INSTRUCTORS' UNDERSTANDING OF TEACHING FIRST-YEAR ENGINEERING TEAMING: CHARACTERIZATION AND REDIRECTION

Alice L. Pawley,[1] Cara Margherio,[3] Stephanie Masta,[2] Darryl Dickerson,[4] and Matthew W. Ohland[1]

[1] School of Engineering Education, Purdue University, USA
[2] Department of Curriculum and Instruction, Purdue University, USA
[3] Center for Evaluation and Research for STEM Equity, University of Washington, USA
[4] Department of Mechanical and Materials Engineering, Florida International University, USA
apawley@purdue.edu, clm16@uw.edu, szywicki@purdue.edu, darryl.dickerson@fiu.edu, ohland@purdue.edu

Abstract – *Teaming is increasingly important to teach well in undergraduate engineering education. Teams composed of both majority and minoritized students have an increased risk of majority members harassing minoritized members. Instructors of large classes have a difficult time identifying in which teams such harassment is taking place, and knowing what to do to interrupt it. This paper, part of a bigger project grounded in microaggression theory and selective incivility theory, specifically considers what instructors currently do, and indeed whether it is their job to address teammate harassment. We undertook a rough thematic analysis of interviews with instructors of a large first-year engineering course at a large American research-extensive majority-white university in the Midwest. We found instructors adopted an individual-centric model of teaming, intervened mainly in severe instances, and their interventions tended to be subtle. We offer an early version of an alternative model to structure forthcoming training sessions with instructors, graduate teaching assistants, and peer teachers.*

Keywords: Teamwork; Undergraduate first-year students; Gender; Race/ethnicity; Qualitative research; Instructors.

1. INTRODUCTION

Undergraduate engineering students are increasingly expected to be able to work effectively in diverse teams upon graduation, and both ABET (accrediting US programs with criterion 3.5) and Engineers Canada (accrediting Canadian programs with Criterion 6) have explicit criteria focused on students' abilities to work well in teams that reflect this expectation [1], [2]. However, it is common engineering education research on teaming has focused on characteristics and problems of student teaming without focusing on the experiences of minoritized students (by gender, race/ethnicity, sexuality, nationality, colonial/settler status, etc.).

The work reported in this paper is drawn from a larger project whose goal is to find ways to make discrimination and harassment more visible to instructors of large undergraduate engineering courses so they may then elect to interrupt it. Some of our previous publications from this project argue that microaggressions are prevalent and identifiable through CATME (a web-based tool for assessing student teamwork; [3]), and that minoritized students, particularly those who identify as Black or Brown, have resigned themselves to the low-to-high grade harassment they experience on a daily basis from teammates and sometimes instructors. This paper specifically focuses on the experiences of instructors in teaching such a class that relies on CATME to evaluate teaming effectiveness. We explore what instructors' perspectives are on how they teach about teaming and why, how they assess when teams are struggling, and how they make decisions about when to intervene when teams are functioning poorly together. We are particularly attentive to how instructors think about the experiences of minoritized students in the midst of these reflections.

This paper summarizes some of the literature that situates this work and points the reader to other publications on the same project, then outlines the method by which we interviewed instructors then analysed the transcripts. We share results specific to the matters described above and some insights based on those results, and then introduce our early thinking about an alternative model that can be used to structure instructor training as well as content to teach teammates. We conclude with some specific recommendations for how instructors who are looking to produce an effective and supportive learning culture for all students, including minoritized students, could learn to do so.

Peer reviewed

2. BACKGROUND

2.1. Teaming in engineering education

Both educators [1], [2] and industrial employers [4], [5] increasingly recognize engineers' ability to function effectively in diverse teams as a fundamental skill that one can learn to do better, and that students can learn during their undergraduate degree.

Numerous assessment tools exist to assess students' teaming function in courses [6]–[9], but less guidance exists to help instructors know what to do with what they learn through these assessments to help improve students' ability to work together.

One such tool is the Comprehensive Assessment of Team-Member Effectiveness (CATME), a web-based team evaluation tool that uses a scientifically developed behaviourally anchored rating scale to measure five ways of contributing to a team. In addition to the peer evaluation instrument, the system can measure other scientifically developed and published scales measuring team processes and outcomes, including psychological safety, team conflict, and team satisfaction, all of which can be helpful in identifying teams that are dysfunctional [10]. The system includes a rater practice feature that helps calibrate student ratings. Instructors receive quantitative scores (converted from the behaviourally anchored scale), qualitative comments team members address both to peers and confidentially to instructor, and flags based on the quantitative scores that identify exceptional team conditions. If and when the results are released by the instructor, students receive an indication of their ratings from teammates (which also places them in the context of the team average), automated written feedback on things they could do to improve their ratings, and the comments from their peers. CATME evaluations focus on behaviour (such as "Notices changes that influence the team's success.") rather than intent (such as "wants the team to succeed."). A significant amount of research using CATME has been done, including findings that rating accuracy can be improved with training [11], that task interdependence moderates the importance of warmth and competence in team dynamics [12], and that various rating patterns can be anticipated and related to team functioning [13]. CATME has a partner application, Team-Maker, that assists with criterion-based team assignment. Team-Maker has been shown to be better and more consistent at meeting instructor criteria than an experienced instructor [14], in addition to the more obvious benefit that it saves instructors considerable time, especially in large, multisection classes. In the context of this work, the most important team-formation criteria were to avoid isolating people who self-identify as women or people of colour on a team.

