 134) used a single strategy to cope with or address the HC, whereas some participants paired strategies (n = 16) or used three strategies (maximum) to address the HC (n = 2), for a total of 172 strategies used by the participants. Some participants (n = 6) used strategies from multiple themes to cope with HC.

We split categories of singular strategies used (n = 154) into three themes, ranging from strategies that women used to resist HC to those they used to avoid HC: changing environment (outward strategies), negotiating self (inward strategies), or taking no or minimal action (avoidant strategies). A summary of the three themes of strategies and categories within each theme can be found in Table 2. We note that percentages of strategy categories used by majority and minoritized groups are normalized to each group's population and not to the study population as a whole. Please note that we were limited in the number of illustrative quotes we could use by manuscript length requirements.

Theme 1: Changing environment (outward strategies)

We want to highlight categories of strategies that the participants (n = 56) used to change their environment, which include: (1) mediating, (2) addressing issues directly, (3) seeking help or resources, or (4) looking for/increasing representation for women engineers. We refer to these strategies as "outward strategies" because these women realized they should address the HC in their environment instead of adjusting their own identity or beliefs to fit into engineering. These strategies required women to either outwardly display mastery experiences when encountering HC, seek vicarious experiences from others, and/or be a vicarious experience and source of positive verbal persuasions for other women. Thus, participants who used these strategies needed the most self-efficacy to challenge HC. We discuss these outward strategies from participants who addressed interpersonal issues (mediating) to systemic problems (increasing representation).

Mediating. Participants (n = 3) served as mediators when they felt they needed to be a bridge between peers or learned how to improve their communication with male colleagues to overcome an obstacle. Mediating was the least common strategy and majority and minoritized racial/ethnic groups employed this strategy similarly (2% vs 1%). For example, a

Hispanic/Latina industrial engineering undergraduate student mediated a team confrontation with her male peers because, “This was a personal obstacle because my grade was on the line, and I had to figure out how to communicate with these men who would not even respond to me.” The participant talked receiving a bad grade was a potential risk of not cooperating with her male peers, even though her male peers communicated an HC that they did not value her opinion because she was a woman. Thus, this participant turned receiving HC into a mastery experience because she was able to successfully communicate with her teammates even though they did not provide positive verbal persuasions.

Addressing issues. Participants (n = 12) addressed the HC by speaking directly with the person who communicated the HC, whether it was an HC derived from systemic issues, or from a professor or peer. Women who used this strategy also sidestepped or “jumped” an authority level, i.e., approaching another professor or a department chair, to address an issue. Majority racial/ethnic group participants used this strategy slightly more than minoritized participants (8% vs 5%). Hispanic/Latina, electrical engineering undergraduate student noted, “Professors may sometimes make sexist comments which can make females uncomfortable. I've learned to overcome this obstacle by expressing myself and always try to offer my perspective on the matter when there is no one else to do it.” This woman spoke up for herself (e.g., mastery experience), and for other women by extension (e.g., vicarious experience), instead of waiting on the communicators of the HC to change their behavior. However, we note that she was tokenized because she felt that she was the only person who could address this inequity.

Seeking others or resources. Participants (n = 28) sought academic, financial, and emotional support from others, including family, peers, professors, mentors, and tutors. Majority and minoritized group participants used this strategy similarly (17% vs 18%). Participants asked for help and support, sought others who could help boost their belongingness or confidence in engineering, or looked for internships and scholarships to aid with their financial stability. For example, a Black, computer engineering graduate student stated: “I didn't have the funds to go to undergrad. I didn't have any way at all. But through applying for literally hundreds of scholarships, I was able to fund my school.” The participant resisted the HC that everyone is can afford an engineering education, and she did so by locating other forms of funding that would allow her to continue (i.e., scholarships). Thus, the participant boosted her self-efficacy by developing mastery of overcoming financial HC.

Increasing representation. Participants (n = 13) sought to increase representation for themselves and other women as a result of feeling underrepresented or undervalued in engineering. Majority and minoritized group participants employed this strategy similarly (7% vs 10%). Women noted that they did not want to perpetuate the norm of being undervalued to other women engineers and that they preferred to be a representative of women in courses and jobs where they knew they were underrepresented. These women joined together in affinity groups in order to help other women. Women engineers also sought representation of other women in successful roles, such asbeing given awards at professional engineering conferences. For example, a White, environmental engineering graduate student noted that “…it is rare to see practicing women engineers as examples either as guest lecturers or professors.” However, the participant mentioned, “I attended a professional conference that recognized many “young professionals” who were women, and it made me believe that a company will appreciate and respect my work regardless of my personal life.” The participant generated self-efficacy to be respected and valued in her future career because she saw vicarious representation of other

successful women engineers.

