How the Hidden Curriculum Reveals the Enculturation Experience of Underrepresented Students in Engineering

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***Abstract*—In engineering education in the United States (as elsewhere), it is widely recognized that the percentage of women and minorities who acquire engineering degrees is significantly lower than their representation in the general population. Many studies have investigated the cause of this lack of representation in engineering and other STEM (science, technology, engineering, and mathematics) degree programs. It is widely recognized that the percentage of women and minorities who acquire engineering degrees is significantly lower than their representation in the general population. Adolescents' occupational identity development depends in large part on their internalized mental models of what a given type of professional "looks like," their subjective sense of their own capacity to be successful at certain tasks and with certain types of knowledge, and the degree to which they feel as if they belong to a community of practice. This paper considers how the concept of "hidden curriculum" can be applied to how underrepresented students experience engineering education uniquely. The concept of the "hidden curriculum" is used to describe the set of structured learning experiences or conditions that occur beyond the design intent of the learning journey established by the explicit curriculum. The hidden curriculum is typically unintentional, unplanned, and less "controllable" than the explicit curriculum. Despite the difficulty in assessing hidden learning expectations, hidden curriculum consistently places expectations on students beyond the explicit curriculum. It is critical to understand not just what variables prevent underrepresented students from persisting, but also what factors encourage their persistence, as such persistence is critical to ensuring a more diverse engineering workforce. This work focuses on how minoritized groups specifically develop professional identity through the hidden curriculum. We consider their perception of belonging in engineering, their experiences of exclusion in various forms, and the mechanisms by which exclusion transpires. By better understanding the cultural dimensions of exclusion, we hope to advance efforts toward inclusion.**

Keywords—hidden curriculum, engineering education, underrepresented students, student experience, enculturation

I. Introduction

In engineering education in the United States (as elsewhere), it is widely recognized that the percentage of women and minorities who acquire engineering degrees is significantly lower than their representation in the general population. Many studies have investigated the cause of this under representation in engineering and other science, technology, engineering, and mathematics (STEM) degree programs. Lack of pre-college academic preparation, financial concerns, lack of social and cultural capital, and other socio-cultural dimensions are all identified as barriers to STEM for minoritized students [1]. For example, according to studies focused specifically on female student underrepresentation in STEM disciplines, women are deterred from entering these fields due to socio-cultural influences and self-confidence concerns [1] [2]. Adolescents' occupational identity development depends in large part on their internalized mental models of what a given type of professional "looks like," their subjective sense of their own capacity to be successful at certain tasks and types of knowledge, and the degree to which they feel as if they belong to a community of practice [3]. This plays a significant role in their pursuit of engineering careers. Addressing the challenges of underrepresentation requires both recruitment and retention efforts, as students' experiences within engineering programs can significantly impact their levels of commitment and engagement [1].

Challenges associated with underrepresentation are understood to include both recruitment and retention dimensions, so the problem is not resolved simply by bringing underrepresented students in through the door. Once enrolled, students have academic and social experiences, such as contact with teachers and peers, as well as curricular experiences, such as navigating prerequisite structures, all of which contribute in varying degrees to their level of commitment to their original educational goals [1]. During college, social and intellectual activities and experiences can reinforce or undermine an individual's objectives and their institutional commitments, leading to judgments about whether to stay or leave the program or institution.

To better understand the social and cultural dimensions of underrepresented students' experiences in engineering, we sought to answer the following research questions: 1) How does the hidden curriculum in engineering education impact the ethical development of underrepresented students? 2) What are the implicit values and norms that the hidden curriculum conveys to engineering students, both in and outside of the classroom? 3) How do these hidden curriculum messages contribute to the perpetuation of cultural

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expectations within the field of engineering? 4) What role do existing systems and structures play in either excluding or amplifying nondominant voices in engineering educational spaces?

While scholars have considered how explicit curriculum designs may disengage underrepresented students, there are also other, unintentional or implicit components of engineering learning that can be equally (and sometimes more) detrimental to underrepresented students' sense of inclusion. These unintentional and implicit learning expectations form an informal, almost invisible set of requirements placed on students—the hidden curriculum [4]. This paper aims to use the concept of hidden curriculum as a conceptual lens to aid in understanding the experience of underrepresented students.

