18

Transforming Engineering Education Through Social Capital in Response to Hidden Curriculum

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1 Introduction

We present this research-to-practice chapter for prospective and current engineering educators and scholars interested in learning about how individuals navigate hidden curriculum in engineering education by utilizing social capital. *Hidden curriculum* (HC) represents the unacknowledged and oftentimes "hidden" lessons or messages in a working or learning environment that hinder marginalized groups from navigating their environments successfully. HC propagates structurally (i.e., manifestation of systems of racial or other forms of bias across institutions and society; National Museum of African American History and Culture, 2021) through social networks and interactions where norms, values, and beliefs of a context are transferred to the learner. What an individual learns about their surrounding environment, in turn, influences how they respond to, react to, and act upon HC they experience. While not all HC is negative (Villanueva, Gelles, Di Stefano, et al., 2018), a failure to address the potential negative outcomes can lead to unintended consequences (e.g., attrition) in engineering.

1.1 What Is HC, Where Did It Come From, and How Have Researchers Described It?

Hidden curriculum (HC), a term originally coined by Philip Jackson in his book *Life in Classrooms* (1968), consisted of the behaviors that children learned in schools, such as learning manners, making an effort, and being punctual. These behaviors provide "a distinctive flavor of classroom life . . . which each student must master" to make their way "satisfactorily through the school" (p. 33–34). As Jackson (1968) stated, HC is formed through an "apparent shaping power of forces that had little or nothing to do with standard explanations of what goes on inside schools" (p. xv). Around the same time, Robert Dreeben (1968) examined the norms of school culture and concluded that students were taught to bury much of their personal identity in schools and accept their categorical treatments. While researchers did not fully understand the tenets of HC at that time, the work of these early scholars provided the foundation for understanding how systems and structures in schools derive from societal norms to train their students (Higham, 1959).

Over time, other theorists, such as Henry Giroux and Anthony Penna (1979), Michael Apple (1980), and Eric Margolis (2001), advanced the definition of HC to include what happens outside

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the formal curriculum of school and higher education. These norms, values, and belief systems percolate not only in the formal curriculum but also through life in ways that guide and inform the student daily. The constant reproduction of HC, in turn, creates ways for people to hold on to power and reinforce their control over others (e.g., the ruling class over the working class). For a deeper explanation of the evolution of HC theories, refer to Kentli (2009).

Previous researchers have studied HC in undergraduate and graduate education (e.g., Smith, 2013; Lyles et al., 2022). Also, HC has garnered interest in disciplines, such as nursing, science, informational technology, medicine, and engineering (e.g., Allan et al., 2011; Abramovich & Bower, 2004; Bejerano & Bartosh, 2015; Hansson, 2018; Hafferty & Franks, 1994; Sellers & Villanueva Alarcón, 2021a; Villanueva et al., 2020), all of which provide a service to society. Educators and other professionals in these fields view HC as a mechanism to help create consciousness in the treatment of others (e.g., medical doctors with their patients) and their service-to-society roles through curriculum interventions.

We want to clarify the grammar and language we use to describe HC. We are aware of the discussion of using hidden "curriculum" versus "curricula"; however, we use "curriculum" throughout this chapter to encompass the multiple invisible norms, values, and beliefs that exist across educational and professional systems and structures. This is in alignment with HC scholarship, where researchers use both "hidden curriculum" and "*the* hidden curriculum" to describe the concept. Furthermore, although it is called *hidden* curriculum, individuals may be well aware of norms, values, and beliefs, yet individuals may not acknowledge or examine them. Norms, values, and beliefs become "hidden" when individuals uncritically accept or address them, which contributes to the unconscious and normalized part of educational systems and professionalization processes.

We note that HC is not always negative. Individuals process HC in many ways that are uniquely contextual and situational, which is contingent on the way that structures and systems communicate HC to individuals. For example, instructors in medicine use HC to teach students how to identify biases and potential inequity in their patient treatment (Hafferty & Franks, 1994). Nursing instructors use HC to debunk negative connotations and beliefs about the discipline and promote practices of care and empathy (Allan et al., 2011). Instructors can use HC as a counternarrative for positive educational and workforce change if deployed appropriately.

We, as researchers and educators, came together because of our shared interest and passion for deconstructing HC in higher education institutions and normative disciplines like engineering. We use our common goals and enthusiasm to provide an overview of HC, present findings from HC research, describe a practical example of a program designed to deconstruct HC, and give readers recommended actions. We framed this chapter as a research-to-practice because HC should not just stay in the "hows" and "whys" but rather should be used to enact action and justice (Martin, 1976). We are all passionate about this work, and we are confident that acknowledging and addressing HC in engineering will lead to transformative educational change.

1.2 Hidden Curriculum in Engineering

In engineering, the exploration of HC is still in its infancy. Tonso (2001) first discussed HC-related topics in US engineering education when she introduced the concept of "gender curriculum"; she used this term to describe implicit messaging present among women engineering undergraduate students as they described the disparities they experienced in their classroom activities (e.g., design projects). Erickson (2007) formally introduced the term "hidden curriculum" when she published a dissertation on the experience of women doctoral students in engineering and how they tied their sense of belonging to the implicit messages they received from others in their research environments.

To our understanding, the earliest known international research around HC in engineering was conducted by Tormey and colleagues (2015). These researchers compared the formal and hidden

curriculum of ethics in engineering education to explore how "students learn implicitly through the social and organizational nature of their studies" (Tormey et al., 2015, p. 2). These authors showed that in engineering courses in Switzerland, students showed a bias towards higher levels of moral reasoning in their judgment of ethical dilemmas. Bejerano and Bartosh (2015) conducted a study with engineering students in New Zealand and found four gendered themes included in syllabi that reflect salient engineering values: women as incompetent, women as helpers, autonomy and separation, and masculine thinking. Rottmann and Reeve (2020) used an HC lens to address issues when case studies derailed in Canadian engineering courses designed to address ethics equity; they found that adding more critical analysis into case study learning and respectful dialogues instead of rational argumentation was important in avoiding pitfalls to moral relativism. Pehlivanli-Kadayifci (2019) explored HC among Turkish engineering faculty and found that jokes and other institutional structures ignore the presence of women and mock their contributions in engineering, posing several disadvantages to their representation. Thus, international HC research includes engineering ethics, as well as gender issues.