2.2. Theoretical frameworks

Our theoretical framework relies primarily on Sue et al.'s germinal work on microaggressions [15], and on Cortina's theorizing of selective incivilities. Sue et al. [15] operationalized the concept of racial microaggressions coined by Pierce [16] to interrogate how racism was shifting culturally in the US from a more Jim Crow-informed form of *de jure* and explicit racism to a more "covert" form. They situated microaggressions in the context of literature denoting a prejudice continuum organized by one's consciousness of one's own racism; the continuum is structured thusly:

> "...aversive racists are the least consciously negative ["strongly motivated by egalitarian values as well as antiminority feelings"], followed by modern and symbolic racists, who are somewhat more prejudiced, and finally by old-fashioned biological racists." (p. 272)

Sue and colleagues were interested in developing a framework for thinking about the more aversive, modern, and symbolic forms of racism that white psychology clinicians should understand in order to be more useful therapy providers to clients of colour.

Sue et al.'s foundational paper on microaggressions denotes three sorts (defined on p. 274): micro*assaults*, micro*insults*, and micro*invalidations*. Microassaults are "explicit racial derogation characterized primarily by a verbal or nonverbal attack meant to hurt the intended victim through name-calling, avoidant behaviour, or purposeful discriminatory actions." In contrast, microinsults were "characterized by communications that convey rudeness and insensitivity and demean a person's racial heritage and identity." Finally, microinvalidations were characterized by communications that exclude, negate, or nullify the psychological thoughts, feelings, or experiential reality of a person of colour." Subsequent scholars have extrapolated from Sue et al.'s framework to consider the concept of microaggressions as applied to other dimensions of marginalization, including gender, sexuality, class, nationality, language of origin, age, ability/disability, neurodiversity, and so on.

In later work, Sue et al. [17] importantly draw our attention to two important misconceptions commonly made about microaggressions. First they note that the "micro" term does not indicate any sense of a microaggression's smallness of scale or triviality, or indeed of intent or even covertness; instead, "micro" indicates an act operating at the micro-level of interpersonal interaction, in contrast with meso-level actions at the level of institutional racism, and macro-level actions at the level of societal racism. To illustrate this contrast, Sue et al. use the quotidian albeit horrific example of "the unwarranted shooting and killing of a Black male suspect" by police officers as a microassault - the use of "micro" is not intended to

minimize the shockingly harmful impact of it, but is to indicate a focus on the everyday interpersonal-ness of it. Considering a criminal justice system where many such acts are routinely and systematically minimized and where perpetrators are rarely held to account, involves analysis at the meso and macro levels. The second misconception involves distinguishing microaggressions as specifically racialized rather than other more everyday forms of rudeness, all the way up to assault. Microaggressions are:

> "a. constant and continual in the lives of people of colour, b. cumulative in nature and represent a lifelong burden of stress, c.) continuous reminders of the target group's second-class status in society, and d) symbolic of past governmental injustices directed toward people of colour (enslavement of Black people, incarceration of Japanese Americans, and appropriating land from Native Americans)." (p. 130)

Switching theoretical directions for a moment, we also draw on workplace incivility theory, established by Andersson, Pearson, Cortina, and other colleagues [18]–[20], and defined as "low-intensity deviant behaviour with ambiguous intent to harm the target, in violation of workplace norms for mutual respect." [18, p. 457] Cortina and colleagues operationalize a subset of these workplace incivilities, "selective incivilities," as an illustration of "modern" racism and sexism present in workplaces. Drawing on theory based on concepts of intersectionality and double-jeopardy, as well as the Aggressive Experiences Scale, Cortina and colleagues establish that "women and people of colour reported significantly more experiences of incivility on the job than did men or [white people], respectively. The uncivil behaviours assessed in these studies were neutral in content with respect to both gender and race." [20] In other words, white women experienced more instances of incivility than white men, Black women experienced more instances of incivility compared to Black men (in this study), and Black women were "uniquely vulnerable to incivil treatment" than any of the other 3 groups - white women, Black men, or white men. However, the instances in terms of their content were not particularly clearly coded as racist or sexist or both.

