Bridging the Research-Practice Gap: Development of a Theoretically Grounded Workshop for Graduate Students Aimed at Challenging Microaggressions in Science and Engineering

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Bridging the research-practice gap: Development of a theoretically grounded workshop for graduate students aimed at challenging microaggressions in science and engineering

Amy C. Moors1*, Lindsay Mayott2 and Benjamin Hadden3

Abstract: Efforts to promote diversity and inclusion often lack a theoretical basis, which can unintentionally exacerbate issues. In this paper, we describe the development and evaluation results of a theoretically grounded workshop aimed at reducing microaggressions and promoting ally engagement among graduate students in science and engineering. In Study 1, using a Delphi method, eight science and engineering faculty members with backgrounds in diversity efforts provided feedback on workshop development. In Study 2, 107 graduate and advanced undergraduate students engaged in the 90-minute interactive workshop. Results indicate that attendees found the workshop valuable, developed new skills for ally engagement, and planned to engage as an ally moving forward (all averages of closed-ended assessments were 4.21 out of 5.00 or higher). Themes that were identified from qualitative responses mapped onto learning objectives, including raised awareness about microaggressions, sufficient practice, and confidence to improve one’s academic climate. Although microaggressions are common in science and engineering spaces, the present findings illustrated that, for many attendees, the information was new, including research on microaggressions and evidence-based ally strategies. This study offers a theoretically grounded approach to bridging the research-practice gap.

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PUBLIC INTEREST STATEMENT
Great strides have been made in developing diversity and inclusion trainings in science and engineering disciplines. Unfortunately, many of these trainings lack a theoretical basis which can unintentionally exacerbate issues. The present research developed and tested a new theoretically grounded 90-minute workshop-style intervention aimed at challenging gender- and race-based microaggressions in science and engineering through ally development. The present intervention introduces graduate students in science and engineering to five evidence-based strategies to intervene as an ally when confronted with microaggressions. The present research describes the development, implementation, and evaluation results of this intervention and provides resources (e.g., workshop slides, survey instrument) for researchers and university personnel interested in implementing the workshop.
intervention that facilitates intentional behavioral changes, which can help students change norms to support the advancement of women and people of color.

**Keywords:** student diversity; microaggressions; gender; race; ally; cultural climate

**Subjects:** Education - Social Sciences; Gender Studies - Soc Sci; Sociology & Social Policy; Psychological Science; Higher Education

“From what I can tell, there are many people who mean well, but don’t understand the perspective of a [woman],” an electrical engineering graduate student told me. “[They] don’t know how their actions, although intended as jokes or a harmless comment, affect the recipients and bystandersHu (2014).”

The number of women and people of color earning doctoral degrees in science and engineering disciplines has steadily increased over the past 20 years in the U.S. (National Science Foundation, 2015). Despite greater representation of women and people of color in science and engineering spaces, feeling included in these spaces remain a critical issue (Barthelemy et al., 2016; Hurtado et al., 2011). As illustrated in the quote above, repeated actions that invalidate certain groups—even if intended as jokes or harmless statements—weigh heavy on people with marginalized identities. These subtle insults, slights, and invalidations (known as microaggressions) saturate science and engineering spaces and contribute to the daily unwelcoming, and often hostile, experiences of women and people of color (Harrison & Tanner, 2018; Johnson, 2012; Moors et al., 2014; Sue et al., 2007).

A popular way to promote the advancement of women and people of color in science, technology, engineering, and mathematics (STEM) academic spaces is to implement diversity and inclusion educational opportunities. Unfortunately, sometimes these educational trainings are ad hoc and lack a theoretical basis, which can unintentionally exacerbate issues (Apfelbaum et al., 2012; Cundiff & Murray, 2020). The quest for answers to “how do we best foster inclusive science and engineering spaces?” is now a motivator of new analysis and action to bridge the research-practice gap. The present research seeks to remedy this gap by developing a workshop grounded in theories of prejudice and evidence-based practices for ally engagement.

In the present paper, we describe the development, implementation, and evaluation results of a workshop-style intervention aimed at promoting ally development and an inclusive academic climate: **Speak Up in STEM! Intervening as an Ally and Challenging Microaggressions**. We developed a new conceptual model that synthesized theories of prejudice and strategies for ally engagement when witnessing microaggressions. Central to our workshop was research related to gender- and race-based microaggressions as well as the marginalized experiences of women and people of color in science and engineering. The workshop was designed to facilitate ally-engagement skills among majority members. Our target audience for this workshop was graduate students in science and engineering. We focused on this time period because it may be the highest point of attrition for women and racial-ethnic minorities from the science and engineering academic pipeline (Brown et al., 2016; Espinosa, 2011). Moreover, students in these career stages often value diversity as part of their learning and perceive their identities as important and salient within STEM spaces (Lee et al., 2021; Marey et al., 2021). Thus, this career stage is ripe for the development of skills to promote a positive climate.

1. **Science and engineering academic climates and transformation initiatives**

Unwelcoming and hostile professional climates are a top contributor for women and people of color’s disinterest in and departure from science and engineering disciplines (Cabay et al., 2018). In studies examining the experiences of women in science and engineering programs, women reported experiences with both micro- and macro-aggressions (such as overt discouragement, sexual harassment) and perceived that their research tasks were restricted by gender roles
Barthelemy et al., 2016; Gallaher & Pearson, 2000. Similarly, people of color in science and engineering programs report feelings of inferiority and invisibility in response to microaggressions and express frustration with a lack of institutional support to address microaggressions (Alexander & Herrmann, 2016). Women and people of color who remain in unwelcoming academic work environments tend to experience low job satisfaction, lack of belonging, and feelings of inability to influence department culture (Settles et al., 2007).