Theme 2: Negotiating self (inward strategies)

Women who did not outwardly challenge HC often changed themselves, or negotiated their authentic selves/identities, in response to HC; these are "inward strategies" because women placed the onus on themselves to cope with HC communicated by others instead of challenging the persistence of HC. Women (n = 96) either: (1) made no major changes, (2) changed their mentality, (3) developed skills, or (4) increased their effort to cope with HC in engineering. "Negotiating self" is the most common theme used by women engineers in response to HC. We consider women who used strategies within "Negotiating self" to display less self-efficacy to address HC because they did not question the HC or work to change their environments. By extension, they did not serve as vicarious models for changing situations for other women. The following strategies are in order from least to most visible changes.

No major changes. Many participants (n = 37) made no major changes after HC was communicated to them. We include women's persistence to continue in engineering within "no major changes" because while they were doing something to mitigate HC, they did not adjust their strategy to challenge HC. We note that majority group women used this strategy less than minoritized women (18% vs. 26%). A Black, environmental engineering undergraduate student mentioned, "I feel like sometimes people don't take me seriously. I want my work to speak for itself." The participant did not make any major changes to her approach to engineering but wanted her work to gain merit instead of it being undervalued based her intersectional racial and gender identities. She did not challenge the HC that others undervalued her directly, but rather, relied on her existing engineering mastery to subvert the HC indirectly.

Developing skills. Some participants (n = 10) developed skills to cope with HC. "Developing skills" means that participants develop academic skills, such as taking courses, learning to solve engineering problems, practicing soft skills, or pursuing interests as a way to negotiate some aspect of their personal and engineering identity. Majority and minoritized women used this strategy similarly (6% vs. 5%). For example, a Hispanic/Latina industrial engineering graduate student noted that because she was an honors student, a tennis player, and worked, she "learned to organize and manage my time and your tranquility in a cost-effective way to achieve everything successfully." This participant aligned her skills and identity to match normative engineering skillsets, so she developed mastery experience of the HC that engineering students' education should be their only focus, instead of leveraging sources of self-efficacy to challenge the HC.

Changing mentality. Participants (n = 24) changed their mentality as a way to cope with HC. Wedefine changing mentality as the mental work that women do to overcome an issue, such as becoming resilient, "getting over it," or developing self-assurance. We note that majority and minoritized women use this strategy similarly (14% vs 14%). A Black civil engineering assistant professor declared, "Every day, I overcome. There is so much prejudice that I deal with on a daily basis." The participant has to exert mental and emotional effort every day to contend with racism and sexism directed at her in engineering. Thus, she demonstrated mastery of coping with racism and sexism but did not develop mastery to challenge the HC directly.

Increasing effort. Many participants (n = 35) increased their effort in response to HC being communicated to them. This category is similar to "Changing mentality" because this is extra effort that women place on themselves to cope with HC; however, this category is different

because it includes women who directly increased their effort as a response to HC from male peers and professors. We note that majority group women used this strategy more than minoritized women (25% vs 16%). An Asian mechanical engineering undergraduate stated that "I also wanted to prove the people who told me that I couldn't succeed wrong because they didn't believe in me and were making me feel like I truly couldn't succeed." The participant noted that she worked harder in order to prove to herself and others that that hard work would lead to success. She also wanted to disprove others' opinions of her abilities and by disproving others' opinions of her, she could correct their wrong appraisal of her abilities. "Increasing Effort" is on the brink of an outward strategy because others are able to see changes in women's behavior; however, women do not challenge the HC directly or work to change any systemic representation or undervaluing issues and was deemed an inward strategy instead.

Theme 3: No/Minimal Action (avoidant strategies)

Women (n = 6) who did not change their environment or negotiate their identity and feelings either took no or minimal action. We consider these to be "avoidant strategies" because while they are still exhibiting mastery experiences by being in engineering, negative physical or emotional states or external systemic factors may impede them from action. These women have the least self-efficacy to challenge HC because they did serve as a source of positive vicarious experience or social persuasion or had gained mastery experiences when dealing with HC.

Does not know how to mitigate. A few participants (n = 2) did not know how to mitigate situations where HC was communicated to them. A White, environmental engineering undergraduate student noted her reluctance to act on HC: "I have had male group project members ignore me when I assign tasks for everyone to do, despite the fact I was elected team leader. These are personal obstacles because there is nothing [that] I can do about them as a female." In this instance, the participant did not know how to change others' behaviors in order to fight a norm that women are undervalued in engineering.

Avoiding. A few participants (n = 4) avoided HC. Minoritized women were slightly more likely to use this strategy than majority women (4% vs 1%). A Hispanic/Latina industrial engineering undergrad stated that she had "problems with team members due to lack of communication and respect," which she overcame "by analyzing if the team is a [good] fit for myself and doing a better judgment for other teamwork projects." The participant reported low self-efficacy to influence the men in her group to change their behavior, so she avoided this challenge by choosing different team members for future projects. This category is different than "increasing effort" because women who avoided situations with HC did not necessarily mention that they cared about the opinions of others, but they were likely forced to cope with the situation because the benefits outweighed negative impacts of staying in the environment in light of HC.