In this research, we were interested in the number and nature of instances that either we as observers, instructors, or students identified as microaggressions, with a focus in this specific work on microaggressions or incivilities rooted in racism. We draw on theory about coded language as one lens through which we see instances of more covert expressions of racial bias. Coded language theory is strongly connected to racism in US politics [21]. Himelstein [22] defined "code words" as "a word or phrase which communicates a well-understood but implicit meaning to part of a public audience while

preserving for the speaker deniability of that meaning by reference to its denotative explicit meaning." This definition embodies one category of coded language in which strong, culturally derived stereotypical connotations are encoded into the words thus providing a way to veil biases and perpetuate those stereotypes. Examples include words such as "urban", "inner city", and "illegal aliens". Another category of coded language includes those words and phrases that elicit negative stereotypes when selectively applied to specific groups. We use this understanding of how language expresses values and implications beyond the literal meaning of the words as a mechanism through which microaggressions are enacted.

3. METHODS

3.1. Study design and changes due to COVID

The broader project had a complex data collection strategy that was further complicated by COVID. We summarize the broader strategy for context, then describe the method used for the data in this paper.

The project received funding in October 2019. The study site was a large research-extensive engineering-centric university in the US Midwest whose population was predominantly white and disproportionately male given other peer institutions of its size. We intended to collect data mostly from two required, team-taught, large-scale undergraduate engineering courses, here called "Engineering 1" and "Engineering 2." Both courses are taught in both fall and spring terms, although the enrollment is skewed to have one large offering in the primary semester (approximately 15 sections of 120 students each) and a smaller offering in the "off" semester (2-3 sections of 60-90 students each). Engineering 1 has its large offering in the fall and small in the spring; Engineering 2 is the converse. Sections are formed from 120 students, an instructor, half of a graduate teaching assistant (GTA), four undergraduate peer teachers who attend class, and two undergraduate graders who do not attend class. Each course meets for 4 hours per week across 16 weeks; the goal is to have flipped content, where students prepare by watching videos, and completing pre-class quizzes, and perhaps ⅔ of the time scheduled for class meetings is focused on students or teams working together, and asking individual questions of the teaching team. The instructors and GTAs across all sections of the same course meet weekly for 90 minutes. Course design is set centrally: learning objectives are set by a steward team of faculty and staff who review materials at least annually and make big changes to the design during the small course offering as a pilot before pushing them out to the big course offering. The course is supported by a full-time staff of 5 employees, and does not follow or require any textbook.

In the proposal, we had intended to do the following data collection:

- analysis of CATME data collected from previous years of Engineering 1 and 2, and from spring 2020;
- group interviews with minoritized students who were recruited through various minority support programs;
- classroom observations of students working in teams in Engineering 2;
- interviews with Engineering 1 and 2 instructors;
- a diary study conducted with minoritized students in the observed class of Engineering 2. Students would write daily entries for a week at 3 points in the term, with pre/post interviews.

With the start of funding, due to staffing changes since writing the proposal, we decided to focus on historical CATME data analysis starting in October 2020, and doing group interviews in spring 2020, putting off classroom observations and diary study until fall 2020.

In March 2020, COVID brought numerous challenges. We made research design changes in light of our own work conditions and childcare support, given centrally-made decisions at the study site being announced daily about course modality in both spring 2020 and fall 2020. As a result, we ended up doing the following data collection:

- we continued with the CATME analysis we had begun on historical data, and threw out our plans to collect contemporary data;
- we completed one group interview in spring 2020 before the study site shut down in-person activity; we then pivoted to individual interviews conducted over Zoom;
- we shifted plans from observing classroom interactions in person during fall 2020 to observing teams working in breakout rooms in Zoom, as both Engineering 1 and Engineering 2 centrally shifted to online instruction for all of AY 2020-21;
- we disconnected our recruitment for the diary study from our selection of sections for classroom observations conducted in fall 2020, and instead ran the diary study with students recruited via email and interviewed in spring 2021; and
- we interviewed instructors as planned in summer 2020, Jan/Feb 2021, summer 2021, and summer 2022 over Zoom.

3.2. Focus of this paper

This paper is largely based on the interviews we conducted with instructors across the life of the project, although it draws a little on insights gained in other parts which are documented in other publications [10], [23]–[25]

The second author, as the project's external evaluator, conducted the interviews with instructors by video conference, and wrote short memos after each interview. The interview protocol is Appendix A. We used thematic analysis to determine themes to include in the project's annual report, then cross-referenced the themes with the post-interview memos for confirmation. The author made pseudonymized transcripts available to the PI team, and communicated the themes to the PI team through the annual report and through annual reflections on the project's logic model during PI meetings.