In the United States, Villanueva Alarcón[1] developed a structural framework and pathways model that allows researchers to investigate HC issues in engineering (NSF Award Nos. 1653140 and 2123016). Structural frameworks, in sociology, describe how groups or institutions have moving parts that are integrated in cohesive ways and are a function of common norms, customs, traditions, and cultures to promote solidarity and stability of a system (Parsons, 1977; Turner, 1985; Urry, 2012). Analogously, Villanueva (2017) suggested that individuals process HC by four factors that situate how they receive and respond to HC. Villanueva, Carothers, et al., 2018; Villanueva et al., 2020) developed and validated an instrument to identify the four factors: HC awareness (factor 1), emotions (factor 2), self-efficacy (factor 3), and self-/advocacy (factor 4). Villanueva and colleagues disseminated the validated UPHEME (Upending Previously Hidden Engineering Messages for Empowerment) survey to 58 colleges of engineering in the United States and Puerto Rico to 984 engineering faculty members and students between 2018 and 2019; an additional 120 individuals participated in follow-up research activities between 2020 and 2021. While analysis is still underway, Sellers and Villanueva Alarcón (2021a) performed a sub-analysis among 333 Black, Indigenous, and people of color of all intersecting identities (BIPOCx) in engineering who responded to UPHEME. They found that individuals cope with HC by changing their environment, negotiating their identities, or avoiding HC altogether. They also found that individuals with intersectional, marginalized racial, and gender identities avoided HC more than those in majority groups, yet majority groups in engineering (e.g., White) traded their personal identities the most in exchange for an engineering identity.

Other researchers have propagated the research from Villanueva (2017) and colleagues (Gelles et al., 2019; Gelles et al., 2020; Villanueva, Campbell, et al., 2018; Villanueva, Carothers et al., 2018; Villanueva, Gelles et al., 2018; Villanueva, Gelles, Di Stefano et al., 2018; Villanueva et al., 2019, 2020; Villanueva Alarcón & Sellers, 2022) in the United States and among international engineering education research and practice circles (Paul, Adeyinka, et al., 2021; Paul, Behjat, et al., 2021; Polmear et al., 2019, 2022; Rea et al., 2021; Villanueva, Campbell et al., 2018; Villanueva, Carothers et al., 2018; Villanueva, Gelles et al., 2018; Villanueva, Gelles, Di Stefano et al., 2018; Villanueva et al., 2019, 2020; Villanueva Alarcón & Sellers, 2022). In the United States, Polmear and others (2022) used Villanueva's HC model to uncover unexamined assumptions about leadership in engineering. They found that students conceptualize leadership in three ways, including whether individuals can develop leadership, how they practice it, and how they define it through their traits and behaviors. In Canada, Paul, Adeyinka, et al. (2021) and Paul, Behjat, et al. (2021) have used Villanueva et al.'s HC model (2020) to conceptualize ways to model situational HC. Paul, Behjat, et al. (2021) have also proposed an individual-based model to study Canadian engineering education programs, specifically those designed to tackle a given HC and encourage a sense of belonging and

mindfulness in their students. Paul, Adeyinka, and others' (2021) and Paul et al. (2020) curriculum design, framed as a case study later in the chapter, recognizes that other researchers should study HC in engineering in ways that uncover impact on "specific demographics, rather than only having data about the population-level changes" (Paul, Behjat et al., 2021, p. 2).

These studies point to the pervasiveness of HC in engineering education internationally and in the United States. Also, these studies indicate how structures, embedded in fields like engineering, can cross boundaries, culture, language, systems of education, employment, and gatekeepers. It also alludes to the potential dangers that individuals can experience from HC, if not designed and delivered for the benefit of all. Since HC, according to Villanueva (2017) and others (Villanueva, Gelles, Di Stefano et al., 2018; Villanueva et al., 2019, 2020), is conceptualized as a structural framework that affects individuals differently, let us explore in more detail the factors that influence an individual's experience. Let us also explore how individuals cope with HC in various ways in engineering.

1.3 A Pathways Model to Explore Hidden Curriculum in Engineering

Villanueva and colleagues (NSF Award Numbers. 1653140 and 2123016) conceptualized HC as a structural framework that included several interconnected pathways via a validated instrument UPHEME. The instrument contains a four-factor model (Villanueva, Campbell et al., 2018; Villanueva et al., 2020) composed of HC awareness (factor 1), emotions (factor 2), self-efficacy (factor 3), and self-/advocacy (factor 4). Villanueva and colleagues found these factors to be main contributors to how individuals received, reacted to, and responded to HC (Villanueva et al., 2020). Villanueva and others note that there may be other, unexplored factors as well. A brief summary of these factors is provided in what follows, although the readers are encouraged to read Villanueva et al. (2020) for more details.

Factor 1: hidden curriculum awareness. Awareness is an important subcomponent of consciousness that helps individuals recognize and discern what and how information is being communicated. "Regardless of the level of awareness a person may have about an [HC] issue, these can't be brought up to full consciousness unless they are internalized first" (Villanueva et al., 2020, p. 1551).

Factor 2: emotions connected to hidden curriculum. In the context of HC, emotions signal to a person how external expressions, glances, gestures, and other behaviors connect to motivational outcomes (e.g., sense of belonging). These emotions assist individuals to focus on what factors are important when making decisions, learning, or socializing (Pekrun & Linnenbrink-Garcia, 2014). Individuals manifest emotions as: (a) valence (positive or negative emotions) or (b) activation level (focused or unfocused energy). When emotions are positively activated (e.g., enjoyment), individuals may experience an increase in "reflective processes, whereas negatively activated emotions (e.g., anger) may result in low levels of cognitive processing" (Villanueva et al., 2020, p. 1551). Readers can further explore the connection between emotions and engineering education in a chapter in this handbook, "Emotions in Engineering Education," by Lönngren and others (2023).

Factor 3: self-efficacy connected to hidden curriculum. An individual's emotions cannot lead to a decision or action unless they believe that they have an ability to cope with challenging scenarios, which is coping self-efficacy (Bandura, 1986). In the context of HC, individuals with higher self-efficacy can take actions like changing their environment, whereas lower self-efficacy leads to individuals avoiding HC (Sellers & Villanueva Alarcón, 2021a). At the same time, an individual's higher self-efficacy may not necessarily relate to greater awareness of HC unless someone has helped a person to "see the HC" around them (Villanueva, Gelles, Di Stefano, et al., 2018).

Factor 4: self- and other forms of advocacy in hidden curriculum. An individual may choose to self-advocate to cope with HC based on their level of self-efficacy. Those with higher self-efficacy are

more likely to self-advocate by changing the environment around them; individuals with moderate self-efficacy will change themselves or their mindsets, and those with low self-efficacy will take no or minimal action (Sellers & Villanueva Alarcón, 2021a). Of course, individuals' levels of self-efficacy may be a response to the systems of power around them (Sellers & Villanueva Alarcón, 2021a).

To date, researchers have only presented the pathway model of HC on an individual level, with an ultimate goal of self-/advocacy, which serves as an "indication of a person's willingness to take action and speak up about a matter to improve their quality of life" and for others (Villanueva et al., 2020, p. 1553). Because HC is a structural framework, advocacy is not just an individual action but is also collective action, systemic action, or structural action. Villanueva's research group is currently exploring this thread. In this chapter, we build upon prior work from Villanueva, Campbell, et al. (2018), Villanueva, Carothers, et al. (2018), Villanueva, Gelles, Di Stefano, et al. (2018), Villanueva, Gelles, Youmans, et al. (2018), Villanueva et al. (2019, 2020) to present how social stakeholders in engineering (e.g., students, faculty members), either individually or collectively, acquired and acted upon HC.