Table 2: Three themes of strategies with ten categories of strategies and examples

Theme	Self-efficacy needed	Strategy category	Strategies by racial/ethnic group		Example
			Maj. %	Min. %	
Changing environment (Outward strategies)	Most		34	34	
		Mediating	2	1	Diffusing a team situation between peers
		Addressing issues	8	5	Speaking directly with peer to address issue

		Seeking others/resources	17	18	Finding peers who helped herbe outspoken
		Increasing representation	7	10	Working hard to be a good model for other women
Negotiating self (Inward strategies)	Moderate		63	61	
		No major changes	18	26	Persisting through a difficult course/subject
		Developing skills	6	5	Practicing "soft" skills to set herself apart
		Changing mentality	14	14	"Toughens up"
		Increasing effort	25	16	Working harder to prove others wrong
No/minimal action (Avoidant strategies)	Least		2	5	
		Does not know how to mitigate	1	1	Feeling like she cannot do anything about situation
		Avoiding	1	4	Doing the project herself

Discussion

We expand previous research [15], [22] about self-efficacy sources and beliefs by describing themes of strategies women use to contend with challenging engineering environments, and how they may differ based on racial/ethnic intersectionality. We determine that diverse women either challenge HC and change their environment, cope with HC by negotiating themselves, or avoid HC by taking no/minimal action. We interpret that women change their environment by responding to interpersonal HC **and** by working at institutional levels to improve a sense of belonging for other women, such as entering leadership roles to improve gender diversity and being a role model for other women (i.e., serving as a vicarious example). Thus, women develop self-efficacy and share strategies to challenge HC. We note that a third of participants changed their environments. Previous researchers [15], [22] also found that women challenged chilly environments by using support from co-workers, as well as addressing microaggressions or hostility directly. We added intersectional insight with this research that minoritized and majority group participants changed their environments **similarly.**

Both majority and minoritized women most commonly negotiated themselves in response to HC and did not directly challenge HC, but instead found ways to cope with it, like strengthening their skills or self-assurance. By negotiating within themselves (inward strategies), women placed the burden of change on themselves more than challenging structures of power and individuals who communicate HC. Previous research [15] has similarly recognized that women modify their appearance or behavior to fit the environment. This may lead to women not consciously considering the impact of negotiating within themselves. By internalizing their strategies, women may open themselves up for psychological costs, such as frustration, anger, and burnout [36]. These forms of self-preservation approaches may suggest higher systemic powers of oppression that this study could not address. We will pay closer attention to this phenomenon in future work.

We were able to identify a major difference in strategies employed by diverse women engineers within the theme of "Negotiating self", specifically the "no major changes" strategy, where minoritized women employed this more than majority group women. While we do not

have a concrete justification as to why more minoritized participants used this strategy than majority group participants, we surmise that participants' gender and racial intersectional identities or divergent ways of knowing/being may contribute to feeling 'cornered' or at a higher risk of being targeted if they adopted an outward strategy. Future work will explore this phenomenon in more detail.

We previously noted that majority women increased their effort more than minoritized women engineers around HC. We cannot justify with data as to why this happens, but we presume that majority women engineers may subscribe more to meritocratic ideals [34], such as working harder leads to success, than minoritized women. Conversely, minoritized women may be less likely to respond to HC by increasing their effort because they have been primed to identify HC previously, which targeted their abilities on the premise of their intersectionality. This phenomenon is known as ***stigma consciousness*** and refers to the awareness that others will stereotype a person, based on their racial or gender identity, regardless of that person's behavior [37]. Researchers have found that women with high stigma consciousness could describe sexist incidents with greater specificity than women who had lower stigma consciousness, but the researchers were limited because they were unable to provide specific insights of intersectional women [37]. Majority group women may be more likely to believe others' negative opinions of their competency and choose to work harder because they have not been primed by racialized incidents or have not overcome HC by working harder prior to entering engineering. Therefore, our research begins to explain differences in stigma consciousness between minoritized and majority group women.

A prominent way that participants in this study increased their effort as a way to negotiate themselves in response to HC was to prove others wrong. "Prove them wrong," or working harder can be a way for participants to change the opinions of others who communicate HC and indirectly change how women are perceived. Other researchers [36], [38], [39] have described the Prove-Them-Wrong Syndrome as a phenomenon of persistence against discrimination, which Black students have employed in their adolescence and carried into their STEM educations. The phenomenon is also used by women engineers and is not only evident in this study, but the Society of Women Engineers [9] similarly reports that 61% of women engineers have to prove themselves **repeatedly** to get the same level of respect and recognition as their colleagues. This strategy highlights how social persuasions influence women's engineering self-efficacy, and because their self-efficacy is diminished by being undervalued, they try to reclaim some of their self-efficacy by eliciting positive social persuasions from others. However, these forms of strategies may come at a cognitive, emotional, psychological cost to the individual as they may fundamentally negotiate their identities to embrace a more normative engineering identity in the process.