For this paper, we did not follow a formal methods text or systematic coding approach. Instead, we reviewed the insights from the annual report in the context of insights from the historical CATME analysis, the student interviews, and the diary study. We looked for common patterns around teaching approach, beliefs about what made teams have difficulties working together, and beliefs about racism, sexism, and homophobia as cultural phenomena. Through writing about these patterns, we formed insights about the broader approach to teaming, some of which we have shared elsewhere [10], [23] and which we introduce here. We read or re-read pseudonymized interview transcripts with these insights in mind, and edited the insights as we went to make them more precise. We strongly anticipate these insights will continue to evolve as we work with these data in conjunction with the other datasets. We may edit quotes included here for stylistic consistency, readability (such as adding punctuation and paragraph breaks) and focus on the topic; we mark excluded or edited text with square brackets except when we have (lightly) edited crutches of speech (like "um").

3.3. Instructor interview participants

The initial instructor interviews were conducted about teaching that occurred across the starting period of COVID - that is, instructors in spring 2020 were asked about their teaching and teaming approaches given that instruction began in person in spring 2020, and switched to entirely online starting after spring break for the remainder of spring 2020. Teaching in Engineering 1 and 2 remained online for the 2020-21 academic school year. In the 2021-22 academic year, the courses were mostly taught in person with some COVID restrictions during fall and early spring (including classroom de-densification, required masking, and social distancing, encouraging vaccination and self-reporting vaccination status, and requiring flu shots from on-campus workers); those restrictions were largely dropped later in the spring 2022 semester. Some instructors of Engineering 1 and 2 remained online during 2021-22 AY to teach students who preferred learning that way or in light of their own health conditions; some other instructors were scheduled to teach in person but added online options, thereby teaching in a hybrid mode. Table 1 outlines the number of

instructors (who included faculty, staff, and graduate students) interviewed and when they were interviewed. No instructor was interviewed twice; during spring 2022 there were 10 potential instructors who had not yet been interviewed from which to recruit participants.

Table 1: Instructor participants.

Term inter-viewed	Course	# of instr & pseudonyms	Mode of instruction
Spring 2020	Engineer-ing 2	2/7; A,B	In person then online
Spring 2021	Engineer-ing 1 & 2	12/20; C-N	Online
Spring 2022	Engineer-ing 1 & 2	4/10 new; O-R	In-person, online, or hybrid

We did not ask instructor participants to self-disclose gender, race, or other demographic information. We assume that the pool of instructors is similar to the courses' home department, which is majority white, and majority female among the faculty and staff. The graduate students are majority female (cisgender and transgender), and about one quarter are international students, with the remainder almost evenly split between domestic white students and students of color together, meaning that white students constitute the plurality of any racialized group. Compared to engineering departments at this institution and as a whole, the home department is more diverse by both gender and race.

4. RESULTS

We believe our data show us that instructors have co-constructed an individualistic model of teaming. Under this model, and with some variation, the centrally-produced slides and videos on teaming are largely sufficient for teaching students about the content, teams experiencing problems don't need much intervention until the problems are severe, and when interventions are necessary, it is usually best done in a subtle manner, with the team together. When applied to teaching, this model generates a classroom culture that leads Black and Brown students to experience lack of support and that this neglect (at best, or hostility at worst) is the best that they can expect from instructors of these required courses, as some of our other publications illustrate [23], [24]. We now lay out the claims that describe the contours of this model.

4.1. Insights from prior work

In our other work, we draw on historical CATME data and from the individual interviews with students to

establish two findings that matter for this paper's subsequent points:

1. We can see precursors of problematic teaming behaviour through CATME data collected early, including coded language used in peer-to-peer comments [25]; and

2. Students of colour report that microaggressions are subtle, often called into question their capabilities, and caused them frustration and anger. [24] At the same time, some participants were reluctant to label them as harmful, minimizing their impact and dismissing events because they felt teammates "didn't mean it." [23] Students felt resigned to such treatment, which they thought was inevitable, and indicative of how little regard the university gave to them.

We will return to these two points and how they relate to instructors' perspectives on teaming in the discussion.

4.2. Instructors' behaviours regarding teaming content

The two courses approach the content about teaming with many similarities (such as pedagogical approach, foundational content, the pace, structure, and grading scheme for assessments, reliance on CATME as primary assessment tool on teaming, etc.). There are a few differences, including that Engineering 1 includes learning objectives regarding teaming as assessable material, while Engineering 2 does not even list any learning objectives about teaming. At the same time, while at least articulating some learning objectives, Engineering 1's objectives are limited to a focus on process awareness, and the team's own awareness of its effectiveness; the learning objective list articulates:

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."

This approach implies the culture of teaming is entirely controlled by the members of the team themselves, and is independent of any culture of teaming that influences expectations at the classroom or course levels, let alone at the disciplinary level.

As described in 3.1, course content is set centrally by a team of faculty and staff, both instructors and support personnel. Content presented in class through slides is both amplified and deepened with short videos students watch before and after coming to class, and it is picked up in aligned assignments. In theory, this alignment strengthens the opportunity for students to achieve the

learning objectives. In practice, however, course content can adopt a legacy status where it remains in the slide deck used to form next term's content, unless a faculty member initiates and carries through what is often a herculean effort to change the aligned content in slides, videos, and assignment documents, and done during the production schedule laid out by the support staff. This schedule is important and necessary to have the support staff manage and balance their work demands; it also means that content can only be changed centrally when most instructors are not teaching and thinking about it.

