Participants' Conceptions about Self-/Advocacy around Hidden Curriculum in Engineering

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Introduction

This work-in-progress paper is part of a greater effort to characterize hidden curriculum (HC) in engineering education [1]–[12]. Researchers have defined HC as unwritten and unacknowledged values, beliefs, and opinions in an environment [5], [7], [9], [11]–[14]. HC also encompasses historical and structural issues (e.g., racism; affordability) that percolate into the values and beliefs in a field such as engineering [2], [3], [15]. Additionally, we relate these to institutional messages at the university and departmental levels (e.g., underrepresentation; hiring practices; cost of tuition) as well as to interpersonal messages between students and instructors (e.g., microaggressions) [2], [3], [15]. As an example of underrepresentation, women earned 8% more bachelor's degrees over the past 10 years, yet they still only represent 23% of bachelor's degrees earned [16]. Also, bachelor's degrees earned by Black engineering undergraduates have stagnated over the past 10 years at 4 to 5% [16]. In addition to underrepresentation, marginalized groups report persistent racism [17], sexism [18], [19], and ableism [20] within engineering. Therefore, we must examine undercurrents of opinion in engineering that continue to contribute to an exclusive discipline.

We initially intended this thread to investigate the individuals' strategies to advocate for themselves and others (self-/advocacy) when faced with HC. Yet, during descriptive and thematic coding, we uncovered an extreme case of participants (n = 27) with four conceptions that may limit self-/advocacy around negative HC. By exploring these conceptions of self-/advocacy around HC, we can inform future research and professional development efforts to address resistance to self-/advocacy around HC in engineering.

Literature review

Origins of HC research

HC includes unwritten and unacknowledged values, beliefs, and opinions in an environment [5], [7], [9], [11]–[14]. Researchers initially discussed HC in K-12 educational contexts and noted a connection between schooling and national economic and political issues [21]. Further, researchers noted that the curricula in K-12 educational contexts reproduce capitalist values, such as competition and evaluation, hierarchical divisions of labor, bureaucratic authority, compliance, and fragmented work [22]. Researchers have extended this work to higher education contexts [23], including surgical education [24] and psychology [25].

Status quo in engineering

The status quo in engineering has been built upon the theoretical myth of meritocracy [26], or "a social system that develops based on intelligence testing and educational attainment" [27, p. 385]. Members of a meritocracy—engineering, in this case—may feel that their level of effort or educational attainment affords them power,

status, or wealth [27]. This “rational, technical meritocracy is rewarded above all else” [28, p. 199]. Because the engineering discipline values merit, engineers consider the discipline as value-free [29], as well as colorblind, class-blind, and gender-blind [28]. However, individuals in engineering who do not acknowledge structural social inequalities, such as the historical exclusion of people of color and women from engineering [19], [30], [31], may relate those who do not participate, do not excel, and who need support as failing to exert enough effort to be successful [27]. Thus, it is no surprise that middle-class, heterosexual White able-bodied men [28] largely comprise engineering because they have not been historically excluded from the discipline due to discrimination or financial difficulty.

Prior research has acknowledged that HC socializes students to conform to the status quo [21]. Within this largely middle-class, straight, White, able-bodied, and male discipline, the status quo perpetuates gendered values (HC), such as masculinity, objectivity, and autonomy through messages embedded in institutional and instructional ways [32].

HC in engineering

Individuals process and respond to HC by recognizing it (awareness), processing it (emotions), deciding what they can do about it (self-efficacy), and acting (self-advocacy) [2], [4]–[7], [9], [11], [12]. Previous research characterized individuals’ responses to HC into three categories: 1) minimal/no action, 2) negotiating self, and 3) changing the environment [2]. Individuals who had the greatest self-efficacy changed their environments, such as seeking like-minded individuals for support (i.e., affinity groups) and improving the discipline for others [2]. However, previous research featured individuals who experienced HC and responded to it. This current research thread is focused on individuals who are resistant to self-/advocacy around engineering HC.