The concept of the "hidden curriculum" (HC) is used to describe the set of structured learning experiences or conditions that occur beyond the design intent of the learning journey established by the explicit curriculum [5]. HC is typically unintentional and unplanned, and it is therefore less "controllable" than the explicit curriculum. HC learning requirements can include expectations about how to act in public (e.g., how to speak to peer students), how to interact with authority figures (e.g., how to address a professor), and how to navigate social hierarchies (e.g., what is acceptable to tease about, what different grades mean in different contexts), and so on. Gender expectations are an important element of the hidden curriculum. Schools reinforce broader cultural messages about gender, including the idea that gender is an essential characteristic for organizing social life [6]. While these hidden teachings are enforced in indirect and distributed ways, HC consistently places expectations on students beyond the explicit curriculum. While subtle, these expectations are pervasive, and so HC is a fundamental component of the educational experience of most students, not least university students in engineering programs.

Our interest in HC lies specifically in how students come to think about ethics within engineering education, so we seek to understand how HC implicitly communicates to students, both within and outside of the classroom, the set of moral values and norms engineers are expected to hold and abide by [5]. Magnifying the impact of HC is the insight that teaching and learning are never value neutral: communicating values constitutes a foundation of all educational practice [5]. It is essential to examine how these unspoken values are transmitted within and outside the classroom. Moreover, the hidden curriculum can perpetuate cultural expectations and inequalities within the engineering field.

A status quo emerges when system and structures absorb repetitive patterns of values and beliefs that are informed by dominant individual and collective experiences [7]. Once this status quo has been created, implicit expectations cumulate and begin to solidify as a hidden curriculum, which then perpetuates cultural expectations within a given setting. For engineering, the status quo and its associated hidden curriculum can be found in multiple layers and dichotomies such as the role of technical versus social dimensions of education, educational aspirations around "rigor" versus flexibility, individualism versus community achievement, access versus exclusiveness/ exclusion, heteronormativity versus non-heteronormativity, and performative versus authentic approaches to diversity, equity, access, and inclusion.

Since engineering is a field historically and currently dominated by socially and politically influential groups—in the U.S., largely White, heterosexual men—the values of these groups often permeate the educational experience of all participants, typically in ways that underlie intended educational goals and structures. Underrepresented students experience the messaging from their educational environment differently than their counterparts [8] [9], because underrepresented students' distinct backgrounds present different ways of interpreting and responding to dominant cultural communications. As a result, underrepresented students have substantially different educational experiences. While underrepresented students may experience the formal education similar to majority students, their experience with HC can be entirely different. Therefore, it is critical to address how the hidden curriculum may positively or negatively affect all engineering students and its specific impact on historically marginalized groups, what the role of existing systems and structures is in excluding or silencing nondominant voices, and how we can enhance inclusiveness of multiple perspectives in engineering educational spaces.

By investigating the hidden curriculum in engineering education and its impact on underrepresented students, this paper aims to shed light on the mechanisms that perpetuate inequality and exclusion within the field. Understanding the dynamics of the hidden curriculum will enable us to develop strategies and interventions that promote a more inclusive and equitable educational environment in engineering. By challenging the cultural status quo and amplifying diverse perspectives, we can create a supportive and empowering community that encourages the success and persistence of all students, regardless of their backgrounds or identities.

II. Methods and Methodology

Our investigation included a review of relevant scholarship on HC followed by a review of interview transcripts (that were collected as part of a larger project by members of the research team) in light of the findings from our literature review. To identify scholarship related to underrepresented students' experiences with the hidden curriculum, we conducted a systematic search of the American Society for Engineering Education's PEER document repository using keywords "underrepresented," "hidden curriculum," and "interview." We also had the added criteria that these terms were present in the body of papers that addressed this topic (rather than results whose hits were based only on associated author biographies, citations, etc.). We initiated our search by querying PEER using "underrepresented" and "hidden curriculum. This resulted in an initial set of 10 papers, which were then parsed

for direct quotations from interviews with students. In a follow-up search we used the terms "underrepresented" and "interview." Three publications met our full set of criteria. The publications served as valuable introductions to the current landscape and helped us identify novel places to apply the hidden curriculum framework. Interview transcripts were read after publications to best profit from their insights.

