On Faculty Responsibility for Increasing Students' Sense of Support in the Classroom: Lessons from I-MATTER about Black and Brown Students

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Abstract

Teaching engineering students how to work in teams is necessary, important, and hard to do well. Minoritized students experience forms of marginalization from their teammates routinely, which affects their access to safe learning environments. Team evaluation tools like CATME can help instructors see where teaming problems are, but are often normed in ways that obscure the subtle if pervasive harassment of minoritized teammates. Instructors, particularly of large courses, need better ways to identify teams that are marginalizing minoritized team members. This paper introduces theory on microaggressions, selective incivility theory, and coded language to interpret data collected from a complex study site during the COVID-19 pandemic. The team collected data from classroom observations (moved virtual during COVID), interviews with instructors, interviews with students, interpretations of historical data collected through an online team evaluation tool called CATME, and a diary study where students documented their reflections on their marginalization by teammates. While data collection and analysis did not, of course, go as the research team had planned, it yielded insights into how frequently minoritized teammates experience marginalization, instructors' sense of their responsibility and skill for addressing such, marginalization, and students' sense of defeat in hoping for more equitable and supportive learning environments. The paper describes our data collection processes, analysis, and some choice insights drawn from this multi-year study at a large, research-extensive white university.

Introduction

Teaching engineering students how to work in teams is necessary, important, and hard to do well. Existing research in engineering education typically has overlooked investigating harm that teammates enact on each other, and instructors' understanding of how to teach about teamwork or about their responsibility for providing all students a safe and supportive environment. There is ample evidence that teaming experienced by women in undergraduate engineering education experience regular and routine marginalization by their teammates, threatening their right to learn in a safe and supportive environment in ways that their majority teammates don't experience [1]–[4]. There is much less research on the experience of racially minoritized students precisely because they are so much less represented, yet it is clear that they also experience harmful treatment [5], [6].

Our project, called I-MATTER (Identifying Marginalization and Allying Tendencies to Transform Engineering Relationships), assesses what marginalization looks like in engineering student teams in the classroom. In this multi-year project, we collected observation data collected from virtual teams during the pandemic, interviews with marginalized students, historical peer evaluation data, interviews with instructors, and diary study data from students to think about

what marginalization in the classroom looks like. Our study site is a large Midwestern, historically and predominantly white institution with a large established undergraduate and graduate engineering program. Our project's main research question asks, when students exert microaggressions on their teammates, what do they look like at scale so that instructors of large courses can see them? Based on current data collection and analysis, our project's original intent to provide instructors with observation tools to identify at scale when teammates are engaging in harassing behavior in order to interrupt it, seems insufficient and perhaps even damaging in how trivial it treats the depth of engineering's marginalization of minoritized students.

Our paper briefly describes three current findings that lead us in this direction:

1. We see that teammates enact microaggressions and selective incivilities against their minoritized teammates frequently and predictably.
2. We see that Black and Brown students have given up on the hope that their instructors will provide them with a safe and supportive learning environment, free from harassment and marginalization.
3. We see that many instructors don't sufficiently know how to teach teaming or function appropriately in diverse teams, and they might not even be sure it is their responsibility to intervene when teammates harass each other.

As a result of these findings, this paper concludes with suggestions for tools for thinking for engineering instructors who want to think more about how they enable a culture of marginalization in their classrooms, and start on a path forward for making changes to their practice and their commitment to their students.

Background

It is well established that teaching undergraduate students, particularly engineering students, how to work in teams is important [7], [8], difficult [9], and worth doing because students can improve [10]. Teamwork assessment tools like CATME (a web-based peer evaluation tool found at catme.org) can help instructors identify teaming problems amongst students [11], [12]. Challenges remain, however, for instructors of large courses who want to address such problems in getting enough of the right kind of information to effectively intervene to help students improve their teamwork skills, and then knowing how best to coach teams exhibiting evidence of dysfunction.

Researchers have established the outsized burden that minoritized teammates carry in participating in engineering team-based assignments [4], [13]. At the same time, there is a dearth of research on how, in educational settings, instructors can and should handle racist, sexist, and homophobic peer-to-peer interactions. Much existing research identifies various ways that these issues manifest in negative team experiences for minoritized students [14]–[16], but fall short in providing guidance on how to identify emergent cases of marginalization while there is still time to intervene to improve the team experience for minoritized students and change the behaviors of those who marginalize them.

For this project's theoretical framework, we apply theory on microaggressions, selective incivility, and coded language to understanding undergraduate engineering team-based

harassment of minoritized members (by gender, race, ethnicity, sexuality, nationality, settler status, and other categories). For this paper, we predominantly focus on data from student participants based on race.

Literature on microaggressions as a form of interpersonal harassment has been well established, anchored by the germinal theoretical work of Sue and colleagues [17]. Sue and colleagues operationalized microaggressions as constituting microinsults (verbal and behavioral expressions that denigrate someone's identity), microinvalidations (when someone diminishes or invalidates the experiences of marginalized people), and microassaults (verbal and non-verbal attacks and avoidant behaviors) [17]. This ground-breaking work has inspired a broad research field [18] which has been brought into many disciplinary domains, including engineering education.