1.4 The Relationship between Social Capital and Hidden Curriculum

Social capital allows individuals to unveil HC. Social capital includes information-sharing that holds groups of individuals and their sense of belonging together in relationships, networks, and competencies (Pooley et al., 2005). For this and other research, we use Pierre Bourdieu's (1986) conceptual framework of social capital. Bourdieu defines *social capital* as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (p. 248).

Bourdieu acknowledges the valuable social resources and benefits individuals and families acquire through social relationships and networks. Social capital provides access to institutional cultural capital, which is the knowledge that individuals use to decode, interpret, and navigate the culture of a given environment (Smith, 2013). Individuals acquire institutional cultural capital by building relationships with people (social capital) who have insider knowledge about how institutions function and what knowledge is valued. Thus, individuals need institutional cultural capital to decode, interpret, and understand HC (Smith, 2013).

It is also important to understand how social capital relates to one's sense of belonging. *Sense of belonging* refers to a feeling of connectedness to others (Rosenberg & McCullough, 1981). A sense of belonging takes on heightened significance in environments that individuals experience as different, unfamiliar, or foreign, as well as in contexts where individuals feel marginalized, unsupported, or unwelcomed (Freeman et al., 2007). Previous researchers have linked a strong sense of belonging to persistence (Soria & Stebleton, 2013). Sense of belonging has been found to both conceptually and statistically act as an indicator for social capital (Ahn & Davis, 2020). Both concepts are rooted in developing relationships through social networks and participation in social activities (Ahn & Davis, 2020).

Individuals develop relationships with weak or strong ties. Individuals use weak ties to cross a societal divide, such as class or race, allowing for information exchange, ideas, and innovation (Claridge, 2018). Individuals form strong ties within a group or community and are a source of social support (Claridge, 2018). Thus, engineering stakeholders (e.g., students and faculty members) build their sense of belonging by developing social capital via strong and weak ties. Social capital leads to institutional cultural capital, which helps individuals unveil HC. In the next section, we detail how engineering stakeholders use social capital to navigate HC, where HC is a barrier between social capital and institutional cultural capital in engineering.

2 How Engineering Stakeholders Use Social Capital to Navigate Hidden Curriculum in Engineering: A Study of the United States Context

Villanueva and others (2020) administered the UPHEME instrument to engineering students and faculty members across 58 colleges of engineering across the United States. Participants answered questions related to the four-factor model conceived by the research team. The instrument had both qualitative and quantitative questions. Out of 984 respondents, approximately a third (333) responded to all items of the UPHEME survey. Individuals identified as Black, Indigenous, people of color of all intersecting identities (BIPOCx), although some identified as White or of Eurocentric roots. We will only discuss the qualitative responses in this chapter, and we utilized an *expo facto* and inductive coding of participants' responses for this chapter.

In response to qualitative questions of UPHEME, individuals described an example of an HC message they experienced in engineering and strategies they used to navigate it. We found four prevalent HC messages in engineering: (1) engineering is difficult, (2) engineering is inflexible, (3) people feel underrepresented or undervalued in engineering, and (4) people feel supported in engineering. We also found that individuals utilized three categories of strategies to navigate HC messages, such as changing the environment, negotiating themselves, or avoiding the issue. We recommend that readers review Sellers and Villanueva Alarcón (2021a) for more details about the strategies.

From the 333 respondents, we noted that a sixth of the respondents (43 undergraduate and graduate students) explicitly acquired social capital to navigate HC; these participants also related social capital to a greater sense of belonging in engineering.

We categorized participants' responses of how they changed their engineering education environments using their social capital through relationships and associated resources with others. From the analysis, we identified three descriptions of individuals who utilized social capital to navigate HC: (a) seekers, collectors of social capital; (b) bridgers, sharers of social capital; and (c) agents, brokers of social capital. We present a detailed description of the findings and archetype character traits in the following sections.

2.1 Seekers: The Collectors of Social Capital

Seekers of social capital (n = 24, 56% of total participants) looked for support from others to navigate structural or situational HC in engineering. Of all seekers, the majority were self-reported men (n = 15, 63% of seekers), were White, or had an ethnicity that is Eurocentric (n = 19, 79% of seekers). Approximately 67% of participants self-reported as continuing-generation (parent or guardian completed some college) students (n = 16, 67% of seekers) and had a traditional, uninterrupted K–16 educational pathway (n = 18, 75% of seekers).

Most seekers (n = 18, 75% of seekers) experienced HC messaging that engineering is difficult but felt they could not express to others that they were struggling amid this difficulty. Others indicated that engineering was inflexible to them (n = 6, 25% of seekers), but felt that they could not communicate to others the nature of such an HC.

In terms of the strategies used, seekers indicated that they quickly became friends with others who knew how to build technical skills to successfully navigate their education, which increased their sense of belonging in engineering. For example, a Latino mechanical engineering graduate student stated that he had a "poor work ethic" and was "not performing well" in engineering classes when he started in engineering; this message that engineering is difficult prompted the student to see himself as having a deficiency that he needed to fix. The student opted to make "friends in the

engineering department" to boost his skills, demonstrate his work ethic, and feel welcomed by his peers. Thus, this individual developed social capital in the form of weak ties with others who held institutional cultural capital needed to help him navigate and persist in the engineering program.

Seekers also used strategies to pursue help from other social stakeholders they perceived to have more power than them. These social stakeholders were advisers, professors, or mentors. For example, a White man and civil engineering undergraduate student similarly described difficulty with his engineering homework, but he strategized by "working with other students on the homework, as well as even going to [the] TA and professor [*sic*] office hours for help." This participant sought social capital through weak ties to elevate his technical skills and connect to the holders of knowledge and power over his performance. By choosing people who held more power than his peers, this individual understood that both skill-building and acquiring institutional cultural capital are important for his success and persistence in engineering.

Seekers become aware of HC in their surrounding systems and structures and use social capital as one way to navigate it. Seekers build social capital to identify the deficits they need to address and collect information to succeed and belong in engineering. Seekers quickly realize that institutional cultural capital is powerful and that the more social capital they develop to access institutional cultural capital, the more power they will have. You can visualize this in Figure 18.1, where seekers accept more social capital from others than they return. In socialized settings, seekers pair up with holders of knowledge (e.g., peers from majority groups, administrators, advisers, mentors) to learn about the intricacies of an unknown environment or setting and then use that knowledge for personal advantage. Seekers can hold different roles in engineering (e.g., students), and their goal is to understand the environment and the institutional capital around them.

While seekers' ultimate outcome is to persist and succeed in engineering, they do not often question or even recognize that HC guides their actions. By not questioning HC and improving their abilities, skills, and competencies, seekers may inadvertently perpetuate an ongoing cycle of meritocratic values, beliefs, or ideals in engineering. While seekers may indeed achieve professional success, their embodiment of the norms of engineering may result in severe consequences to their mental and emotional well-being that they may not address.