Our larger research project aimed to explore the holistic experiences of engineering students in learning about ethics during their university tenure. Team members from this larger project recruited participants from a private undergraduate university using the Discord social media platform. Discord, initially popularized by the gaming community, has gained broader adoption, including within university communities, particularly due to the onset of COVID-19. As part of the interview protocol, participants were asked about their demographic profiles, including their pronoun preferences, gender, and race/ethnicity. Of 33 individuals interviewed, 19 identified as members of an underrepresented race/ethnicity: 9 identified as Asian, 5 as Hispanic or Latinx, 3 as African American, and 3 as multiracial, some of whom also counted towards other categories. (Though it is beyond the purview of this paper, we recognize that socioeconomic class also plays a significant role in patterns of underrepresentation in engineering programs. In the United States specifically, class and race are often closely correlated [11]. Further intersectional analysis of underrepresented identities in engineering could be explored, such as in [12].)

We analyzed interview transcripts for mentions of identity in relation to participants' experiences as engineering students. This exploration encompassed references to race-based organizations, including those endorsed by the institution, as well as interactions both within and outside of the classroom where identity was relevant.

III. Barriers to Engineering

In the United States, engineering fields historically have been and remain primarily dominated by heterosexual White men. Through over a century of development, members of this group have been the primarily determinants of what it means to be an engineer and the expectations one must meet to enter this prestigious profession. These expectations are communicated to students both within and outside of their formal studies, as part of their educational requirements and messages about who is suitable to be an engineer. Women and minorities in middle and high school have historically been discouraged from pursuing engineering because of perceived lack of "fit" even before reaching the point of applying to relevant college programs. Many may also lack pre-college academic preparation, lack necessary funds, have concerns over their ability, or experience other barriers related to socio-cultural factors [1]. For those students who manage to overcome these barriers and apply to collegiate engineering programs, additional barriers await.

In surveys of 50 high-school teachers and 1,200 high-school students, perceived barriers to successful enrollment and matriculation were examined by Weatherton et al. [10]. Students groups that were less likely to consider STEM fields as intended majors included students with disabilities, those who identify as female, and non-white students. Undergraduate students in engineering were asked the degree to which they agreed or disagreed with the surveys given to the high-school students. The most widely held perception with regard to representation was that students with disabilities were likely to feel they do not fit in. There was also agreement that engineering curricula fail to consider learning differences and that there was a lack of encouragement from high-school advisors. Disabled undergraduate students were six times more likely to agree with the statement: "They are not as smart as able-bodied people who pursue careers in engineering" [10], suggesting concerns over self-efficacy. The majority of undergraduate students agreed that females are underrepresented in engineering, and 64% of females also agreed with the claim that they "did not fit in" was a barrier to their success in engineering. Despite longstanding efforts to correct these trends, students continue to experience exclusions. Students from underrepresented groups in these interviews tended to view curriculum and instruction as barriers more than their mainstream counterparts [10].

IV. Assimilation

Educational environments place expectations on students to fit the mold of an engineer: how an engineer talks, behaves, thinks, learns, etc. All students adjust to their university or workplace culture, but with underrepresented students this transition is distinct. While all students experience enculturation, minoritized students typically experience the forces of enculturation as a need to assimilate. Underrepresented students in engineering often respond to the expectation of assimilating into the dominant engineering culture by conforming to established norms, behaviors, and ways of thinking. This expectation places a significant burden on these students as they are asked to override their own sense of identity and adopt a non-authentic set of characteristics associated with being an engineer. Such enculturation processes can have profound implications for the experiences and well-being of underrepresented students in engineering.

Minoritized students often feel the pressure to assimilate or risk compromising their status as engineers-to-be. A female student interviewed by Carol Haden [1] described this as becoming "one of the guys." Despite increasing percentages of women in the field, the enduring gender imbalance is still experienced as a detrimental force by many women engineering students, and male identity characteristics continue to be seen as the norm for engineering. Additionally, women students often feel pressure from their male peers to "prove yourself" [1]. Similarly, it is not unusual for minority students to feel that they must do extra work to gain acceptance to the field and to become an equal member of the learning community, even after successful admission to the university and program. Interviewed individuals also recognized that admission differed from attendance, referring to the challenge of retention:

"It's one thing to recruit or to get a lot of students that are minorities, and it's another thing to keep them here."