Methods

Data collection

The research team utilized responses to the UPHEME (Uncovering Previously Hidden Messages in Engineering) survey, a mixed-methods survey that has been previously validated [12]. The survey contains a video vignette that provides an example of what HC looks like in engineering contexts. The video vignette features actors playing a Latina professor and Latino student who mentioned the contributions of a Puerto Rican civil engineer, Oscar Marty, in their classes during Hispanic Heritage Month. In the video vignette, the professor and student are dismissed by a fellow professor and peers because others felt that the reference to Oscar Marty interrupted an HC in engineering, specifically that the focus in courses should be on technical information (i.e., equations and problem sets). The UPHEME survey contains 43 quantitative items and 7 qualitative items that we used to assess participants’ beliefs about who can become an engineer, their justification for becoming an engineer, as well as their awareness, emotions, self-efficacy, and self-advocacy around HC issue in engineering.

We focused on participants' responses to the self-advocacy qualitative item. For this work, we distributed the survey to 58 universities across the US and Puerto Rico.

Positionality

The authors of this paper are first-generation college graduates. Victoria Sellers is a White cisgender woman and engineering and science education researcher. She is from the rural South, where communication is high-context [33] and, arguably, full of HC. Victoria utilizes her background to "see" the omnipresent yet tacit messages in engineering. R. Jamaal Downey is a cisgender, heterosexual biracial man and a language, literacy, and culture education researcher. Jamaal is a military brat who moved several times, including four different high schools. His biraciality allowed him into and around whiteness while remaining a perpetual outsider. Idalis Villanueva Alarcón is a cisgender, heterosexual Latina woman whose doctoral degree is in chemical and biological engineering. Idalis brings expertise in science and engineering, professional formation, workplace dynamics, and STEM education research. All authors bring different perspectives to this work, which affords them the ability to see trends that might not be obvious to those coming from a STEM background. The authors have transformative worldviews, which "holds that research inquiry needs to be intertwined with politics and a political change agenda to confront social oppression at whatever levels it occurs" [26, p. 9]. The authors acknowledge the potential detrimental effects that oppressive forms of communication can have on the subsequent decisions and actions of marginalized and minoritized students in disciplines like, but not limited to, engineering.

Data analysis

We began analyzing all participants' (N = 984) responses to the open-ended qualitative item in the UPHEME survey that allowed participants to discuss their experiences about self-advocacy around HC issues in engineering:

> Briefly explain how you have advocated for yourself in engineering around an HC. What factors influenced your self-advocacy?

Responses to the self-advocacy item ranged from one sentence to multiple paragraphs in length. The first author initially conducted a first round of descriptive coding on all participants' (N = 984) responses to the self-advocacy item. In this first round of coding, the first author summarized participants' self-advocacy strategies and factors that influenced their self-advocacy, such as a justification for self-advocacy (e.g., wanting to prove others wrong) or who/what helped them self-advocate (e.g., like-minded people in an organization). The first author indicated if participants' responses contained: 1) resistance to self-/advocacy around HC in engineering, 2) racist, sexist, or ableist sentiment, or 3) self-/advocacy that conveyed HC. In an initial discussion between the first and third authors about the analysis of the self-advocacy responses, they agreed that the undercurrent of responses could be valuable to explore further as extreme cases [34] because they seemed substantially different from the other responses. Therefore, the first author extracted the responses (n = 27) and organized

them by similar attitudes and sentiment using a case study-inspired approach [35]. The research question that guides this inquiry is: What are engineering students' conceptions of HC that may hinder or prevent self-/advocacy?

The participants (n = 27) and their demographic information can be reviewed in Table 1. Participants selected for this data subset are mostly men (85%), White (67%), and early in their engineering paths (18-29-years old, 89%). The participants are mostly civil engineering majors (52%) and have one or both parents/guardians who have attended college (67%). Participants are split into traditional (48%) and non-traditional (52%) students. In comparison to national enrollment statistics about the engineering field [16], men (85% vs 76%), White people (67% vs 55%), and civil engineering students (52% vs 8%) are overrepresented in this sample. We note that the first author hid participants' demographics while she performed data analysis.