More recent work by Sue and colleagues has introduced the idea of microinterventions [19]. To preface this concept, they note how the concept of microaggressions, based on the prefix of "micro," suggests that the acts so categorized are minor or inconsequential. However, they call this a misinterpretation, emphasizing that the "micro" designation is to indicate the interpersonal aspect in contrast with meso (at an organizational or institutional level) or macro (at a societal) levels. As an example, they describe how a single incidence of police brutality against a Black man is a form of microassault, not to diminish the significance of an incident that can (and does) result in murder, but to focus on the interpersonal aspect of it. That many such incidents form a more societal-level pattern around police brutality and race is a systemic matter requiring different responses than those described by microinterventions. (We will return to microinterventions in the conclusion.)

Furthermore, Sue and colleagues describe how racial microaggressions are different from "everyday rudeness" because they are:

1. "constant and continual in the lives of people of color";
2. "cumulative in nature and represent a lifelong burden of stress";
3. "continuous reminders of the target group's second-class status in society";
4. "symbolic of past governmental injustices directed toward people of color (enslavement of Black people, incarceration of Japanese Americans, and appropriating land from Native Americans)" (p. 130)[19]

This final point is relevant for interpreting how language can be racially coded: for example, while saying a Black person is "articulate" appears on its face as a compliment, it also draws on an all-too-recent history of white people in the US legislating Black people's access to formal education, including enacting restrictions on their right to learn to read and write. Such restrictions then also functioned alongside legislation about voting rights to limit Black people's right to vote. Loud echoes of this history remain consequential today.

Andersson and Pearson [20], Cortina, and other colleagues, [21], [22] have anchored research on workplace incivility, defined as "low-intensity deviant behavior with ambiguous intent to harm the target, in violation of workplace norms for mutual respect" ([20] p. 457). Schilpzand, Pater and Eretz, in their review [23], have noted the variety of theoretical models and domain-specific measures developed to understand workplace incivility worldwide, but have concluded that there are three distinct types of research: experienced (where the researchers investigate "the feelings, thoughts, behaviors, and other correlates of employees who are the *target* of uncivil workplace

behavior" (p. 59)), witnessed (where "research … considers the relationships for witnesses of workplace incivility" (p. 59)), and instigated incivility (where the researchers investigate "instigators of workplace incivility directed toward employees and assesses its antecedents and outcomes" (p. 59)). We collected data from a variety of sources in such a way that we could consider all three types of incivility questions. Cortina (2008) has argued for a conceptualization of "selective incivility" as a specific kind of workplace incivility, which describes understanding how workplace incivility is a modern mode of discrimination in organizations [21]; Cortina and colleagues have studied how women and racially minoritized people receive more uncivil treatment compared to their white, cis-gender male, colleagues, with women of color, and women who are sexual minorities being most at risk from, and compared to, their colleagues [22], [24].

The overlap of the engineering teaming literature and these theoretical frameworks leads us to consider the literature on coded language as an entrée into seeing how majority teammates perform microaggressions against each other [25], [26]. We focused on two types of coded language: first, language that provides a stealth way to talk about social categories like gender, race, sexuality, nationality, language of origin; and second, language that is culturally selectively applied to particular social groups in order to develop negative associations [27].

Based on this theoretical foundation on microaggressions, selective incivilities, and coded language, our original project's goal was to find a way to make microaggressions in the classroom "visible" to instructors of large undergraduate engineering classes so they would be able to address them to help teams improve their abilities to work together.

Methods

This project's funding started in October 2019, and we planned to start data collection in spring 2020. We had planned to do group interviews with minoritized students, observations of classroom behavior from both instructors and teams, an analysis of historical and contemporary (i.e. collected at the same time) peer evaluation data (collected through CATME), and a diary study with individual students on teams in classrooms being observed.

The classroom observations were going to be drawn from two courses that are normally taught in sections of 120 students, working in teams of 4, with a teaching team of one instructor, half of a graduate teaching assistant, 4 undergraduate peer teachers for 20 hours a week, and 1-2 graders for 20 hours a week, taught in two sessions of 110 minutes across a semester of 16 weeks. Instructors (who have varied experience from never having taught the course to instructors teaching it annually for a decade or more) shared centrally-produced technical content, assignments, and exams. Instructors can modify the centrally-produced technical content, but still need to aim for the same learning objectives on which that centrally-produced content is based. Learning objectives are theoretically determined by a curator team of faculty, ranging from 1-3 faculty historically, but in reality tend to pass from one semester to the next with little rewriting or reorganization. The two courses on which we based our data collection are both taught in both spring and fall; however, the first course for first-year undergraduate engineering students - pseudonymized as "Engineering 1" - has its large offering in fall, and a much smaller offering in the spring, while "Engineering 2" has the reverse balance. The instructors have a

(separate) weekly instructor meeting at which they can ask questions about the technical content; this meeting is mainly driven by the instructional support staff who support the logistics of each course.

While we began analysis of the historical CATME data immediately, some logistical difficulties made it difficult to start the other data collection plans in January 2020, so we delayed the classroom observation portion until fall 2020.

However, like for everyone else, all our plans for data collection were disrupted with the start of the COVID-19 pandemic, shutting down in-person instruction and co-located meetings starting in mid-March 2020. By this point, we had conducted one in-person group interview, where it became clear that the group interview format was not going to get at the depth of responses we had anticipated from students. Given the institutional shift online, and associated logistical problems with co-scheduling students across time zones and with new stressors in their (and our) lives, we decided to shift group interviews to be individual interviews instead. We recruited participants by emailing campus organizations and student groups, explaining the purpose of the study, and seeking students who identified as marginalized within their engineering experience. Students then scheduled an individual interview with two members of the research team, conducted over Zoom. We include some of these data, selected for race, in this paper and explore them further in other publications [28]–[30].