2.2 Bridgers: The Sharers of Social Capital

Whereas seekers build social connections to improve their skills or abilities to navigate HC in engineering, **bridgers** of social capital (n = 14, 33% of total participants) looked for current support from like-minded individuals to cope with HC directed at them and their personal identities. Most bridgers felt marginalized in engineering or that others undervalued them (n = 12, 85% of bridgers). A few bridgers experienced HC that engineering is difficult (n = 1, 7% of bridgers) or HC that engineering was inflexible (n = 1, 7% of bridgers). Most bridgers self-reported as women (n = 11, 79% of bridgers) and were from marginalized ethnic/racial groups (n = 8, 57% of bridgers). Most of these bridgers were continuing-generation students (n = 11, 79% of bridgers), and most pursued a traditional, uninterrupted K–16 educational pathway (n = 13, 93% of bridgers).

A strategy shared by bridgers, in addition to seekers, was that they found support with peers. However, a key difference was that bridgers found kindred peers who experienced similar situational HC to create stronger relationship ties (i.e., stronger social capital). Bridgers sought like-minded individuals to support each other as a community academically and interpersonally. For example, a Latino and chemical engineering undergraduate student described difficulty adapting to his "college setting and to navigate the language barrier" because he is an international student. He navigated his sense of "onlyness" by finding "faculty members that are not only international but also Hispanic." Thus, this individual surrounded himself with others who could understand his experiences and help him build social capital in engineering and develop strong ties. The social capital acquired by

this participant also strengthened his sense of belonging with faculty members in his engineering program to survive this stage of his engineering education.

A White woman and environmental engineering undergraduate student discussed how she was marginalized because there was a "large population of males" in her classes. However, she coped with this HC by surrounding herself with "peers who don't believe in the stereotypes perpetuated by HC" so they "can all work together to better ourselves and our grades." This participant described bonding with peers where gender-based HC was not a decisive factor, and was able to work with her peers, as opposed to competing against them, to improve her grades. Thus, this participant and her peers collectively built stronger social capital through strengthened relationship ties to increase their access to institutional cultural capital and override gender-biased HC.

While bridgers may not necessarily coalesce to change their environments structurally, their focus is survival and equipping others to do the same. Bridgers understand that addressing their mental well-being is important, and they find support by being a member of a community. Bridgers tend to share social capital with others as much as they receive it in the form of social support, as depicted in Figure 18.1.

2.3 Agents: The Brokers of Social Capital

Agents of social capital (n = 5, 12% of total participants) aimed to change engineering education for future generations, particularly for members of marginalized groups. Most agents self-identified as women (n = 4, 80% of agents), were from majority ethnic/racial groups in engineering (n = 4, 80% of agents), were continuing-generation (n = 5, 100% of agents), and had traditional and uninterrupted K–16 educational pathways (n = 5, 100% of agents).

Agents acted as representatives or spokespersons of a marginalized group. A Black man and electrical engineering undergraduate student navigated HC of underrepresentation of Black people in engineering curriculum by relating "construct concepts of an African American famous engineer" even though his professor "kept stating that what I was talking about . . . was not a direct representation of what we were talking about [in class]." The participant "tried to introduce it more" to his teacher, and the participant "was able to teach the class" and his instructor concepts from the famous African American engineer, of which they were previously unaware. The participant navigated the HC so that he could become a source of social capital to others and they could be aware of African American contributions to engineering that were not previously in the formal course curriculum.

Among the strategies used by agents, they also want to be role models for others. They provided a voice for others and were not afraid to communicate concerns to other important social stakeholders (e.g., instructors). For example, a White woman and material engineering undergraduate student described how men in her program did not believe women should be engineers, but she noted that she wanted to continue in engineering because "if [she] stick[s] with it and help[s] make a difference in the field, more young women will be able to enter the field without fear." The participant noted that she intentionally persists in engineering so that she can make it better for future classes of women. The participant described being an agent of future social capital for other women, which inadvertently increased her own self-efficacy to become an engineer, with the altruistic goal to provide future women engineers with the hope that they can also persist.

Agents of HC enact strategies and practices that challenge their surrounding systems and structures. They take acquired institutional cultural capital and use it to raise awareness for others in the future, which bridgers do not consider. Individuals can experience agents' actions vicariously, such as seeing agents speak up for themselves and others and raising awareness of issues that others do not see (Sellers & Villanueva Alarcón, 2021a). Agents' sense of self, their personal and professional identities, and their sense of belonging with others in engineering (and not the profession) are strong. As such, agents are willing to suffer the consequences of their advocacy to disrupt the status quo, even

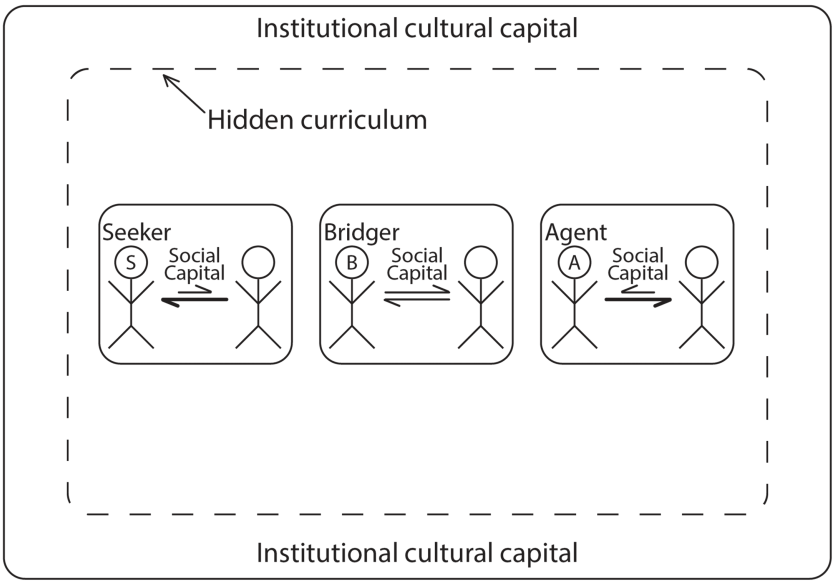

Figure 18.1 Conceptualization of social capital (SC) between seekers, bridgers, and agents, with arrows that indicate the amount and direction of social capital exchanged. Seekers receive more social capital than they lend to others, bridgers exchange social capital equitably with others, and agents lend more social capital than they receive. Individuals aim to build social capital to uncover HC, strengthen their social ties and networks to gain institutional capital, cultural capital, and/or a sense of belonging.

if it affects their own belonging to a non-supportive community or profession (strong social capital is independent of strength of relationship ties). Thus, agents tend to share more social capital with others than they receive, as depicted in Figure 18.1.