Table 1: Demographic information of sample of participants (n = 27*).*

Demographic	*n*	% of sample total
Gender		
Men	23	85
Women	3	11
Prefer not to say	1	4
Racial/Ethnic Identity		
Asian	2	7
Asian and White	1	4
Hispanic, Latina/o, Chicana/o	5	19
Other	1	4
White	18	67
Age		
18-29 years of age	24	89
30-39 years of age	3	11
Major		
Civil Engineering	14	52
Mechanical Engineering	6	22
Electrical Engineering	3	11
Computer Engineering	1	4
Hydraulic Engineering	1	4
Manufacturing Engineering	1	4
Electronics Engineering	1	4
First-Generation Student		
Yes	9	33
No	18	67
Non-Traditional Student		
Yes	13	48

Demographic	*n*	% of sample total
No	14	52

Limitations

There are a few limitations with this inquiry. We acknowledge the small number (*n* = 27), as well as the sample method (open-ended response), to utilize as participant data. Specifically, the data may not allow for a "thick description" [36, p. 194] of the participants' conceptions. However, it is possible that this approach captured participants' discriminatory responses that a researcher may not have captured during an interview. We will explore this in future work.

Results

Here, we arranged participants' responses (*n* = 27) according to their conceptualization of HC and their self-/advocacy around HC. We note that only 27 of 984 (~3%) participants had responses that indicated conceptions about engineering that could prevent advocacy around HC in engineering education and industry spaces if perpetuated. Participants' conceptions range from HC is not an issue and there is not a need for self-/advocacy to participants who hold beliefs that HC self-/advocacy endangers the engineering status quo.

Conception 1: HC is not/is no longer an issue, so there is no need for self-advocacy or advocacy.

A few participants (*n* = 2) did not think that HC in engineering is an issue and as a result, did not have to self-advocate for themselves or advocate for others. Participant 323, a White and Asian man who is an undergraduate electrical engineering student, stated: "I never needed to [self-advocate]. Engineering is the least biased profession." This participant indicated that he had never experienced HC that he had to advocate around and assumes that his lack of experience with HC extends to others' experiences in engineering. Current literature states that individuals report HC and experiences with biases in engineering, particularly women with intersectional identities who experience racist and sexist microaggressions [19], [37], [38]. Additionally, this participant revealed an engineering HC that the field is "…just numbers and math." Previous researchers have indicated that "objectivity, math-intensiveness, empiricism/positivism, and reductionism" [39, p. 256] are the basis for engineering rigor and ignore the subjectivity of scientific researchers [39]. Thus, this participant, and others, may fail to acknowledge HC that impacts themselves and others in engineering and as a result, do not see a need to advocate against it.

Another participant (*n* = 1) acknowledged that HC related to racial underrepresentation in engineering is an issue, but this HC does not currently impact them; as a result, they do not advocate. The participant (Participant 373), an Asian man who is a computer engineering undergraduate student, stated: "I go to [University in US Northeast], and [University] is very diversified." Participant 373 also stated that he does not "…have to worry about self-advocacy since over 50 percent of the school is non-White." While the representation of various underrepresented groups is a crucial step

for overcoming HC around race and ethnicity in the US, we note that engineering programs are still majority White (55%) [16]. It is possible that this participant related to racial HC in the video vignette and either did not consider other issues around HC in engineering (affordability, sexism, etc.) or does not experience other HC-related issues. For participants who hold this conception, it may be useful to expand their awareness of different HC issues beyond their salient experiences so they can build empathy for others' experiences and solidarity for self-/advocacy.

Conception 2: Regardless of HC experiences, everyone should be treated equally.

Participants who hold this conception differ from previous participants in that they acknowledge HC issues, yet they discuss advocacy based on equality. A few participants (*n* = 3) acknowledged that regardless of HC-related experiences in engineering, they will advocate for equality. Participant 51, a White man who is a civil engineering undergraduate student, stated that he will "…advocate the equal treatment of all and hiring of those that have the skills–not based upon their sex or race." This participant advocates for competence-based hiring, regardless of a person's gender or racial/ethnic identity. Similarly, Participant 50, a White man who is also a civil engineering undergraduate student, stated, "Because of my religion and how I was raised. . .everyone is equal and deserves to be treated as such." This participant bases his advocacy for equality in his religious beliefs.