We had developed our classroom observation protocol, now scheduled for fall 2020, anticipating in-person instruction. Due to the institution's decision to offer online instruction in addition to in-person instruction in fall 2020, to manage logistical constraints of having students work on teams when students could be situated across time zones, and to facilitate the kind of one-on-one instruction on coding possible when instructors can help individuals personally in the classroom, the course leadership decided to hold the class online in fall 2020 and spring 2021. We therefore adjusted our observation protocol to anticipate observing teams through joining breakout rooms in teaming portions of each class period. We quickly found, however, that student teams tended to operate with their video cameras off, and mostly with their microphones muted, which had an adverse impact on the formation of a cohesive team, and gave us little to observe. This widespread tendency to keep video and audio off even when in small groups was addressed by the instructor, to little effect. Although it had become commonplace for instructors to require camera usage, first-year instructors agreed that such a requirement was inappropriate since there are various legitimate reasons for keeping the camera off – lack of a camera, low bandwidth, a desire to maintain privacy in one's living space (particularly before background effects worked well), etc. Ultimately, through persisting for several weeks and documenting interactions in field notes, we concluded that attending classes when held virtually to observe teaming behavior was not worth the project staff's time.

Our interviews with instructors continued apace despite the move to online instruction. Margherio developed the interview protocol (Appendix A) and recruited instructors of our large first-year engineering courses at the end of fall 2020, spring 2021 (covering both fall and spring terms), and spring 2022 (covering both fall and spring terms) for interviews held virtually. Table I articulates additional detail on each semester of interviews. Margherio analyzed the data for inclusion in the project's annual report using thematic analysis. Margherio reviewed the

transcripts, wrote memos on key themes and interesting findings that emerged and then reviewed each interview's associated memo to examine the themes across the interviewees. These were communicated to the PI team through the annual evaluation report, included in the annual report to NSF. For this paper, we share key insights from 3 evaluation reports, along with pseudonymized interview data (where faculty are pseudonymized as Professors A-R). This is the first publication with data collected and analyzed through these instructor interviews.

TABLE I: Instructor interview participant information

	Course	**Number of instructors, pseudonyms**	**Mode of instruction due to COVID**
Spring 2020	Engineering 2	2/7, A, B	In-person then mid-semester shift to online
Spring 2021	Engineering 1 and 2	12/20, C-N	Online
Spring 2022	Engineering 1 and 2	4/10 who had not already participated; O-R	In-person or hybrid
Total		13 unique individuals	

Throughout these other data collection periods, we continued to analyze CATME data, although we focused solely on historical data (i.e. collected during spring 2017, fall 2017, spring 2018, fall 2018, and spring 2019). This reduced focus was due to reduced staffing available due to COVID (for example, some team members who had been scheduled to contribute to research were instead teaching online and caring for children at home). Briefly, we used an algorithm (described in [31]) to identify teams at risk of engaging in marginalization of minoritized teammates. We looked at the peer-to-peer comments, where teammates made qualitative comments about each other at 4 points during the term. We tracked patterns of coded language use [27] amongst selected teams, and did a deep analysis of how coded language increased in intensity across the term. We also assessed how minoritized teammates indicated warnings of their marginalization. We have reported some analysis from these data elsewhere [27], [28], [31].

Finally, we conducted a diary study during spring 2022, much delayed from our original timeline. We conducted in-person initial interviews with diary participants who were recruited based on their self-indicated identities as someone from a historically excluded group in engineering, using the device of a career journey map to structure the conversation. We then asked them to reflect on three prompts daily for a week, at three different points in the term. We completed data collection with an exit-interview. We conducted a thematic analysis of the diary content and have two papers in preparation: one focused on the daily experiences of students who identify as marginalized and a second paper reflecting on the role of harm and replication of harm in the research process [29], [30]. We do not refer to data from this study explicitly in this paper; however, its analysis formed the backdrop for our analysis of the individual interviews.

All our data collection and analyses were approved by the institutions' Institutional Review Board. CATME participants had previously approved for their team evaluation data to be used for research purposes. We pseudonymized student interview participants, instructor interview

participants, and CATME participants. Student interviewees received $10 gift cards for their participation. We offered $25 gift cards to instructors in recognition of their time contributed to interviews, but no one took us up on the offer. Students who were interviewed are identified by race and gender here based on their self-identification.

Author positionalities and roles

Masta, Dickerson, Ohland and Pawley constitute the project PI team. Margherio is the project's external evaluator, and Grant is the graduate research assistant. The PI team conceived of the original study motivation, focus, and general design, and acquired the funding. Masta applied for the original IRB approval, and oversaw revisions and compliance. Masta and Grant designed conducted all the data collection and analysis on new student data, including the group interviews and diary study, contributing to and writing Findings 1 and 2 of this paper. Dickerson worked on CATME data analysis, supported by Ohland. Margherio designed, conducted, and analyzed the interviews with instructors as part of the grant's annual external evaluation, and provided de-identified transcripts to the PI team for additional analysis. Pawley supported the general grant, conducted the analysis of the instructor interviews for this paper, and wrote Finding 3 and the bulk of the rest of this paper.