The result is that the formalized content presented in the Engineering 1 and 2 courses presents a particular view of teaming that reinforces an individualistic view of teaming. Students learn that teams go through regular phases of development, that engineering work is often organized by teams, that teams that are made up of people with different backgrounds and identities make better engineering decisions or develop more innovative designs than those that are demographically or otherwise more homogeneous. Instructors assign a group activity of developing a team flyer to "represent" the team to help them get to know each other, and to develop a team contract of how they will work together over the rest of the term, based on templates supplied centrally. The students watch videos produced by the course about CATME dimensions of teaming, and take a quiz twice worked on with their team, on the material. Students also complete the team evaluation portion of CATME 3 to 4 times in the term (the courses centrally switched from 4 times to 3 times during our study period).

When asked how they teach about teaming, most instructors across terms and courses said they relied largely on the centrally-produced content - slides, associated videos, activities, and assessments. Some instructors knew this content was not sufficient. Some supplemented the material with some additional commentary they found valuable, such as different roles that teammates may productively take on in teamwork, or the positive impact of diverse teams working well together on specific industry-based cases, or other real-world circumstances. A few instructors talked about marginalization, bias, and discrimination, and some acknowledged the difficulties instructors have teaching content about working in diverse teams when they themselves are not necessarily proficient in working in diverse teams.

4.3. Instructors' perspectives on when teams need intervention

Many instructors talked both about how they relied on CATME to identify struggling teams, and how CATME was insufficient for assessing whether teams were functioning appropriately. No instructors solely relied on CATME data; some used CATME to identify teams that were struggling that then they and the rest of the teaching team could observe more closely. Instructors acknowledged that teaming remotely during COVID was a new situation for which they were underprepared, and for which their tools were not calibrated or sufficient. Generally instructors tried to "triangulate" findings from CATME with observations and conversations with teams they identified through CATME as struggling.

Instructors overwhelmingly identified frequent teaming problems as relating to time management or project management, such as work distribution, individuals who did not meet their commitments for whatever reasons (like missing meetings, not getting work in on time, etc.). Sometimes workload issues arose when there was large variability in students' coding abilities (either real or perceived) across a given team. Some instructors identified other problems, such as students who had taken up leadership roles from a more authoritarian stance, or teammates who articulated clear (sometimes unreasonable) boundaries for which teammate should do what work. And some instructors acknowledged issues with microaggressions that teammates enacted on each other.

Instructors varied on whether they considered microaggressions as a reason to intervene with students. Some thought that the main reasons that teams struggled to work together had to do with poor communication amongst teammates, or because the teammates had not developed enough empathy for one another, or because they were not managing their workload appropriately. Two instructors talked about personality conflicts, while one talked about a teammate "marginalizing themselves" because they didn't engage with teammates. Some instructors articulated clear example of microaggressions: for example, Prof. D said:

> "...at one team where a white male team member. they actually invoked, like all three stereotypes, for their teammates in their comments, was amazing. They you know, the short summary of their comments would be like the Black guy my team seems lazy, the... No, so sorry, the Black guy on my team seems dumb, the Latino guy on my team seems lazy, and the Chinese guy on my team seems quiet. I'm like, wow, that's like, that's the trifecta of stereotypes, way to go… so I, like I, immediately flag that team for observation."

Others acknowledged they had seen teammates exhibit gender bias, and language bias (against international students who did not speak English as their first language), while some described not ever seeing teammates micro-aggressing each other. Overall, it was much more common for instructors to talk about gender-based microaggressions than racial microaggressions.

Some instructors explicitly talked about coded language, and how our project's presentations to the instructors helped them identify circumstances that

needed to be addressed. However, we have less frequently discussed theory on selected incivilities with instructors; this can form some of our future work.

4.4. Instructors' perspectives on whether and how to intervene

While instructors expressed varying levels of confidence in their ability to identify and address marginalization in their classrooms, they all explicitly validated the need for this broader research project. They recognized that CATME had its limitations, and for the most part, acknowledged they did not have a sufficiently satisfactory approach for intervening in teams that were functioning poorly.

Instructors described a variety of intervention tools at their disposal, including: whether the peer teacher, GTA, or instructor interacted with a team; whether they should talk with individuals, subsets, or the whole group together; whether they should be explicit or implicit about the problems they were seeing regarding teaming; whether they were more or less directive about how the team should handle the problems in their teams.