The hidden curriculum is easier to navigate for students previously exposed to higher education and/or engineering culture through their family or close acquaintances, enabling "second nature" understanding of implicit expectations of engineering education. "For those who were preceded by a family member, the transition was not as disruptive" [1]. In interviews done with students and alumni who were interviewed previously as students, this outcome recurs. Most interviewees had familial legacies in engineering or at the institution, and their families were often the catalyst for their decision to become an engineer, also helping to prepare them for engineering cultural expectations.

"I think my parents were just like, 'You should do engineering,' but they didn't really care which kind of engineering."

"There's always growing up being responsible, and it's kind of translated as a kid—I have to get good grades; I have to be academically minded—and having my parents as engineers, seeing how they operate."

"Growing up that way [with parents in engineering], kind of influenced me growing up into having these high standards of care."

The self-definition of high standards is significant here. This undergraduate engineering student was in their 4th year and would be well encultured into the expectations of their field, yet they still describe their upbringing as distinct from the standards for others around them. This is representative of a barrier minoritized students have when trying to fit into engineering. Minorities are required to meet higher standards than their majority counterparts to achieve the same perception of qualification. Being brought up from childhood with the ideal of becoming an engineer taught this student that higher expectations were necessary for them.

Students also reported a "natural" inclination towards engineering. Being "a natural" with math or engineering can help underrepresented students overcome one of the first barriers to entering STEM: a lack of confidence. Some are deterred early on by the idea that "I'm not meant to be an engineer" or that "no one like me becomes an engineer." A child's natural prowess can overcome this and be seen as a specialty that allows for their entry into the field despite their minoritized identity.

"I always kind of leaned into the science/math/STEM fields."

"Ever since I was little, I was very interested in building things, experimenting with just putting things together."

Family ties and natural ability in engineering or pre-engineering both help underrepresented students overcome the initial hurdle to enter engineering education programs. This can help students have a pre-established place in engineering, and thus a sense of belonging. This helps underrepresented students identify with their chosen field and prove their worthiness. As elaborated in the next section, students feel and are sometimes even told directly that they do not fit into engineering because of their identity. This can be discouraging, but early acclimation to engineering culture seems to give students more confidence.

The pressure to conform to the dominant engineering culture can result in a loss of personal identity and sense of authenticity. Underrepresented students may feel compelled to suppress aspects of their cultural or personal backgrounds that do not align with the prevailing engineering norms. This can lead to a sense of dissonance and inner conflict, as students grapple with the tension between conforming to societal expectations and embracing their own unique identities. Consequently, underrepresented students may experience a profound sense of isolation within and disconnection from the engineering education community, hindering their ability to fully engage and thrive in their academic pursuits.

Moreover, the expectation of assimilation reinforces the notion that success in engineering is contingent upon adhering to a predefined set of characteristics that may not accurately reflect the diverse talents and perspectives that underrepresented students bring to the field. By prioritizing conformity over inclusivity, engineering education risks overlooking the valuable contributions and innovative ideas that emerge from a diverse range of perspectives. It is crucial to recognize and celebrate the diversity of experiences and backgrounds within the engineering community, as this diversity fosters creativity, enhances problem-solving, and promotes a more inclusive and socially responsible engineering practice.

Creating an inclusive environment in engineering requires a shift in mindset from assimilation and accommodation to inclusion. Instead of expecting underrepresented students to conform to a predefined mold, educators and institutions should embrace and value the unique perspectives and experiences they bring to the table. This entails recognizing and addressing the biases and barriers that perpetuate exclusivity in engineering education, such as unconscious biases in evaluation and promotion processes, lack of diverse role models, and limited access to resources and support networks.

V. Exclusion

Although the hidden curriculum is defined by hard-to-see expectations, these expectations sometimes entail a visually apparent component as well. Engineering students as a whole look to faculty and other engineering authorities, such as celebrities or award winners, for inspiration and as exemplars. When minority students do not see themselves reflected in these groups, it can exacerbate their sense of isolation. This can be discouraging to a young teen trying to overcome century-long institutional barriers and becoming hyper aware of their dissimilarity from those around them.