As a team, we together inhabit a number of marginalized and oppressing social positions across a variety of social dimensions, including race, gender, sexuality, indigeneity/colonizer, class, neurodivergence, nationality, tenured/non-tenured/non-tenure-track employment, among others. The collection of these positions, different for each one of us and undergirded by our conversations with each other over the years, strongly influence numerous aspects of this paper's analysis [32]. These include, but are not limited to, our decisions to engage in the type of research described in this paper, our epistemological and ontological commitments to certain kinds of research questions, methods, and analysis, our connection with our participants and therefore our ability to elicit (or prohibit) certain stories and responses from participants, our skill and capacity (or lack thereof) to do different sorts of critical analysis of our data and of each other's experiences, our need to continuously reflect on our historical and cultural positions, some of us more than others from a place of humility and responsibility, and our determination (some more established and others more fresh) to reduce harm to minoritized participants over protecting any fragile feelings of majority participants, analysts, and readers.

Our authorship order is not based on some simplistic quantification of each author's intellectual contributions to the specific paper itself, or indeed of the overall project. We recognize that our experiences of marginalization and of privilege are situated in an institutional system which values certain kinds of (raced, gendered, classed, and so on) experience and work over other kinds. There are few authorship guidelines, for example, that recognize the unequal and unfair distribution of emotional work that racially minoritized scholars routinely do on matters of race in academia compared to white scholars, or the compounded effort of existing (let alone thriving) as a socially minoritized scholar in an institution designed to advance white supremacist patriarchal heteronormative ideals under the guise of social neutrality [33]. One might also wonder how authorship order should recognize the additional work the institutional system of US academic engineering colleges, designed as they are to maintain cis-gendered heterosexual men as the dominating group, puts on cis- and trans-women, on trans-men, on non-binary or

gender non-conforming people, on gay, lesbian, and bisexual people and other people who are other minoritized sexualities, on neurodivergent or neurominority people, on physically-impaired people, to fit into a system that does not support their social or physical realities and can be also disabling [34]. As a result, we determine our authorship order based on an acknowledgement of these realities and their impact on traditional conventions that organize authorship order, and determine ours through consensus and mutual regard.

Results

In this section, given the complexity of the data collection and sources, we have organized our results by major findings rather than data sources. We share each major finding, then provide evidence for establishing each as a finding.

Finding 1: We see that teammates enact microaggressions and selective incivilities against their minoritized teammates frequently and predictably.

To develop this finding, we used data from our student interviews and reflections from the diary study to better understand how students experienced microaggressions within their engineering teams. Drawing from the transcripts of 17 student interviews we found that microaggressions were subtle, often called into question a student's skills and capabilities, and led to students feeling frustrated.

When asked to define microaggression, students frequently shared that microaggressions were things people said or did without truly realizing the problematic nature of their actions. Student W (a Black woman) shared, "It's not unintentional, but it's not intentional small acts of racism, small comments that you make. You're kind of unaware of it, but it's just instilled within you…" The subtleness of microaggressions meant that students often second-guessed their own reactions to the microaggression, or were quick to label microaggressive interactions as acts of curiosity as opposed to potential harms. For example, Student P (a Black woman) noted that if her classmates asked questions about her identity they would preface anything potentially insulting with "no, I'm just asking." Students within the study were often reluctant to label microaggressions as harmful, and instead minimized the microaggressive behavior by pointing to their teammate's lack of cultural awareness or exposure.

When students experienced microaggressions, those microaggressions often focused on a student's skills or capabilities within engineering, and when these microaggressions occur, students are left feeling frustrated and angry. Student P (a Black woman) shared that when microaggressions occur in teams it's disheartening and moves her to a place where she doesn't "even want to put forth the effort anymore." Student E (a Hispanic woman) mentioned that she's had teammates tell her "that I got into engineering at [institution] because I'm Hispanic" which leaves her feeling terrible and that she can't be proud of herself. One particularly egregious microaggression occurred when Student C (a Black woman) was purposely left out of group decisions and assignments because her group shared with her "Oh, Black people are always late because you run on CP time" when in fact her lateness was due to the distance between her classes, something her instructor was made aware of at the start of the semester. Student R (a Black woman) also noted that her group refused to give her any meaningful tasks with their project, often ignoring her requests to participate more. Student R rarely pushed back on these

interactions because she shared "I don't want to cause an issue here." Student N (a Hispanic woman) shared that her group would refuse to give her more than basic details about their group project, so she worked apart from the group, and would "pretend to be oblivious" when she pushed for more details or asked why they were excluding her, stating, "Oh, we don't know."

In reflecting on their experiences with microaggressions, students were frustrated and angry. Several of them noted that navigating teammates reduced their learning time and prevented them from learning and practicing essential skills. Student C (a Black woman) noted that working in an environment where she was treated differently ostensibly because of race "definitely did not allow [me] to reach [my] full potential." She struggled to convince her team to give her meaningful tasks, eventually deciding that "I'd rather not be bothered to try and go head to head with someone." Having to work with teammates that did not treat you as an equal partner meant that students missed out on several learning opportunities.

Finding 2: We also see that Black and Brown students have given up on the hope that their instructors will provide them with a safe and supportive learning environment, free from harassment and marginalization.