Education researchers have distinguished equality, or "treating everyone in the same fashion" [40, p. 460] from equity, which "may require providing special encouragement and support for those who are disadvantaged in the past" [41, p. 266]. Both participants invoke colorblindness, also known as colorblind ideology or colorblind racism, where race is neutralized and the voices of people of color are muted by ignoring negative impacts of racism in their lives [42]. This is consistent with values of colorblind meritocracy [28] that underpin engineering. Yet, these beliefs do not acknowledge historical underrepresentation and differential (i.e., harmful) treatment that has occurred in engineering [19], [30], [31], [43], [44]. Thus, individuals who hold this conception may benefit from discussions or other exposure to historical injustice or exclusion from engineering so they can "see" the HC that is the myth of meritocracy and start to understand why some groups may need more support than others.

Conception 3: HC exists, but the participant self-advocates or advocates by perpetuating HC.

Many participants (*n* = 17) acknowledged that HC is present in engineering, yet they self-advocate or advocate for others by perpetuating HC. Participant 324, who is Latino and an electrical engineering student, stated that he has "…encouraged my lil cousins who are girls to decide on what to study based on what they want or like rather than what seems womanly or otherwise not." This participant advocated for his younger cousins to become engineers; however, the participant described how he benefitted from having women as study partners because he lacked "…organization. and they stabilized that a bit for me." While this participant seemed well-intentioned by

advocating for future representation of women in engineering, he perpetuated a common HC-related issue that women in engineering experience—women are more likely than men to adopt passive, supporting, or secretarial roles due to underrepresentation and experiences with negative stereotypes from men about their capabilities [45], [46]. Further, this participant highlighted women in the group who devoted study time to help him with organizational skills rather than those women focusing their time on honing their own technical understanding and self-efficacy perceptions [45].

Participants who hold this conception also self-/advocate around HC by working harder, which we see as an extension of the engineering meritocracy [47]. Participant 457, a White man and civil engineering student, stated that he advocated for others around HC by sharing "uplifting stories and examples of my experiences when I struggled and what specifically helped me." This participant encouraged others and shared helpful advice. However, this participant also stated that "…everyone needs to do their own work and needs to pay their own way…" because "…it teaches hard work and respect for the things you earn instead of feeling entitled to things that others had to work for on their own." Even though this participant advocated for others by sharing his experiences, he stipulated that individuals should only be entitled to the benefits that they work and pay for. We note that being self-sufficient is a form of individualism, which is an HC in engineering that other researchers associate with masculinity [32]. Also, this participant's perspective assumes that an individual's success in engineering is resultant only from their own hard work and abilities. Yet, this perspective ignores support that individuals received prior to and during their engineering studies, such as advanced or preparatory math courses or financial support.

Both participants illustrated advocacy for others yet included HC messages within their advocacy. Individuals who demonstrate similar conceptions about self-/advocacy could benefit from discussions or curriculum geared toward acknowledging the status quo in engineering and its historical underpinnings while supporting themselves and others to challenge the status quo.

Conception 4: Advocacy against HC is unfair.

A few participants (*n* = 7) hold a conception that discussion of HC and HC-related advocacy, such as advocacy against sexism and racism, endanger the current status quo of meritocracy in engineering. Participants who hold this conception also have other conceptions that are resistant to advocacy around HC. We have explored these participants' UPHEME qualitative survey responses more deeply in a parallel paper [3], including their awareness, emotion, and self-efficacy responses. For example, Participant 20 is a graduate manufacturing engineering student who indicated that their racial/ethnic identity originated from an imaginary nation, stated:

> The number 1 reason women don't go into engineering is that they choose to do something else, and there is nothing wrong with that. Most of my classmates have been non-white, there is no systematic discrimination to

> keep POC out of engineering. Most of my professors I've had in engineering were Asians, often from foreign countries. These were people whose background and culture were less relatable to mine. . .So stop with the thought policing.