"In one class for the first few weeks, I was the only female in the class. Now there is one other, but I look around and see 19- and 20-year-old guys and it is almost a culture shock."

Minority students also find themselves struggling to find space with others they share identities with because of visual cues.

> "It's hard dealing with being a White Native American. Unfortunately, people still see color and skin as what makes you who you are, and that's something that I think I'll probably be struggling with until I die."

In both scenarios above, students found themselves reduced to being a stand-in for their counterparts. Depending on their appearance and assumed identities, this counterpart may be the dominant White men of engineering or other minority students. Both are detrimental. Such reductions can make students feel dehumanized, and an outlook on identity in such a manner is damaging to the larger goals of cultural diversity and inclusion within engineering. Students may feel forced to let go of their own histories and identities to adopt the dominant norms associated with White male in engineering, continuing the legacy of exclusion.

The absence of representation among faculty and other authoritative figures can reinforce the feeling of isolation among underrepresented students. When students do not see themselves reflected in these positions, it sends a message that they do not belong and that their voices and perspectives are not valued. This lack of representation can be disheartening, especially for young individuals who are already facing other barriers and trying to navigate their way in a predominantly homogeneous field. It is crucial to create pathways and support systems that enable underrepresented students to envision themselves as future leaders and role models within the engineering profession.

Peer feedback is another way that students are deterred from engineering. While not always hidden, this systemic contributor to student enculturation exists outside of formal teachings and thus fits our definition of the hidden curriculum.

> "A lot of the male students will jokingly but also hurtfully make comments such as, 'You'll only have a job because you're a girl.'"

> "We always get comments about how we're women and we're minorities, so we get all the scholarships, and 'That's not fair; there's nothing for White males.' But you have to defend yourself, because we get it because we're qualified."

Thus far, this paper has primarily discussed how hidden curriculum is communicated and enforced by peers and authority figures beyond the intentionally structured, formal engineering education. The formal structure also contains gaps that may otherwise address the needs of minority students, particularly Native American students.

> "A lot of Native American students do learn through visual and tactile learning, which I find is true for me as well. I have to visually see it in order to understand it, so if it's theory or anything like that, I do kind of bad in it, because I can't visually see it. I have to kind of draw it as best as I can or put it in some format where I can see it. That's the major problem that most minorities have, or at least within the Native American group, is that they have to visually see it."

This narrative identifies a foundational limitation of engineering education in terms of its privileging of particular modes of knowledge generation and transmission, modes that this student recognizes as misaligned with Native American epistemologies. Notably, the student has the knowledge, power, and vocabulary to articulate how formal engineering education fails to consider their background. Presuming not all students will have this same ability or opportunity to express this limitation, it seems reasonable that students with other minoritized backgrounds experience similar disjunctions, but do not necessarily identify them as a fault of their education.

An area that minoritized students do openly express is feeling unseen by faculty and the educational institution at large.

> "We are their students, and they should be making sure that our needs are being met, especially if they haven't been historically for years."

> "We've had no support, really, from the Health Center for Black and Latinx students. We've gotten a lot of feedback that there's no real help [for us] in the Health Center."

> "The male counselor in the Counseling Center … doesn't take an account of people's mental health statuses…. He dismissed people's anxiety and depression just as, 'Oh, you're just over-exaggerating.'"

Services like those provided by health, counseling, and tutoring centers associated with the institution are reflections of the values held by the institution at large. As students become professionals, they hold the hidden teachings gained during their early formation as engineers. Institutional values are reflective of the profession, and when students feel unsupported by their institution, they may expect to be unsupported as professionals, diminishing their enthusiasm for remaining in the field. This may contribute as another barrier to retention.

Many students have created communities within their institutions to foster connections among those with shared gender or racial/ethnic identities. Interviewees identified specific groups related to underrepresented communities, including: the Black and Latinx Student Coalition, the Multicultural Sorority Fraternity Council, the Society of Asian Scientists and Engineers, the Chinese American Student Association, the Hong Kong Student Association, the Vietnamese Student Association, and the Women in Transportation Society. These groups typically have inclusive membership policies, where anyone is welcome to participate. Reflecting such an inclusive membership policy is the colloquial phrase commonly articulated within the Society of Hispanic Professional Engineers at the lead author's institution: "You don't have to be brown to be down."