At the end of each individual student interview, we asked participants to reflect on how the institution could support their learning. Students overwhelmingly indicated that they doubted that the institution, or institutional actors such as faculty, would change. For example, Student M (a Latina woman) shared that "Some of the university's policies are somewhat conservative…and it doesn't really fit well with their claim of being a diverse university. So it'd be nice for them to not do that." Student P (a Black woman) noted that she thought "the whole structure needs to be revamped. I mean, for example, look at the people who are in charge. Where's the diversity there? The truth is, I'm just not [Institution's] number one priority"

Students' perspective that university leadership lacked commitment to diversity extended to students' perspectives on faculty and graduate teaching assistants (GTAs). Student N (a Hispanic woman) shared that in her engineering class, faculty did discuss diversity but framed it as an issue of respect. However, as she told us, "I know they were like "Be respectful to your teammates" But also if they added thinking about what you're saying actually means." It is not enough to point out that diversity is important; instructors should provide specific examples of what respect toward diversity looks like. Student C (a Black woman) stated that while the institution let students know to which offices to go for the issues related to DEI, training did not occur for faculty or GTA's. She shared, "I feel like….department heads will send out a letter to everyone, like, "we encourage diversity and inclusion." But when it comes to training, they haven't been taught about having the routine skills to be able to assess each team and to figure out if everyone's having the same learning opportunity." Even when students brought their concerns to faculty and GTA's they felt dismissed. Student J (a Black woman) shared, "We tried to talk to them [faculty/GTAs] about that, and they really didn't do anything, to be frank. They were like, "Oh, we understand, blah, blah, blah, and nothing got done."

While students express very little hope in their instructors, students see offices and programs on campus as the stopgap to certain marginalizations. As Student E (a Latina woman) stated, "I think minority programs are really important and also about educating everyone, not just the people that go through these things." A key program students identified was the school's

minority engineering program. Student B (a Black man) shared that the "minority engineering program is one of the key reasons why I even chose to go to [institution]. The community that [program staff] has been able to build and foster, even before I came here and then continuing while I've been a student." So students are not without resources, but do not consider faculty or GTAs as useful or helpful to them in navigating issues around their identity.

Finding 3: Many instructors don't sufficiently know how to teach teaming or function appropriately in diverse teams, and they might not even be sure it is their responsibility to intervene when teammates harass each other.

To construct this finding, we considered data from our interviews with instructors of two large courses, Engineering 1 and Engineering 2, each which has approximately 1800 students in it in a given semester. Engineering 1, which students normally take in the fall, is a prerequisite for Engineering 2, which students normally take in the spring. Each course has a different approach to teaching content about how to work in diverse teams. Engineering 1 has learning objectives based on teaming, but focusing on process awareness (including the team's awareness of its own problem-solving or design approach and how to continuously improve), and teamwork focusing on team products and discussions. This last dimension was operationalized thusly:

1. "Evaluate the unique knowledge, skills and abilities of each team member
2. "Document all contributions to the team performance with evidence that these contributions are significant.
3. "Develop strategies to support interactions between teammates and learn from one another.
4. "Develop expectations with high quality work and timely completion of team projects."

Content is largely defined by the PowerPoint slides the instructors are provided, and short videos produced centrally. The former covers characteristics of effective teamwork in the context of the course, setting up and revisiting later in the term a set of shared guidelines to govern the work of the group, how to handle common problems with communication and sharing the workload outside of class, documenting the team's work to monitor contributions, and making a plan for getting the group's work done in normal and extenuating circumstances. Instructors also talk briefly about why working in teams that are racially and gender-diverse, along with other dimensions, is beneficial to the team's work, to engineering products, and to the profession as a whole. There is no centrally-produced script, and the slides are expected to communicate to novice instructors enough for them to be able to teach the content without additional preparation or training. The latter, the short videos, cover dimensions of teaming used in CATME that gives students guidance on the expected behaviors of a good teammate. Their understanding of these dimensions are assessed through two small quizzes they can work on as teams and as many times as they like until they get the grade they want.

Students' teamwork skills are assessed through CATME 3-4 times in a semester, which contributes to their final grade. After students have completed their CATME evaluations and the results have been released to their teams, there is some time in the instructional team meeting to talk about logistics and strategy on how to process both the results the teams see about themselves, and the confidential comments to instructors, and how to intervene with teams.

However, this discussion comes amidst many other logistical demands the course makes on the instructors' time.

In contrast, Engineering 2 has no specific learning objectives focusing on teaming; its learning objectives on "professional skills" are focused on professional communication, assessed through writing and not through interpersonal interactions in the team. Similarly to Engineering 1, the content is defined by the provided powerpoint slides, with no additional instructor training on how to teach the content to students; also similarly, teaming is assessed 3-4 times per term through CATME, and the results of CATME are lightly discussed in the instructor team meeting with some time (perhaps 20-30 mins) focused on how to identify and handle teams identified by the tool as in distress.

Specific to Finding 3, our interviews indicate that many instructors don't sufficiently know how to teach about teaming, or might not themselves function well in diverse teams. We share here some illustrations of this interpretation, including the limited ways instructors understand teaming, their preparation to teach how to work in teams, their reliance on similarly underprepared teaching team members, their framing microaggressions as in individual's act through ignorance rather than as a systemic or cultural issue, and their general lack of preparation to consider what microaggressions in diverse teams might look like.