Therefore, we find that in traditional engineering programs in the United States, individuals build social capital to uncover HC, strengthen their social ties and networks to gain institutional cultural capital and/or a sense of belonging. In Figure 18.1, we conceptualize the role that seekers, bridgers, and agents must acquire social capital and navigate HC. While seekers navigate HC to persist and understand their learning and working environments, they internalize and perpetuate the status quo of norms and values in engineering. By forming relationships that share and give social capital and improve access to institutional cultural capital, bridgers and agents are less likely to recreate cultures of exclusion and marginalization in engineering.

With these findings, a question the reader may be wondering is: "How can engineering education intentionally equip individuals to navigate HC they may experience?" Let us explore a case study at the University of Calgary where engineering educators and researchers have created an intentional, formal curriculum to debunk the myth of rational-emotional dualism in engineering (i.e., engineering is rational and emotionless; Lönngren et al., 2021, 2023; Kellam et al., 2018) and promote a sense of belonging in students.

3 University of Calgary: An Engineering Program That Intentionally Aims to Tackle Hidden Curriculum Being Directed to Its Students

In engineering, using HC for positive educational change by bringing awareness to hidden messaging is just starting (e.g., Paul et al., 2021a, 2021b). In this section, we present a case study of a

novel engineering program at the Schulich School of Engineering at the University of Calgary. The Engineering Attributes (EA) program aims to develop mental wellness as well as promote a sense of belonging, lifelong learning, and effective learning strategies through weekly modules across all first-year engineering courses (Paul et al., 2021a, 2021b). Leaders developed the program in 2019 to train first-year undergraduate engineering students to navigate their degree while debunking the myth of rational-emotional dualism (Lönngren et al., 2021; Kellam et al., 2018). The leaders of this program were aware of the pervasive HC of an engineering culture based on pure rationality without emotions (e.g., Huff et al., 2016; Husman et al., 2015; Lönngren et al., 2021; Kellam et al., 2018; Secules et al., 2021; Villanueva, Carothers et al., 2018; Villanueva et al., 2020). They wanted students to understand that engineers have emotions, and emotions are inextricably linked to cognition. Thus, there is a benefit of bringing emotions into the forefront of awareness instead of hiding them (e.g., Husman et al., 2015; Lönngren et al., 2021; Villanueva, Carothers et al., 2018; Villanueva et al., 2020). To do so, leaders created a curriculum based on theories of mindfulness, mental wellness, and learning strategies (Paul et al., 2021a, 2021b). Leaders present the modules in weekly short (10–15 minute) presentations across the first-year engineering curriculum. There are typically 12–15 modules; leaders deliver these modules across four or five of the core first-year engineering courses during the academic year. Leaders intentionally designed the modules to be regular, short tidbits of information so that they expose students to activities and strategies they need to mitigate and bring awareness to negative, pervasive HC messaging in engineering.

Within the EA program, the goal of the weekly modules is to remind students that they are human and to dismantle some of the dualisms and HC that exist in engineering (Paul et al., 2021a, 2021b). Colloquially, the program leaders call the program the *Engineers Have Feelings* project, as they encourage students, through reflective activities, to bring their emotional awareness to their engineering academics. Leaders remind students that they are more than just logical problem solvers, encourage students to bring emotional awareness to their critical thinking (Kellam et al., 2018), and to build community with their peers to support social capital building (Pooley et al., 2005). For each module, first-year engineering undergraduate students submit qualitative reflection responses on the weekly topic (see Table 18.1 for overview of topics). Leaders grade these responses for completion, and the responses count for a small percentage of the final grade for each first-year course, at the discretion of the instructor. The program leaders inform the students that they will only be checking a small set of responses each week. The program's emphasis is to support students to understand the importance of reflection for themselves, more than focusing on the grading of the reflections. Program leaders provide brief summaries of the previous week's reflection responses to encourage thoughtful responses and to help students know they are not alone in their feelings. In open-ended student feedback about the program, students often speak positively of the reflections' importance. For example, one student indicated:

> The most helpful part [of the EA program] has been the [reflection] quizzes because they allow me to reflect on myself, my habits, and my thinking. They help me realize that I have been in these situations and through the quizzes, I start to think about strategies to deal with these situations.

We summarize an outline of the main objectives of the curriculum and course sequence in Table 18.1, where we also provide examples of how the curriculum design parallels the four factors of HC pathways. Lastly, we provide specific tips on attending to each of the archetypes with examples and more details on the module content and examples of reflection questions.

Within HC pathways, there were several character traits that the EA curriculum addressed. For example, the four factors found by Villanueva et al. (2020) are integrated into the curriculum regularly. The first factor, HC awareness, is an important step to recognize what systems or individuals

Table 18.1 Overview of the Engineering Attributes Curriculum, University of Calgary, Schulich School of Engineering, 2020–2021

Term 1 – Fall 2020		*Term 2 – Winter 2021*	
Week	*Module*	*Week*	*Module*
1	Mental Health Continuum	2	Mental Health Continuum
1	Motivation	2	Emotions and Hidden Curriculum
2	Teamwork and Diversity	3	Teamwork and Diversity
4	Time Management	5	Finance
6	Academic Burnout	8	Exam Anxiety
7	Exam Anxiety	8	Academic Burnout
8	Metacognition	8	Errorful Learning
11	Resiliency	10	Resiliency
12	Final Portfolio	11	Motivation
		13	Final Portfolio

Source: Adapted from Paul, Adeyinka et al. (2021).

communicate and discerning unconscious misrepresentations in learning environments (Villanueva et al., 2020). Within the EA program, leaders equip students to navigate the engineering norms and become aware of unconscious beliefs that they might hold. For example, some students believe that engineering is difficult and that engineering programs fail a certain percentage of students. In the *Academic Burnout* module, instructors raise awareness of the challenge of an engineering education by helping students self-assess their emotional patterns; they help students understand that it is abnormal to feel continuously exhausted, have high anxiety, or lack motivation towards school. The instructors use these self-assessment talking points to provide students with tips for recovery, ways to seek help, and how to access support via campus resources.

The second factor, emotions, is important because emotions are required to process the HC that individuals are aware of (Villanueva et al., 2020). Program leaders designed the EA program around the mental wellness wheel (see Figure 18.2), which they adapted from Hettler (1976). Regularly during the program, instructors conduct check-ins on students' emotional well-being. Program leaders also introduce students to a full module on *Emotions and Hidden Curriculum*, where instructors talk about how the brain is interconnected with emotional processing and working memory and how integral emotions are to learning (e.g., Tyng et al., 2017), as well as the emotions that they experience (Gelles et al., 2020).

The third factor, self-efficacy, allows individuals to believe they can improve their environment (Sellers & Villanueva Alarcón, 2021a; Villanueva et al., 2020). One of the most popular EA modules, *Resiliency*, gives students the tools to change how they think. In this module, instructors summarize cognitive distortions and give students tools to manage these intrusive thoughts using the *catch it, challenge it, change it* framework, which program leaders modified from cognitive behavior therapy (CBT) techniques (Stallard, 2019). In the context of HC, these tools are valuable to help students be aware of HC messaging they receive, use self-efficacy tools to change their own internal dialogue, and challenge HC they receive.