These groups serve to support minoritized students' distinct experiences from their majority counterparts, providing an opportunity for minoritized students to gather in communities where they have control and voice. However, the more active students' participation in these culture-based organizations, the more minoritized or marginalized these participating students'

perceived identities on campus might be. These communities are often constructed as divergent from engineering's dominant cultural forms, so members of these communities often experience the need to justify their presence or activities that promote their participation.

> "[When] you justify why you're spending money for multicultural clubs, it's a little bit harder [than other clubs] to describe the importan[ce] to administration [because of] an unconscious bias. Some implicit bias."

The formation of identity-based communities is often a response to the exclusion and lack of representation experienced by underrepresented students. These communities provide a sense of belonging, support, and empowerment. They offer a space where students can share their experiences, find mentors, and create a sense of identity that aligns with their cultural and personal backgrounds. However, it is important to recognize that the mere existence of these communities should not be seen as a solution to the broader issues of exclusion and underrepresentation. While they can provide a supportive network, they should not be a substitute for stiving to create a more inclusive and welcoming environment within the engineering community as a whole.

Furthermore, the formation of identity-based communities can inadvertently perpetuate the marginalization of underrepresented students. When these communities are seen as separate and apart from the dominant engineering culture, it can reinforce the notion that underrepresented students are outsiders or exceptions. This can lead to a constant need for justification and validation of their presence and activities within the engineering community. Rather than being conceived as exceptions, identity-based communities could be construed as faces of a broader engineering community that is multifaceted, promoting inclusivity across different groups as well as vision of engineering that is not bound to any specific demographic group's ways of being and knowing.

These experiences highlight the ways in which underrepresented students in engineering are sometimes reduced to an identity distinct from engineering norms, both by the lack of representation among typical engineering personas and by the need to seek out communities based on shared identities. These experiences contribute to a sense of isolation, marginalization, and disconnection from the broader engineering community. Addressing these issues and their consequences can foster a more inclusive and equitable engineering education system.

Institutional support and services also play a crucial role in addressing the experiences of underrepresented students. When students feel unsupported by the institution, it not only affects their academic success but also shapes their perceptions of the engineering profession as a whole. If underrepresented students perceive a lack of support during their educational journey, they may anticipate similar challenges and limited belongingness as professionals, potentially leading to lower rates of retention and representation in the engineering workforce. Institutions need to ensure that support services are accessible, inclusive, and responsive to the needs of underrepresented students, fostering an environment where all students can thrive personally, academically, and professionally.

VI. Opportunities for Undoing

Not only do faculty design and implement the explicit curriculum, which formally denotes who can become an engineer upon graduation, but they also exercise informal authority through a variety of mechanisms that establish and enforce the values and norms that are privileged within engineering education. This is the hidden curriculum. Because the hidden curriculum is structured, albeit implicitly and usually inadvertently, it can also be restructured. Educators and students alike have the power to combat this exclusive version of the hidden curriculum. The first step to changing the exclusions experienced by minoritized students is being aware of the hidden curriculum's influence.

Some students interviewed were dissatisfied with authority figures at their institution, including both faculty and administrators. While students believe that these figures have the power to make change, they also experience negative outcomes associated with that power not being exercised or not being appropriately directed.

> "Some things aren't okay … in terms of how [the] administration treats our Black and Latinx students."

It is crucial for administrators and faculty to exercise their power in ways that prioritize the well-being and success of underrepresented students. This includes addressing systemic barriers and creating a supportive environment where all students feel valued and heard. To combat the exclusion experienced by underrepresented students, faculty and administrators need to be aware of the influence of the hidden curriculum. By understanding how their actions and policies can inadvertently perpetuate exclusion, educators can work actively towards restructuring the hidden curriculum to be more inclusive. This requires a commitment to challenging biases and promoting diverse perspectives within the engineering community.

Fostering an environment where underrepresented students feel welcomed and supported can increase their enrollment in engineering programs and make them more likely to succeed once having entered the program.