Instructors often described how they understood good teaming as relating to "acceptance", empathy, and professionalism rather than task-focused language centered in synergy and division of labor. Similarly, they understood teaming problems as based on poor "communication" - sometimes relating to the sometimes limited English language use of international students (perceived by some students as limited knowledge and understanding).

Instructor participants reported seeing value in teaching about how to work in teams well and acknowledged that it is a required professional skill for engineers. Some described how, in their class lectures, they stress the value of working in diverse teams in particular. However, because they usually have no additional training or expertise in teaming *per se*, and because the PowerPoint slides are brief on the topic and without additional technical knowledge included in the notes, instructors (especially new ones) tended to stick to the slide decks as provided, with only a few reporting that they had added some additional content when they felt they have the technical foundation to do so. Some instructors noted difficulties with this approach: for example, Professor G (Spring 2021, Engineering 1) highlighted, "It can be challenging to have faculty teach students how to be good at teamwork without marginalization, when they themselves are not good at it…when they themselves are either marginalized or they're the ones doing the marginalizing [when working on faculty teams]." Similarly, Professor E (same term and course) noted, "we're asking faculty to teach something that they may not be good at."

Perhaps as a result, as well as due to the large number of logistical demands in the course that they are already managing, instructors rely on their graduate teaching assistants (GTAs) and their undergraduate peer teachers to help them identify teams in distress. This is the case although GTAs and peer teachers are also not usually trained in how to identify teams that are poorly functioning, let alone when teammates are harassing one another personally. So while CATME was and is never intended to be the primary source of identification of teaming problems, it tends

to be where the teaching team starts, given that teaching team members are also often preoccupied with other logistics of the course, or underprepared for identifying teams in distress.

Instructors' understanding of structural inequities and marginalization on student teams varied, as did their capacity to respond to marginalization within teams. Interviewee responses reflected a range of preparedness for and comfort with responding to instances of marginalization in teams. Multiple instructors described addressing the issue of a silenced or sidelined teammate; some instructors, however, acknowledged they had little experience responding to instances of marginalization on student teams. A few felt that marginalization in teams could be alleviated if the students knew each other better on a personal level, demonstrating a belief that marginalization stemmed from individual misunderstanding rather than cultural or structural reasons. When asked if they had witnessed instances of marginalization, two instructors described personality conflicts, such as dominant versus shy personalities, or cliques that form in a team. Sometimes instructors demonstrated they thought marginalization could be self-inflicted: Professor N (Spring 2021, Engineering 2) shared, "Sometimes students marginalize themselves because they don't engage." Instructors further explained that identifying marginalization and bias can be difficult because, "it's generally behind the scenes…it won't happen in class or during the Zoom, it'll usually happen during the out-of-class group meetings." To recognize instances of marginalization, Professor L (Spring 2021, Engineering 2) asks their graduate teaching assistants and peer teachers to pay attention to identify "speech that would be hurtful for other team members," when they observe student teams.

Of the types of marginalization that instructors were familiar with, most frequent was binary gender-based marginalization: three interview participants referred to gender-based inequities in their responses. Professor J (Spring 2021, Engineering 2) described observing instances of gender bias in teams, "I've seen female students who get assigned the roles of note taking or 'you do the lit review, and we'll do the programming.'" One instructor acknowledged non-binary gender-based marginalization, and several raised concerns about international students or students whose first language is not English. Conspicuously absent is any discussion of race- or ethnicity- based marginalization; like in other engineering disciplines, domestic white and/or international instructors constitute the majority of the instructors for this course, and remain less likely to be comfortable, let alone fluent, when talking in their teaching about race and racism. Other forms of marginalization stemming from homophobia or transphobia, xenophobia, ability/disability, neurodivergence, or settler colonizing mindsets are similarly undertreated by most instructors.

Taken together, these reports suggest that instructors, responsible for teaching teaming to their students, often don't sufficiently know how to teach teaming, and themselves may struggle to function appropriately in diverse teams.

Our second claim in Finding 3 is that these instructors were not sure it was their responsibility to intervene in circumstances where teammates were harassing peer teammates. Given that instructors had largely adopted a variety of individualistic mental models about why marginalization happens, rather than structural or institutional models, the implied appropriate response when an individual transgresses acceptable norms of workplace civility is focused on the individual. While we consider this logic inaccurate, even if it *were* accurate, instructors were

telling us both that they still did not know how to identify marginalization, and that they didn't know how to respond when they did identify it. Furthermore, given the other demands on their time, they did not seek to gain knowledge or skills to rectify this deficiency. If an instructor adopts a model of individual responsibility for individual acts as a model for how culture is made exclusive, it makes sense that the instructors feel overwhelmed when considering their responsibility for making an inclusive environment: through such an individualistic model, it appears they must intervene at the individual level repeatedly in a large class to make it so, which feels unreasonable in addition to their other responsibilities. They may therefore cope with this difficult expectation by setting the bar for intervention as very high - for example, Professor G (Engineering 1, Spring 2021) acknowledged, "I generally don't intervene. I mean, the comments have to be very, very negative for me to actually take action."

This individualistic model is reinforced by instructors' reliance on CATME to identify when something was wrong, even though CATME didn't necessarily give them enough information at the right time to intervene, rather than starting from in-class observation or discussion with peer mentors or the GTA and using CATME as confirmation. Professor C (Engineering 1, Spring 2021) elaborated that, "A balance has to be struck between the students having enough information about their teamwork to be able to respond, but it being early enough to identify and disrupt some of these patterns of marginalization." Professor H (Engineering 1, Spring 2021) similarly commented, "Sometimes [issues] don't reflect in CATME early enough." Interpreting the data CATME collects without structured guidance can be challenging, especially for new instructors: Professor L (Engineering 2, Spring 2021) found sorting through the comments provided in CATME to be "overwhelming."