Finally, students use their gained confidence (self-/advocacy) to take action or speak up for themselves (Villanueva et al., 2020). An early module in the EA program on *Teamwork and Diversity* discusses the idea of brave spaces where the program leaders supply tools and strategies to students to have difficult conversations. Students are encouraged to advocate for themselves while owning their intentions, being respectful because everyone defines *respect* differently, and engaging in "controversy with civility," where program leaders cordially frame challenges and conflict

(Arao & Clemens, 2013). These conversations provide students with the tools needed for self-/advocacy.

In consultation with Villanueva and colleagues (2020), Villanueva Alarcón & Sellers (2022) and Smith (2013), leaders re-evaluated the EA program to see how the curriculum (Paul, Adeyinka, et al., 2021; Paul, Behjat, et al., 2021) aligns with this description of seekers, bridgers, and agents. While these curricular elements are not prescriptive, we hope that these strategies will ignite similar ideas in other engineering classrooms, departments, and programs for transformative educational change.

3.1 Supporting Seekers: Acknowledge Emotions, Normalize Help-Seeking, and Provide Resources

As described in a previous section, seekers aim to build social capital to belong and succeed in engineering. Typically, they are looking for support to better navigate through HC in engineering. Aligned with this, one of the primary aims of the EA curriculum is to help students understand that they are not alone and to provide them with tools to navigate their educational degree.

The resiliency module described previously uses the *catch it, challenge it, change it* framework with reflection questions to give students an opportunity to reflect on their feelings and internal dialogue, consider how they can challenge this internal dialogue, and then create a plan to change it. This process helps students become aware of and acknowledge internalized thoughts based on norms in engineering, challenge these thoughts, and make a plan to bring them to conscious awareness so they can navigate HC of engineering. One student emphasized the importance of awareness in their reflection when they indicated:

> I feel that a way to change those feelings, is to talk about your feelings, be it through writing it down or speaking it. I feel that if you take a moment to write or prepare something, you can see things in a different light.

Another student acknowledged that they experienced HC messaging that made them feel like they did not belong in engineering: "Most of the time, I feel like I don't belong here, and that I made a mistake of choosing engineering." By asking them how they could reframe their internal dialogue and navigate HC, they emphasized how it was important to remember that everyone struggles:

> I could reframe my internal narrative by telling myself that everyone feels confused all the time and that it is not just me. I'd tell myself that the course is just really hard and that I am not stupid and that I belong here.

Finally, they concluded by reminding themselves, "I got accepted into engineering because I am capable and that I have what it takes. During these times, I am most likely stressed so taking a break would help me." This student confronted HC messaging that made them feel they did not belong, and they identified a strategy around reflection and reframing of their thoughts. In the future, they plan to take a break when they start having these thoughts.

Many students applied the tools given through the modules in their reflections. For example, the *power of yet* is discussed, where students add the word "yet" to their sentence. One student who felt like they were struggling more than everyone else concluded with, "I need to count my accomplishments rather than downgrade myself on my flaws. I need to know that I am not understanding chem [chemistry] YET, but I will understand it eventually." The *power of yet* is a helpful tool for seekers as it helps them navigate HC messaging that they are internalizing. Another student applied to join the

Solar Car team, but she wrote, "I couldn't help feeling that I had faked the interview, or that I didn't deserve to be on the team. I felt that, as a female, I didn't belong (all the other new recruits were male)." To overcome these feelings, she noted that it has been really helpful to find mentors to look up to: "I think talking to other women about this specific situation has helped a lot. . . . I usually think about how others have done the same thing before me and succeeded, so I should be able to as well." She sought out social capital from mentors who are women to help her gain knowledge and succeed in her role.

Also, the EA program emphasizes the importance of seeking support from peers, professors, and advisers if students are struggling. As seekers looked to gain social capital for their own personal advantage, they commonly reflected on seeking support from peers. A student doubted their coding abilities, and they planned "on asking the people around [them] if they understand something better than [them], and if they do, could they please explain it to [them] too" to help overcome their doubts. Another student who was nervous about looking "dumb" for asking questions, indicated that:

> Over time, I start to ask a few questions during class time. It is my opportunity for me this year with online learning, so I feel much better to ask questions. One thing that surprises me is that my friend is also supportive, some of them even give me answers [in the chat] before professors notice them.

It is evident these students seek more social capital to support them through their academics, and because of the EA reflections, they have committed to ask for help and talk to their peers more often.

Overall, the EA program provided a curriculum structure allowing seekers to gain social capital by first acknowledging their emotions, seeking help more often, and understanding the tools and resources that are available to them. This provides seekers with a foundation and helps them build social capital so they can begin to transition to becoming bridgers and agents.

3.2 Encouraging Bridgers: Supporting Group Dialogue That Allows for Sharing Personal Identities, Individual Sense of Belonging, and Community Building

Bridgers look to build social capital with like-minded individuals to navigate HC messages in engineering that target their identity. They aim to share social capital within their communities to help themselves persist and support others to understand HC messages directed to them. Within the EA program, the modules are delivered with three components: content, in-class interaction, and personal reflections. This structure creates many opportunities throughout the curriculum to allow for bridgers to connect with like-minded peers, as well as reflect on these conversations.

The teamwork and diversity module introduces the diversity wheel (see Figure 18.2) and discusses the multiple dimensions of identities to support bridgers in finding ways to relate to their peers. In the EA program, after introducing the wheel, students are asked to consider elements of their identity based on the prompts and then answer two questions: *What are the elements of your identity that are most important to you? What are the elements of your identity that others notice first?* After spending a couple minutes on this activity on their own, students go into groups to discuss these questions with their peers. This activity has been impactful in helping bridgers understand more ways that they can find kindred peers and support each other. Most people will first notice external elements of our identity to find community (e.g., perceived age, skin color, gender, etc.), when there are also many other elements of our identity that can be used to connect with and support each other. For example, one student identified themselves as creative and noted, "[W]hen working in groups, this can come as an advantage because we can all bounce around creative ideas and put our