> "I have always been intimidated the first time I go to see a professor, but they have always been very welcoming, helpful, and supportive. The professors have helped me to feel comfortable in class and to understand the material." [1]

Creating a welcoming and supportive environment for underrepresented students in engineering programs is essential for their attendance and success. Faculty can play a key role in this process by being approachable, supportive, and culturally responsive. By fostering an inclusive classroom atmosphere, where students feel comfortable and understood, faculty can enhance students' learning experiences and promote their academic achievement.

Students suggested some specific solutions to undoing the pattern of exclusion and the expectation of minoritizes students assimilating.

> "[H]elp the Help Center on how to treat the minority students, even when they go absent randomly. Not just giving us support, or telling us things, certain things that are not helpful."

> "I think an awareness course … would be very educational for [clubs, sports, and organizations] to talk about within their communities."

> "[I]f teachers were to understand that Native American students do have a hard time learning through words alone, that would help out a lot." [1]

At times, the influence of the outside world, including current events and societal discussions on race, has also empowered underrepresented students to speak openly about their experiences and perceived injustices. The Black Lives Matter movement and resulting discussions of race and race relations in the media and across society has empowered some students to talk about their own experiences. Similarly, institutions could recognize and acknowledge such external influences as an avenue to responding more effectively and proactively to the needs and concerns of underrepresented students.

> "It's kind of like being more willing to call out something adverse."

Opportunities abound for preemptively identifying and preventing underrepresented students' negative experiences in engineering programs. We suggest further research into these experiences with special attention to how the hidden curriculum creates implicit but systemic expectations of performance, values, and behavior. This can help us move beyond merely identifying the variables that prevent underrepresented students from persisting and to the factors that encourage their persistence, thereby helping to ensuring a more diverse engineering workforce [1].

Further research is needed to explore the experiences of underrepresented students in engineering programs, specifically examining the impact of the hidden curriculum on their persistence and success. Understanding both the barriers that hinder underrepresented students' progress and the factors that encourage their persistence is crucial for fostering a more diverse and inclusive engineering workforce.

VII. Conclusion

Underrepresented students embark on their engineering journeys with the goal of achieving equal standing within a field historically dominated by heterosexual White males. Yet, they encounter a myriad of barriers, both overt and subtle, that can hinder their sense of belonging and inclusion. These obstacles manifest through explicit interactions; implicit messages conveyed by peers, faculty, and institutional structures; and the hidden expectations that silently communicate whether they belong or stand apart in the world of engineering. Minoritized students can find themselves with a choice to assimilate into the dominant engineering culture, which may create dissonance with their identity, values, and sense of self, or to be excluded from the group, not "fitting" within engineering's unnecessarily narrow norms and expectations.

In response, educational institutions have taken steps to diversify their student and faculty populations, and students themselves have formed identity-centered groups to broaden the norms of engineering. While these efforts are vital, they alone cannot dismantle the deeply embedded structures of inequality perpetuated by the hidden curriculum. Engineering educators and institutions bear a collective responsibility to create spaces that celebrate diversity, cultivate a sense of belonging, and provide opportunities for underrepresented students to express their authentic selves. This can be achieved through inclusive pedagogies that incorporate diverse voices and perspectives, fostering a richer learning experience for all students, establishing mentorship initiatives that connect underrepresented students with supportive role models who can guide and inspire them, and fostering a culture of respect and openness where all students feel empowered to share their ideas and experiences and where they are not penalized for failing to meet implicit expectations.

To create a more inclusive engineering education system, it is essential to challenge and dismantle the reduction of underrepresented students to their identities. This involves increasing representation in faculty and other authoritative roles, promoting a sense of belonging and inclusion within the engineering community, and addressing the biases and barriers that perpetuate exclusion. By valuing the diverse identities, experiences, and perspectives that underrepresented students bring to the field, we can cultivate an engineering education system that truly reflects and serves the needs of all its participants. By embracing diversity and creating an inclusive engineering community, we can unlock the full potential of underrepresented students, leading to greater innovation, creativity, and social impact within the field. It is only by challenging the expectation of assimilation and fostering an environment that values and supports diverse identities that we can truly achieve equity and excellence in engineering education.

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