Some women took no or minimal action instead of changing their environments or negotiating themselves. We note that majority and minoritized women took no or minimal action similarly. In situations where women did not act or avoided the situation, they did so because they felt their actions would be ineffective or the stakes for speaking against HC were too high. Women felt that changing their environment would negatively influence group or workplace dynamics or would further contribute to their peers' evaluation of their abilities as women engineers and lead to negative social persuasions, impacting both their engineering and coping self-efficacy. Women were also concerned about non-social academic or workplace consequences, such as bad grades or negative performance evaluations, if they addressed HC.

The theme of taking no or minimal action confirms the influence that negative social persuasions and vicarious experiences [14] have on women engineers' self-efficacy, in that negative HC reduces a woman's capacity to act on HC. Previous researchers have noted this for graduate students in engineering whose emotional responses to HC led to inaction on their part [5].

Limitations

A limitation of this work is that participants provided examples of barriers in engineering they strategized to overcome, but we were unable to ask participants to expand their explanation of their HC. Therefore, we could not ask clarifying questions that would add richness or context to HC or their strategies. However, we feel this limitation is balanced by instances of HC communicated to women and the unique contexts where HC is shared. An additional limitation of this work is that we only used responses from participants who self-identified as women. We plan to address this presumption of the gender binary in future work by discussing the shared written responses from engineers with other gender and sexual identities, including cis-gender heterosexual men, and LGBTQ+ people.

Implications

Implications for theory. We determined that women engineers either change their environment, negotiate their authentic selves and their identities, or do not take action to address HC in engineering. Our research extends the conceptualization of coping self-efficacy to interactions in engineering where women experience microaggressions or products of systemic sexism and racism. We began to uncover differences in stigma consciousness among minority and majority women in engineering. It is important to note that our identified strategies parallel the framework of LatCrit [40], which presents different forms of resistance (transformational resistance and self-defeating resistance) that Latinx students use to address oppressive conditions.

Implications for research. This research is a part of a larger mixed-methods effort to categorize and identify responses pathways of situational HC in engineering. Because HC research in engineering is still relatively new [1], [5], [22]-[23], we were able to use participants' qualitative responses to build the first set of strategies that women engineers use to resist situational HC. This research approach has allowed us to glimpse the impacts that systemic sexism and racism have on women engineers. We were able to mirror novel HC inquiry in engineering by using inductive analysis to develop in-vivo strategies into categories and themes, which we extrapolated to coping, stigma consciousness, and resistance literature. Since we were able to determine cursory levels of self-efficacy needed (most, moderate, least) to use each category of strategies, we will be able to mix women's perceived self-efficacy (quantitative survey responses) to the strategies they chose to write on (qualitative responses) for future work; this may help us actualize any breakdowns between women's perceived self-efficacy of addressing HC and how they really address HC. This work will a deeper dive into how overt or covert forms of HC in the message (e.g., personal costs of pursuing engineering- overt; sexism in engineering-covert) guide the actions, decisions, and perspectives of diverse women engineers.

Implications for practice and workplace. We suggest that strategies to address situational HC are particularly important for educators and practitioners. It is not only important for practitioners to encourage women and other engineering students to counter HC to change their environments, but we also state that it is crucial for practitioners, especially women who are professional engineers, advisors, lecturers, and professors of engineering, to discuss the HC they have encountered and the strategies they used to cope with them. We posit that it is vital for

women who have persevered and succeeded in engineering, to share those strategies and elaborate on how they addressed HC, negotiated with themselves (if they chose this path), and contextualize those factors that weighed in on their choice along with its risks and benefits. With successful women engineers sharing their experiences, other women can use these positive vicarious experiences to build their own self-efficacy for addressing any HC.

Conclusions and future work

We identified three themes of strategies used to address and cope with HC in engineering: (1) changing environment, (2) negotiating self, and (3) no/minimal action. Our future work includes using the qualitative findings and comparing them to quantitative perceived self-efficacy measures to determine mismatches between how efficacious a woman in engineering thinks she is versus the strategy she chooses and if it depends on the type of HC or who the communicator of the HC is. Our future work will compare the strategies used by people with other gender identities in engineering to see how:(1) others work to overcome HC in engineering, and (2) see how different others' strategies are to those that women employ. We also plan to analyze responses to a self-advocacy item to determine how women extend their self-efficacy into advocating for themselves and others in engineering. With these findings, we are developing professional development workshops to support women engineers' advocacy mentoring capacity within engineering departments.

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