There is not a centralized process or training for determining when to intervene with malfunctioning teams, nor how to intervene, which has resulted in widely variable responses across the courses' sections. Many might be in Professor G's circumstances of largely not intervening. When instructors did intervene, they tended to do so in subtle ways, not in ways that called out the action of perpetrators. For example, one instructor in spring 2021 teaching Engineering 1 reported that they email the whole team when one student raises a concern to them. Three of the four interviewees in spring 2022 felt that the best approach was to hold a meeting with the entire team, though Professor J (Engineering 2, Spring 2021) acknowledged that they relied on a "gut feeling" to know when it would be better to hold one-on-one meetings with team members. Professor K (Engineering 2, Spring 2021) was the only instructor who felt that the default response should be one-to-one communication. Professor L (Engineering 2, Spring 2021) offered a more detailed approach, describing a "domino effect of intervention," in which they would first talk to the team during class time, then escalate to one-on-one meetings as needed, and would finally set up ongoing team meetings and establish a detailed workload plan for the team.

Such an ad-hoc approach to intervention muddies the water as to whose responsibility it is to intervene. Is it part of the "storming" teaming process to let the teams muddle through on their own; that is, is it part of the developmental process of (predominantly white, male) teams to engage in such behavior? Is it the responsibility of the instructor, responsible for 30-90 teams (depending on the number of sections they teach) even when they themselves are not necessarily trained how to coach or otherwise intervene? Is it the responsibility of undergraduate peer

teachers, who are encouraged to get to know the specific set of 7-8 teams in their corner of the classroom, but who are undergraduate students themselves and potentially averse to conflict with their peers? Is it the responsibility of the GTA, who is tasked with overseeing the undergraduate peer teachers, who are themselves supposed to be observing the teams' functioning, but who also have many other class claims on their time? All of these feel unreasonable.

We take the perspective that it is indeed instructors' responsibility given their position of power and authority in their classroom. This responsibility exists already, even though given current norms it might feel like "additional" work for already overburdened instructors. However, without coupling a clear designation of responsibility with training on microaggressions as forms of harassment that should not (or no longer) be tolerated as "normal teaming," instructors can continue to operate under the assumption that their intervention is unnecessary until confronted with a crisis. So it is not instructors' responsibility alone: it will take a larger coordinated effort at the course-level and indeed more widely in the broader engineering school to redirect and support instructors, given many themselves may have learned to accept and even perpetuate such microaggressions and harassment as normal and unchanging, to change such a damaging culture of undergraduate engineering teaming in their sections.

Discussion and conclusions

Through the interviews with and diary entries from minoritized students, it was clear how subtle yet frequent the harassment they had to endure from their teammates was, and how they had become resigned to current circumstances as constituting the best they could expect from their learning environments. From the interviews with instructors it was clear how many instructors tended only to engage when problems were severe. When combined with our CATME analysis described elsewhere [28] where we can see how severe problems had subtle antecedents which a trained reader could identify as potentially problematic, these insights suggest some conclusions for instructors and CATME.

When considering the subtlety and frequency of microaggressions and instances of selective incivility, we can see how the teaming content is misaligned with what instructors expect of teams. The instructors seem to have a mental model of teaming dysfunction based on individuals' actions (such as poor communication or workload distribution), which teams can overcome with improved communication, and by majority members developing stronger empathy with minoritized members. But little course content - either time, or information - focuses on either how to improve communication between students with very different backgrounds, or on students developing empathy for one another. Furthermore, no class content focuses on the existence of systemic factors that enable a classroom culture to endure - or resist - teammates' harassing each other. This mental model that focuses on teammates as independent individuals coupled with unclear centralized expectations for intervention enables the reality that untrained instructors will not have bandwidth to bring harassing teammates to account for their actions. Such systemic failures create a culture described in the individual interviews, where minoritized teammates have come to expect that they will have to endure harassment with little-to-no consequences to the perpetrators, and that this is the best their classroom and their university will provide. Without important cultural changes, these distressing perspectives on undergraduate engineering education will remain accurate.

Therefore we recommend teaching teams teaching large multi-instructor undergraduate engineering courses develop and adopt a course-wide model taught to instructors, graduate teaching assistants, and peer teachers of how microaggressions and selective incivilities interact with culture.

One place to start may be with Sue and colleagues' microintervention framework [19]. In this work, Sue and colleagues outline a model (illustrated in Fig. 1) directed progressively to the perpetrator of a microaggression, to institutional so-called "macroaggressions" (or what we might call meso-aggressions), to societal-level macroaggressions. What instructors have control over in the classroom is directed towards the perpetrator. Sue and colleagues then lay out four different responses to consider, each with an articulated strategic goal, set of objectives, rationale, example tactics, and example script putting the previous detail into language that instructors, targets of harassment, or other teammates could use directly. The four different responses are:

- Making the "invisible" visible - where someone names the metacommunication of the microaggression, which can feel empowering to the namer and which can help them feel less unsure about the event later;
- Disarming the micro/macroaggression - where someone "stop[s] or deflect[s] the comments or actions through expressing disagreement, challenging what was said or done, and/or pointing out its harmful impact" (p. 138);
- Educating the perpetrator - where someone interacts with the perpetrator either short term or long term to "plant seeds of possible change that may blossom in the future" (p. 138). Taking the time to differentiate intent from impact may have this effect on someone; and
- Seeking external intervention - intervening may be risky, dangerous, or exhausting for the target, bystanders, or allies. Sometimes gaining support in handling the situation is important; similarly, sometimes intervening is someone's institutional job (such as when one comes across racist flyers or graffiti, or when someone has threatened violence against a teammate).