While we have not yet assessed which was more common, instructors often adopted either an "intervene early" or, contrastingly, a "wait and see" approach to intervening. For the former, Prof. O described their approach:

"…Early in the semester, I pay very particular attention to those situations because I know that small things at the beginning, turn into larger things toward the end of the semester [when] stress gets higher when they're doing finals and projects and other classes, and so as the semester progresses, small things at the beginning, tend to be indicative of larger things at the end, and so I like to nip things in the bud because I want to make my life easier and their lives easier, so I will, sometimes depending on how many students and issues I see, and the I guess the magnitude of those issues…"

Regarding the latter, there seemed to be an escalation approach: if CATME flagged a team in some way, first an instructor might send a peer teacher or GTA to watch the team work together in class, then they might swing by themselves; they might then make a point to talk with the team in class about the team's difficulties; if more severe, they might contact the team outside of class for a special meeting. They also varied in how directly they talked about the team's problems. Prof. F gave this example:

"...but I had a team last fall, there were two women and two men. And the two men contacted me to complain about the two women on their teams, so I set up a zoom meeting with them and the first thing I did was, asked them to tell me about the teammate that was right there in the Zoom meeting, so these two men were meeting with me. You

know, so what is [Student A] like and where does he live and what do you know, have you ever gone out to the dining hall together, and things like that. And clearly they had a relationship; and then I asked them about one of their women teammates and she's an international student; I asked them where she lived and whether she had any siblings. They had no clue, they had no clue, and then I pivoted to their on-campus woman teammate and asked what dorm she lived in, they had [had] no clue and it was like a light bulb went off in their head, and we saw, then I didn't just let them, as I just didn't assume what they understood what I was talking about, I actually discussed this with them about, teamwork is about creating a relationship and you need to start every meeting with a check in about how are you doing, you know how to see your life. And need to know, get to know your teammates and emphasize, you know, you don't have to become friends with them, you don't even have to like them, but you do have to have a professional relationship. And I never heard from them again."

Some instructors had used individual approaches when they felt there was a "perpetrator" of marginalization: for example, Prof. C said:

"It depends on the case, but in the cases where I've seen where they've been a lot more explicit or students have themselves reported it and the anonymous comments I will usually talk to the perpetrator, so to speak, on, and I think that's important that they understand that it's something that I, as an authority figure take really seriously…"

Some instructors acknowledged that teaming problems needed to be "really bad" before they intervened. Usually, such instructors acknowledged the workload of the course, the large number of students for whom they were responsible, and the many other tasks for the class they were already managing.

While we are still working on assessing patterns of frequency on how instructors handled problems, we currently think the balance of approaches tended towards subtle interventions, with teams approached as a unit.

5. DISCUSSION

The study site's large introductory courses benefit from being taught by a large number of instructors who care deeply about teaching well, from a pedagogical perspective which centers student learning, and provides space and points for students to learn how to work together.

At the same time, most instructors' backgrounds and training, combined with other logistical considerations and legacy content, has resulted in co-constructing a

course-wide approach to teaching teaming that is largely isolated from a broader cultural conceptualization about teaming. In other words, instructors described a course design where teammates would need to learn from each other to be successful, and described pedagogical and and other efforts to structure it as such, but then when individual teams struggled with working together, they adopted an individualised approach to diagnosis and treatment. Working in such a context could then lead particularly majority instructors to think of teams where teammates were engaging in microaggressions against each other as isolated matters of individual harm, as misguided young people merely making mistakes through their inexperience, as rare and unfortunate but correctable through the right "trick" of responding. Such a perspective suggests that matters of intervention are mere matters of technique to be mastered, and deployed in the right circumstances.

However, we would like to offer a contrasting perspective. A classroom or course-wide culture where teaming is claimed to be important but where intellectual content on how to do it well is minimal, which takes an approach centered on the actions of a team in isolation from broader social dynamics, where teaching team members' training in how to coach teams is minimal and *ad hoc*, through the experiences of other or more experienced instructors, is not a culture that recognizes the importance of diverse teams nor the difficulty of doing it well.

What might a contrasting culture look like? We think it would be valuable to consider microaggressions not as a mere series of unlikely unfortunate events which, if you don't catch in time, you lose the chance to address, but instead as the water in which we are swimming, which will take a concerted section-wide or indeed course-wide effort to clean. Rather than individual fleeting microaggressions being the sole responsibility of instructors to catch and correct, we could consider microaggressions as forming a broader cultural pattern that continues to be culturally enabled, thereby necessitating a concerted, intentional, and sustained, approach for re-education of and by particularly majority members of the class, including other students on a given team, neighboring teams, peer teachers, and teaching staff. Rather than teaming content being relegated to window dressing that each section's teaching team needs to find extra energy and time to handle in an already stuffed and logistically complex curriculum, teaming would be centered as critically important, conceptually difficult, and culturally worthy, with much more time dedicated to its discussion, with learning objectives and materials on teaming as culture dedicated to its teaching, and with training dedicated to its improvement, while so-called "technical content" would be given the leftovers. In such a context, each instance of microaggression would be understood as both adding to a

lifetime of toxic treatment the target has had to endure, as well as contributing to and maintaining a hostile learning environment for the aggregate of minoritized folks, not just the target; such understanding would therefore allow us to better see the environment as toxic to all learners and workers, not just a minoritized individual that one time. It would no longer be about worrying about an instance of poorly handling a case of teammate harassment identified in the classroom, because every case is both an indicator of a broader cultural acceptance of microaggressions, and an opportunity to practice resisting their acceptance, including for oneself, for the target, and for one's audience of other teammates, students, and instructors.