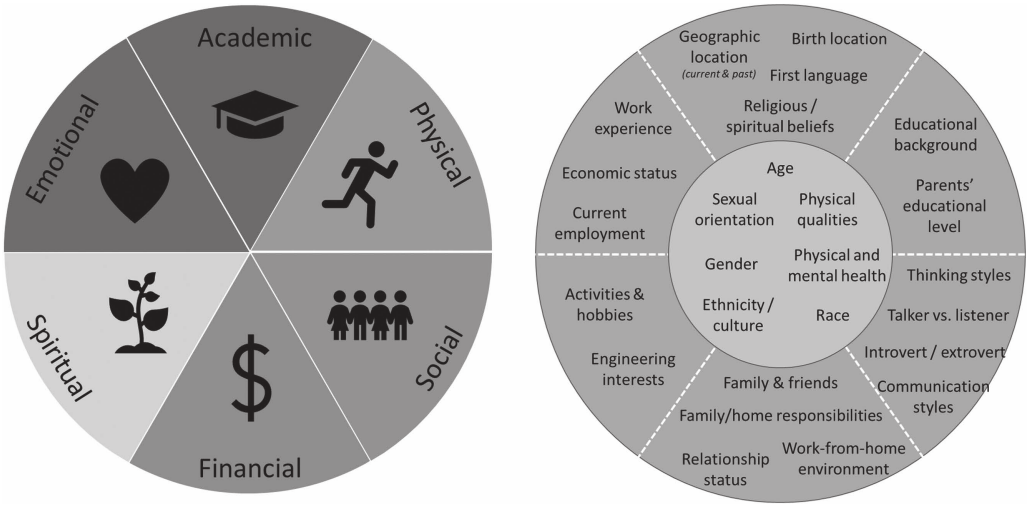

Figure 18.2 Wellness wheel and diversity wheel from EA modules.
Source: Left, adapted from Hettler (1976); right, with permission from Dr. Kim Johnson.

minds together to come up with truly useful solutions." Although HC often sends messaging that creativity is not important in engineering, this student found a way to use their creativity and the creativity of their group members to thrive in engineering problem-solving.

One student talked about how their identity would allow them to share social capital and support other group members. They wrote:

> [M]y own struggles with mental health can help me be more patient and supportive if a group member is having similar struggles. Likewise, my introversion can help me be more cognizant of shy or underspoken group members and lead me to take extra care in ensuring that their voices are heard.

This bridger understands the importance of supporting peers who have similar identities as they may have experienced similar HC in engineering, such as not being heard because they are a quieter group member. Through social capital sharing, this student aims to build a community where peers can support each other. Another student talked about resolving conflict due to diversity and stated that although "[d]ifferences should be appreciated and respected," it is important to remember that the "similarities in a group should always be the driving force because that creates a sense of unity and collectiveness." This student hopes to find commonalities that allow them to share social capital across their peer group to support each other and have greater success as a community. Although bridgers often seek kindred peers with similar identities, during the module, students are reminded that exclusion can also occur when only looking to find peers who are the same as themselves. It is important for bridgers to understand this nuance and build community across identities.

The EA program provides an opportunity for bridgers to reflect on how they can build community with their peers through engaging in vulnerable spaces. Bridgers reflect and emphasize the importance of social capital sharing to support each other when navigating engineering, particularly HC as it relates to their identities. Leveraging this and connecting it directly within the curriculum content and delivery pedagogies is powerful as it supports bridgers in thriving themselves and supporting their community of peers to thrive.

3.3 Empowering Agents: Encouraging Students to Make Change

Agents aim to change social capital, changing their surrounding systems and structures to change engineering for future generations, particularly marginalized groups. Agents raise awareness by advocating for themselves and others on issues that are often hidden. Through intentional curriculum design in the EA program, we create learning opportunities for agents to have the tools they need to change the systems and structures.

For example, one of the modules provides an overview of the concept of HC to empower students to make change. The module provides a definition of HC, and then leaders discuss examples from engineering, including the hierarchical and individualistic nature of engineering, and the assumption of engineering being a difficult and elite program (examples inspired from Villanueva et al., 2020). The module aims to empower students by talking about the importance of bringing these unconscious internal experiences into the conscious mind. Following this module are three reflection questions, where the third question pushes students to consider actions they could take: *Are there any topics you feel have been missing from your engineering education, or do you feel there is lesser value placed on some elements of engineering over others?* Although many students did not communicate significant advocacy in their answers, a few students were agents with a desire to change their engineering education experience. One student noted that the mental wellness modules have been helpful in changing engineering education but that it needs to be taken further. "I think our professors should take mental health more into consideration when conducting their classes (more interaction with peers, extended due dates, having profs be easily accessible to ask questions, etc.)." This student is advocating for change on behalf of themself and their peers to improve and change HC that exists in engineering classrooms.

The EA program also empowers agents to make change by hiring 4–6 students each summer to develop their own modules. The EA program inspires and encourages students who are hired to the summer research program to make changes to engineering culture and HC. During the summer research program, leaders give students autonomy to research a topic they are passionate about and create their own module. The students' choices of topics are often inspired by HC that have influenced them personally. For example, one student chose to develop a module on finances and scholarships. She navigated many financial barriers herself by applying for scholarships and saving money to attend university. To develop the module, the student researched the connection between mental health and finances, pulled together resources lists, and laid out tips based on her experience. Thus, the summer research program provides an opportunity to engage students who are agents in peer advocacy, where they can make more systems-level changes to engineering education curriculum.

Each of these three curricular elements described provides powerful examples of how these strategies connect seekers, bridgers, and agents to content and resources relevant to them. By connecting the curriculum directly to seekers, bridgers, and agents, we can ensure we are supporting as many students as possible to thrive in utilizing social capital to navigate the HC. The EA program aims to normalize help-seeking and provide resources, to foster community and belonging through vulnerable conversations, and to empower students to make change. These values are continuously repeated throughout the year in the weekly modules in the program. The program teaches students that a successful engineer is more than just being able to solve difficult problems and manage high workloads. As one student indicated, "I think the mental wellness program makes us more human and mentally healthy which in turn would make us work more efficiently." The EA modules bring awareness to HC in engineering and help students navigate it. As the program improves and continues to iterate, it will be important to engage faculty members, in addition to students, in the weekly modules so that they begin to deconstruct their own biases and HC that they unintentionally promote in their classrooms.

4 Lessons Learned about Hidden Curriculum in Engineering Through Social Capital

Engineering departments and colleges can create a more inclusive learning environment that can foster the growth and development of seekers to transition into bridgers and agents. In order to produce more bridgers and agents and collaborative learning communities, a competition-neutral pedagogical approach must be created (Secules, 2019). Within the context of the learning environment, faculty members and students must become aware of HC but also know that they have the power and tools to change it.

Since we understand that educational environments are part of a larger ecosystem, we have broken down some of our recommended strategies for department/college, researchers, faculty members, and students. However, we understand that these recommendations are only presented as starting points and encourage readers to adapt it to the context of their realities. Also, these recommendations are not meant to be prescriptive but rather as starting points for reflection and discussions. These recommendations are based on previous or ongoing research by Sellers and Villanueva Alarcón (2021b), as well as work by Paul, Adeyinka, et al. (2021), Paul, Behjat, et al. (2021), and Smith (2013).

4.1 Departments/Colleges

We recommend the following to university departments and colleges for how they can become aware of and address HC in those contexts:

[COMP: Please align below bulleted list also make sure they are aligned and differentiated with the sub-bullets as per given in MS.]