Fig. 1: Microintervention model, adapted from framework established in Sue et al [19]

We see promise in adapting Sue et al's microintervention model to Engineering 1 and 2 specifically because of its practical and specific nature. However, we think it is important to also focus instructors' attention to establishing a classroom culture where teammates and teaching

team members regularly and routinely address microaggressions and selective incivilities with each other. Such refocusing on a cultural level allows instructors some grace: for example, instructors will make mistakes in addressing microaggressions and incivilities - we cannot be everywhere at once, and we might lack expertise in knowing how best to intervene in a particular situation. While making mistakes in individual events implies failure, doing so from a cultural model allows instructors space to develop a plan for responses, take second tries at particular situations, or to apply what one learned from a mistake to the next time it comes up. This is because it is not about every single event, but instead establishing a culture where instructors, GTAs, and students themselves, collectively address harassment.

A prerequisite for a cultural model would then be a course-wide expectation -and associated model - of responsibility, emphasizing that it *is* the teaching team's responsibility to provide a supportive learning environment for their students and therefore to address microaggressions and selective incivilities in teams even when (especially when) they are small. In such a learning environment, minoritized students would experience a stronger sense of support from the faculty and other authority figures in the classroom.

Such a cultural model would then need to be interpreted in various ways for various constituencies, including scenarios for training instructors, GTAs, and peer teachers; developing new powerpoint content (and associated scripts); incorporation in teamwork evaluations and assessments; and incorporation as learning objectives that are assessed for understanding and through behavior.

As we continue with our analysis of the various data collected through this project, we intend to develop theory around this cultural model and curricula to be adaptable by other first-year programs to their own institutional needs. This future work we hope to share in subsequent years at ASEE and other venues.

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Appendix A: Instructor interview protocol
Thank you for meeting with me today! I'm the evaluator of the NSF-funded I-MATTER project, which is designed to improve our understanding of the dynamics of teamwork within engineering classes, with specific attention to marginalization.

I have a short list of questions, and you are free to talk as much or as little in response to each question as you want. There are no right or wrong answers. If it's alright with you, I'd like to record today's conversation. While I am conducting today's interview for the evaluation, I'd like to share the transcript with the research team as our conversation may be useful for this work. Is it alright with you if I record? If at any point in time you say something that you'd rather not be shared with the research team, please just let me know and I can redact it from the transcript. Do you have any questions before we get started?

Introduction/warm-up:

1. Could you start by describing your experience as an instructor in Engineering 1 and/or 2?
    a. [Probe: When did you first begin teaching Engineering 1 and/or 2?]
    b. [Probe: How long have you been teaching undergraduate engineering courses?]
    c. [Probe: What is your professional position or title at [Institution]?]

Approach to teaching teamwork to students

2. What is your approach to teaching teamwork to your students?
    a. How do you help students learn to manage team dynamics to facilitate everyone's ability to contribute?
    b. How, if at all, do you discuss issues of marginalization, such as implicit and explicit racism, sexism, and homophobia, when you are teaching students about teaming?
3. In your experience, what are the common challenges to teamwork that your students encounter?
4. How do you evaluate how well the student teams are functioning?
    a. [Probe: How do you use the information captured by CATME?]
    b. [Probe: What types of information about team functioning have you thus far been unable to capture?]

Capacity to recognize marginalization, bias, and discrimination within teams

5. What would marginalization or bias within the teams look like?
6. When, if ever, have you witnessed marginalization or bias among teammates in your courses?
    a. How, if at all, do you try to be aware of marginalization that might occur within teams in your courses?
7. What makes recognizing marginalization and bias within teams challenging for you?

Capacity to respond to marginalization, bias, and discrimination within teams

8. What is your approach to address any marginalization that may occur within teams in your courses?
    a. [Probe: How, if at all, might you interrupt any marginalization or bias?]
    b. [Probe: How, if at all, do you work with students to help them interrupt any marginalization or bias?]

Impacts of I-MATTER

9. How familiar are you with the I-MATTER project?
10. How, if at all, has the I-MATTER project impacted how you approach teamwork in the classroom?
11. Is there anything that you would like to tell me about teamwork in your courses that we haven't discussed today?

Appendix B: Student Interview Protocol

This written interview protocol is an illustration of the performed interview protocol; however, the interviewer is often flexible with these questions and asking follow-ups or following new directions. This is normal for this type of interviewing.

1. Please describe your experiences in your classes.
    a. Positive experiences
    b. Challenging experiences
2. How do you define the term “microaggression?”
3. Based on your definitions, share any personal experiences with microaggressions.
4. Describe any microaggressions you experienced/witnessed in engineering classes.
5. How do your experiences with microaggressions influence your idea of teamwork?
6. Describe the places you feel you belong and are welcomed on campus.

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