This participant seemed in conflict with the ideas that were presented during the vignette-based HC survey and expressed frustration. He thinks that women do not go into engineering only because they choose not to, which is related to the first conception that systemic discrimination (a form of HC) is not an issue, yet the experiences and statistics of marginalized individuals in engineering argue otherwise. The participant does not account for gender stereotypes and influences that impact women's choices to go into engineering, such as the influence of family, peer groups, and societal/cultural gender stereotypes on the attraction of adolescent boys to STEM-related subjects and emphasis on their performance [48]. The participant also does not acknowledge the negative treatment of people who are not the majority group in engineering, such as the oft-cited "chilly climate" [49, p. 5], underrepresentation [50], and microaggressions [19], [37].

Similarly, Participant 449, a White man who is a civil engineering undergraduate student, also combines multiple conceptions about HC and HC advocacy in engineering:

> I[*sic*] when I sit in a building or cross a bridge, I frankly do not care what color your skin is or what is between your legs, I care that the structure is safe and well designed. I don't like that it is harder for minorities to succeed, but I also don't like being told it is my fault and that I need to give them an advantage over myself. I've spent time in diverse areas, and these things aren't a big deal, but come to [State in US Southwest] and everyone is worried about who is a minority and how to help them instead of helping everyone equally. Female only engineering scholarships are big example. That should not exist. The person who deserves that money should be smart or in need, not have a vagina. If you want to be treated as equal, don't make special bonuses based on the very boundaries you are trying to demolish.

This participant acknowledged that HC does exist for people who are minoritized in engineering but echoes Conception 1 and purported that HC in his environment is not a concern. Further, the participant echoes Conception 2 with an emphasis on equality and thinks that advocacy efforts to combat HC should not focus on one group (women or "minorities," specifically) or "give them an advantage over" himself but should help everyone equally. He repeats this sentiment with disdain for women-only scholarships. This participant juxtaposes individuals "who are smart or in need" against women, as though women are not intelligent or do not need financial assistance. We note if this participant did support efforts to help everyone in engineering, then women and other marginalized individuals would receive support anyway.

These participant excerpts display their frustration at advocacy efforts that raise awareness of HC in engineering, such as in the vignette survey. Specifically, these participants seemed angry that marginalized individuals (e.g., “POC”, “women”, people with “vaginas”) received more recognition, attention, or support than individuals from their own gender and racial/ethnic identities. Individuals who demonstrate similar conceptions may benefit from discussions about how to dismantle the myth of meritocracy in engineering, including awareness of others’ historical and current HC-related issues, as well as how they are harmed by the perceived mandatory fairness in the field.

Discussion

We found that individuals have four conceptions about self-/advocacy around HC in engineering. Individually, participants’ conceptions may seem benign because they do not see HC as an issue; they use equality or involve the engineering status quo to advocate. However, there are a group of participants who have multiple conceptions and illustrate how a lack of critical awareness of HC and an emphasis on equality or choice to advocate with the status quo can lead an individual to not advocate for themself or others. Participants who hold Conception 4 also demonstrate how seemingly benign assumptions can lead to further HC in engineering.

With each of the conceptions, we recommended broad measures that may benefit individuals, such as raising awareness and empathy for others’ historical and current HC experiences, learning how the engineering status quo affects and is harming them, and how they can work with others to build solidarity to change the engineering status quo. While we do not have any specific recommendations for what this looks like, whether in professional development sessions, lectures, or in-class activities, we do feel this undercurrent of opinion in engineering could keep individuals from advocating for themselves and others.

Implications

We highlighted conceptions that individuals have about advocacy around HC in engineering. Because the survey item did not specifically ask individuals why they chose not to self-advocate or advocate for others, it is possible that there are more individuals who hold these conceptions about advocacy around HC. Thus, a future research consideration for this research group and other engineering education researchers is to ask individuals explicitly about their resistance to advocacy in engineering. In turn, this work could lead to more specific recommendations for programming (e.g., professional development sessions) for administrators, faculty, and students on how to become aware of how historical injustice has influenced HC in engineering, as well as how to advocate against HC.

Conclusion

This research utilized a subset of individuals’ responses to a qualitative item of a larger mixed-methods survey to highlight 4 conceptions of HC advocacy that lead to a

lack of advocacy, advocacy that perpetuates the status quo, or an unwillingness to advocate because it is seen as harmful to the perceived meritocracy in engineering. While a limited inquiry, we hope other researchers explore undercurrents in their work that impinge on self-/advocacy in engineering.

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