As we continue to analyse these data from the project's multiple data sources, the research team will continue to interrogate the potential of this idea. In the meantime, we can learn from Sue et al.'s microintervention theory [17].

In 2019, before the pandemic and the summer of racial unrest in the US responding to the murder of George Floyd, Sue et al. [17] published a helpful response to some of the misinterpretations applied to their earlier theorizing about microaggressions (introduced in 2.2), including what individuals could do to resist microaggressions specifically. In this work, they are more explicit about potential theorizing interventions at the micro (interpersonal), meso (organizational) and macro (societal) levels. They embed these three levels of analysis into four different types of responses to consider, meticulously describing for each a strategic goal for the response, a set of objectives, a rationale for this approach, example tactics, and some example scripts, things one could actually say or do. These four responses include:

- Making the "invisible" visible: a focus on metacommunication where the actor (whether the target or an ally) names the subtext of the microaggression; this can help the actor feel empowered, which can help them remain confident in the microaggression as such when others might strive to minimize it;
- Disarming the micro/macroaggression: an actor "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 an actor interacts with the perpetrator over the short 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: where an actor gains support in handling the situation, including someone whose institutional job it is to intervene,

or who can give emotional support to the actor given intervening can be risky and exhausting.

Sue and colleagues provide a detailed table operationalizing this approach (beginning on p. 136) which would be impossible to adequately reproduce here given space constraints, but is well worth reading. We have introduced it to the instructors of Engineering 1 and 2 as a potential path forward to start practicing, and will return to them later in AY 2022-23 to discuss its effectiveness in the context of their classroom teaching.

6. Conclusion

This project is clearly still strongly situated in the analysis phase of its dissemination due to numerous delays and adjustments due to COVID. However, we think the main insights provided here - on the culturally individualistic model of teaming embodied through the structure and pedagogy of a first-year engineering course, and the potential of a replacement model focused more on how teaming interacts with cultural norms enabling microaggressions and selective incivilities - have potential to endure. We look forward to thinking further in this direction for our future analysis, as well as expanding our discussion of selective incivility theory and coded language into more robust interventions for instructors of large undergraduate engineering classes.

Acknowledgements

References

[1] "Criteria for Accrediting Engineering Programs, 2023 – 2024 | ABET." https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2023-2024/ (accessed Feb. 10, 2023).

[2] Engineers Canada, "2021 Accreditation Criteria and Procedures," 2021. https://engineerscanada.ca/sites/default/files/2021-11/2021%20Accreditation%20Criteria%20Book%20Word.pdf

[3] CATME, "Comprehensive Assessment of Team Member Effectiveness (CATME) SMARTER Teamwork Peer Evaluation." [Online]. Available: www.catme.org

[4] K. Börner *et al.*, "Skill discrepancies between research, education, and jobs reveal the critical need to supply soft skills for the data economy," *Proc. Natl. Acad. Sci.*, vol. 115, no. 50, pp. 12630–12637, 2018.

[5] A. N. Azmi, Y. Kamin, M. K. Noordin, and A. N. M. Nasir, "Towards industrial revolution 4.0: employers' expectations on fresh engineering graduates," *Int. J. Eng. Technol.*, vol. 7, no. 4.28, pp. 267–272, 2018.

[6] M. W. Ohland *et al.*, "The Comprehensive Assessment of Team Member Effectiveness: Development of a Behaviorally Anchored Rating Scale for Self- and Peer Evaluation," *Acad. Manag. Learn. Educ.*, vol. 11, no. 4, pp. 609–630, 2012.

[7] K. Willey and A. Gardner, "Improving self- and peer assessment processes with technology," *Campus-Wide Inf. Syst.*, vol. 27, no. 5, pp. 379–399, 2009.

[8] M. B. L. Donia, M. Mach, T. A. O'Neill, and S. Brutus, "Student satisfaction with use of an online peer feedback system," *Assess. Eval. High. Educ.*, vol. 47, pp. 269–283, 2022, doi: 10.1080/02602938.2021.1912286.

[9] M. B. L. Donia, T. A. O'Neill, and S. Brutus, "The longitudinal effects of peer feedback in the development and transfer of student teamwork skills," *Learn. Individ. Differ.*, vol. 61, pp. 87–98, 2018.