- ***Departments/colleges should take a critical look at their engineering cultures and how each member contributes to this culture.***
    - They can plan a department retreat to unpack the unwritten norms, values, and expectations of how they define success for their students in the department and in the profession. If some aspects of HC are revealed to be less affirming and inclusive, they should have a discussion on how to make those changes.
    - If there is agreement that the expectations, norms, and values are not affirming and inclusive, then the department should seek programming that will help all faculty members understand, navigate, and transform HC. For example, offer lunch and learn workshops on an HC topic led by an expert on the topic and/or an administrator or faculty member who has been trained on the topic. The lunch-and-learn workshops can be offered throughout the school year.
- ***Departments/colleges should consult with students on changes to the engineering culture.***
    - Hire a neutral, third-party evaluator (preferably outside the discipline) to conduct interviews and/or focus groups with students on prevalent norms, values, and expectations and things they would like to see changed in the department.
    - From the evaluator's recommendations, establish a plan that includes small suggestions for engineering cultural change directed to faculty and staff members and students.
    - Evaluate plans and revisit suggestions at least once a year.
    - Department can invite campus partners to come in monthly to talk about HC topics. For example, invite the academic counseling and health services to talk about managing stress and the importance of taking care of one's mental health.

4.2 Researchers

We recommend the following to researchers who want to extend HC work in engineering education:

- ***Researchers should consider how to unearth the status quo in engineering.***
  - Consider, "What norms, values, and beliefs may be present in engineering but are unexamined because they are ubiquitous?"
  - Also, ponder, "Who benefits or is harmed by these unexamined norms, values, and beliefs?"
- ***Researchers can utilize research designs to examine HC contextually in departments, classes, workplaces, and other engineering spaces.***
  - Researchers can ask themselves, "How can I design an inquiry that will allow me to see HC authentically in context?"
  - For example, critical ethnography to explore how HC occurs in first-year classes (similar to the University of Calgary example).
  - Use results from critical ethnography or other research designs to inform support for faculty to design and implement curricular change.
- ***Researchers can explore HC longitudinally to determine if stakeholders' experiences with HC change.***
  - Examine the impacts of a departmental cultural change plan to see if stakeholders report changes in their experiences with HC.
  - Use iterative results to continue but adjust aspects of initiative as necessary.

4.3 Faculty Members

We recommend the following to faculty members and researchers who want to become aware of and address HC in their interactions with students:

- ***Design class structure, syllabus, lesson plans, and assignments/projects to foster a strong sense of belonging in students.***
  - Create an assignment that rewards collaboration and not competition to earn full points on that assignment.
  - Create fun class activities that discuss the culture of engineering programs and why diversity is important. For instance, play a Kahoot! phone app game with HC-related topics.
- ***Faculty members can foster a strong sense of belonging in their classroom if they show their own vulnerability so that students can see that they are human and have emotions.***
  - Faculty members could spend five minutes during set class times for check-ins, where professors share their joys and challenges of the day and ask other students if they want to volunteer and share their joys and challenges of the day. Alternatively, faculty members can share with students if they used tutoring and other support services as a student; showing them how you sought support as a student may encourage them to persist in engineering and seek out necessary support.
  - If it has been a hard week for most students (multiple exams for the same engineering concentration), faculty members could consider giving the entire class an extension on the homework assignment for that week. Showing an empathetic stance may engender trust in students and foster a deeper sense of belonging.

  - Provide extra credit to students for attending tutoring and other academic and social support services.
  - Invite former students to come and speak to the class about the benefits of seeking out support and thriving in the department.

- ***Design instruction to encourage student feedback and evaluation.***
  - Empower students that they can offer feedback on the structure of the class and that they are co-creators of their learning experience. One way to do this is to leave a class topic open in the syllabus and poll students on what they want to learn that semester in class.

- ***Professors can reward academic excellence and collaboration.***
  - Professors could assign students into small groups and let these groups identify what are the underlying assumptions of the assignments and what is unclear about the assignments. Then, share those comments and feedback with the entire class, and the professor can provide additional clarity. This is one way to make HC visible for all students and, all students would receive the same information at one time since not all students feel comfortable going to office hours.

4.4 Students

We recommend the following to students who encounter HC in engineering contexts:

- ***Everyone experiences HC in engineering, but some may experience it more than others. Some may experience HC directed at their personal identities (race/ethnicity, gender, sexual orientation, etc.). Be aware that norms, values, and beliefs are difficult to identify.***
  - Ask, "What groups are not represented in my class/group/club/program?" and contemplate how you can include them.
  - Ask, "Why does this need to be this way in engineering?" or question, "Is the way things have always been done the best way to learn/complete them?"
  - Do not be afraid to ask professors questions about the rationale for some assignments, projects, or activities connected to the profession. It is important to understand what norms, values, and beliefs dominate in the engineering profession prior to graduation.

- ***Students may not immediately have the proper resources, support, or strategy to navigate HC, but it is important to communicate what students can do for themselves and others who may experience similar issues. Be aware that using social capital is a powerful strategy to navigate and overcome potentially negative HC.***
  - Ask, "What resources are available to students to mitigate this issue?" or "How can students leverage other people and their resources/connections to help me with my issue?" such as with peer or upper-class students, teaching assistants, advisers, career counselors, and affinity groups, among others.

- ***Engineering has a strong history of maintaining exclusive norms and culture. Students (and faculty) can change this culture, but it is not without its roadblocks. As such, be patient with the progress made and keep bridging or brokering social capital. Students and others can raise awareness of HC and help transform engineering towards more positive educational change.***

5 Final Thoughts

In this chapter, we summarized a four-factor model of HC where individuals must become aware of HC and utilize their emotions and self-efficacy to advocate for themselves. We also presented research findings about how individuals utilize social capital to unveil HC and advocate for themselves, specifically by collecting social capital, sharing it, and lending it. This chapter then connected research-to-practice by describing an engineering program that is attempting to create a new narrative to the emotional-rational dualism in engineering and support individuals to use social capital to advocate around HC. Finally, we presented recommendations and prompts, based on our current research, to assist administrators, faculty members, and students to become aware of and advocate for change around HC in engineering. We acknowledge, because of our research, that transforming the institutional culture of engineering education is a process that should begin with an awareness of HC. Yet awareness of HC is not enough. The four-factor model of HC, as we have shared in this chapter, is a structural framework by which individuals can use to derive strategies and for survival, navigation, or change in engineering. But understanding is not alone; it takes intentional action to create counterspaces and counternarratives to positively transform the landscape of engineering education and practice.

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Note

1 As an act of resistance and counternarrative to the HC of scientific naming, I, Dr. Villanueva Alarcón, decided to include my father's (Villanueva) and mother's (Alarcón) surnames in subsequent authorships related to HC and other areas of research in 2020 to reflect her cultural identity. Please note that while some authorships have only her father's surname, she is the same author in the cited works of this chapter that include her mother's surname as well.

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