[10] D. A. Dickerson, S. Masta, M. W. Ohland, and A. L. Pawley, "How Can We Identify Teams at Risk of Marginalizing Minoritized Students, at Scale?," presented at the ASEE Virtual Annual Conference, Virtual conference: American Society for Engineering Education, Jul. 2021. [Online]. Available: https://peer.asee.org/37250

[11] A. C. Loignon, D. J. Woehr, J. S. Thomas, M. L. Loughry, M. W. Ohland, and D. M. Ferguson, "Facilitating Peer Evaluation in Team Contexts: The Impact of Frame-of-Reference Rater Training," *Acad. Manag. Learn. Educ.*, vol. 16, no. 4, pp. 562–578, Oct. 2017, doi: 10.5465/amle.2016.0163.

[12] J. S. Thomas, A. C. Loignon, D. J. Woehr, M. L. Loughry, and M. W. Ohland, "Dyadic viability in project teams: The impact of liking, competence, and task interdependence," *J. Bus. Psychol.*, vol. 35, no. 5, pp. 573–591, 2020.

[13] A. C. Loignon, D. J. Woehr, M. L. Loughry, and M. W. Ohland, "Elaborating on Team-Member Disagreement: Examining Patterned Dispersion in Team-Level Constructs," *Group Organ. Manag.*, vol. 44, no. 1, pp. 165–210, Feb. 2019, doi: 10.1177/1059601118776750.

[14] R. A. Layton, M. L. Loughry, M. W. Ohland, and G. D. Ricco, "Design and Validation of a Web-Based System for Assigning Members to Teams Using Instructor-Specified Criteria," *Adv. Eng. Educ.*, vol.

2, no. 1, 2010, Accessed: May 06, 2019. [Online]. Available: https://advances.asee.org/publication/design-and-validation-of-a-web-based-system-for-assigning-members-to-teams-using-instructor-specified-criteria/

[15] D. W. Sue *et al.*, "Racial microaggressions in everyday life: Implications for clinical practice.," *Am. Psychol.*, vol. 62, no. 4, pp. 271–286, 2007, doi: 10.1037/0003-066X.62.4.271.

[16] C. Pierce, "Offensive mechanisms," in *The Black Seventies*, Porter Sargent Publisher, 1970, pp. 265–282.

[17] D. W. Sue, S. Alsaidi, M. N. Awad, E. Glaeser, C. Z. Calle, and N. Mendez, "Disarming racial microaggressions: Microintervention strategies for targets, White allies, and bystanders.," *Am. Psychol.*, vol. 74, no. 1, pp. 128–142, Jan. 2019, doi: 10.1037/amp0000296.

[18] L. M. Andersson and C. M. Pearson, "Tit for tat? The spiraling effect of incivility in the workplace," *Acad. Manage. Rev.*, vol. 24, no. 3, pp. 452–471, 1999.

[19] L. M. Cortina, "Unseen Injustice: Incivility as Modern Discrimination in Organizations," *Acad. Manage. Rev.*, vol. 33, no. 1, pp. 55–75, Jan. 2008, doi: 10.5465/amr.2008.27745097.

[20] L. M. Cortina, D. Kabat-Farr, E. A. Leskinen, M. Huerta, and V. J. Magley, "Selective Incivility as Modern Discrimination in Organizations," *J. Manag.*, vol. 39, no. 6, pp. 1579–1605, Sep. 2013, doi: 10.1177/0149206311418835.

[21] I. Haney-López, *Dog Whistle Politics: How Coded Racial Appeals Have Reinvented Racism and Wrecked the Middle Class*. Oxford University Press, 2014.

[22] J. Himelstein, "Rhetorical continuities in the politics of race: The closed society revisited," *South. Speech Commun. J.*, vol. 48, no. 2, pp. 153–166, Mar. 1983, doi: 10.1080/10417948309372560.

[23] J. Grant, S. Masta, D. Dickerson, and A. Pawley, "'I Don't Like Thinking About this Stuff': Black and Brown Student Experiences in Engineering Education," presented at the ASEE Annual Conference and Exposition, Minneapolis, MN, Jun. 2022.

[24] S. Masta, J. Grant, D. Dickerson, M. W. Ohland, and A. L. Pawley, "'There's so many to choose from': Student reflections on classroom-based microaggressions (in preparation for Equity & Excellence in Education)," *Equity Excell. Educ.*, in preparation.

[25] D. Dickerson, S. Masta, M. W. Ohland, and A. L. Pawley, "Is Carla Grumpy? Analysis of Peer Evaluations to Explore Marginalizing Behaviors in Engineering Student Teams," *J. Eng. Educ.*, vol. In review.

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?
   [Probe: When did you first begin teaching Engineering 1 and/or 2?]
   [Probe: How long have you been teaching undergraduate engineering courses?]
   [Probe: What is your professional position or title at [UNIVERSITY]?]

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?
   [Probe: How do you use the information captured by CATME?]
   [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?
    [Probe: How, if at all, might you interrupt any marginalization or bias?]
    [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?