Although people with majority identities (e.g., people who identify as White and/or men) may commit microaggressions without an intention to insult, their “good intentions” often do not translate (Sue et al., 2007). Further complicating the notion of “good intentions,” microaggressions are often brushed off as jokes or victims are made to feel like they are overreacting (Sue & Capodilupo, 2008). As such, there is often a discrepancy between the intention of the message and how the message is received (intention vs. impact; Offermann et al., 2013). Although majority members may not readily recognize the negative impact of microaggressions, ample research has documented that microaggressions are linked with poor health outcomes (e.g., depression and substance abuse; Sue et al., 2008; Torres et al., 2010) as well as poor academic performance and work productivity (Keels et al., 2017; Salvatore & Shelton, 2007).

Recognizing the importance of issues regarding campus climate, many higher education institutions have implemented strategic diversity plans aimed at institutional transformation. Stemming from National Science Foundation ADVANCE Institutional Transformation and National Institutes of Health diversity and inclusion grants, several theoretically-informed educational interventions were developed to improve science and engineering academic climates for faculty members (e.g., Fernandez et al., 2014; Stewart et al., 2004). However, similar endeavours aimed at graduate or undergraduate students have yet to be developed. Previous theoretically-grounded interventions have primarily focused on education related to implicit biases (unconscious associations of stereotypes or negative views with certain groups of people; Carnes et al., 2015) and biases during the...
hiring process (e.g., Stewart et al., 2004). We extend this area of research-to-practice by develop-
ing an educational workshop aimed at reducing microaggressions (distinct from implicit biases) and bolstering ally engagement in academia.

2. Conceptual framework and theoretical grounding
To develop the present intervention, we synthesized theories of prejudice and ally development with evidence-based practices for conflict resolution (Ada Initiative, 2015; Carnegie Mellon University and Google, 2016; Devine et al., 2012; Southern Poverty Law Centre, 2005). Engaging people to combat microaggressions and act as allies is not a simple process, but it can be broken down into parts. As illustrated in Figure 1, there were three central components to the proposed intervention model: consciousness raising and skill development that people progress through to commit to active ally engagement.

The first component, consciousness raising, incorporates principles from the prejudice habit model (Devine et al., 2012). This model posits that biases function like a habit or an ingrained pattern of thoughts and behaviors which can be changed (Devine et al., 2012). On the surface, it may appear that if a person feels motivated to stop enacting prejudice, that person can simply do so. However, a growing body of evidence suggests that motivation to change one's attitudes and behaviors is only part of the “solution” (e.g., Devine et al., 2012; Devine & Monteith, 1993). According to the prejudice habit model, a person must be aware of their biases as well as possess the skills to counteract their prejudiced responses (Devine et al., 2012). Enacting a long-term change in biases can be achieved by treating bias as an unwanted habit. That is, a habit that can be “broken” through a combination of motivation, awareness, and skill development. The prejudice habit model can be likened to other types of behavioral change interventions. For instance, effective smoking cessation interventions are those in which individuals are motivated to quit and have developed skills to unlearn their habit (e.g., behavior replacements). As such, foundational knowledge (e.g., examples of microaggressions) and a discussion on exploring personal motivation to reduce prejudice were incorporated into this portion of the workshop.

Coupling the prejudice habit framework with bystander and ally development models (Bishop, 2002; Casey & Ohler, 2012; LaMantia et al., 2015), the second and third components of our conceptual model focused on skill development and engagement. We drew on scholarship that defines an ally as someone who takes a proactive stance and works to “end oppression in his or her personal and professional life through support of, and as an advocate with and for, the oppressed population” (Washington & Evans, 1991, p. 195). Fostering ally development among majority member peers is a critical component of institutional transformation, as allies can use their privilege to promote inclusion (McGeorge & Bilen-Green, 2021). Complementing the prejudice habit model, contemporary ally development frameworks also utilize progressive stage models of attitude and behavior change (LaMantia et al., 2015; McGeorge & Bilen-Green, 2021). Core aspects of these stages include: raised awareness, acquisition of new knowledge/education, critical self-reflection, development of skills, and planned action to advocate for those with less power and privilege.

3. Workshop content
The first part of the Speak Up in STEM! Intervening as an Ally and Challenging Microaggressions workshop focused on raising awareness about microaggressions by including examples and research related to its effects on well-being and academic climate. The second part of the workshop introduced five evidence-based intervention strategies to use when microaggressions are observed, followed by three role-playing exercises to practice using the strategies in real-world scenarios. In this section, we outline the content of the workshop; see, for workshop overview and Figure 1 for conceptual model with learning goals. For workshop slides, see: https://osf.io/25pz3/.

To ensure that the lived experiences of women and racial and ethnic minority graduate students were reflected within the role-play scenarios, the first author met with two groups of doctoral students in science and engineering (groups of two and four) at a large, research-intensive
Midwestern University. Drawing on the local norms and experiences of people within a given academic space has been shown to be effective tool for consciousness raising and change, especially when paired with empirical evidence (Stewart & La Vaque-Manty, 2008; Stewart et al., 2007). Thus, the goal of these discussions was to develop ecologically valid experiences of marginalized science and engineering graduate students.

In both group discussions, we explained the Speak Up in STEM! workshop initiative as well as our collaborative pedagogical approach to workshop development. The graduate students described various common verbal and non-verbal slights based on their marginalized group membership (or the intersection of multiple marginalized identities) that they have experienced or witnessed. Together, the first author and the graduate students translated these experiences into the several distinct role-playing scenarios which were incorporated into the workshop.

4. Introduction and guiding principles
The workshop began with personal introductions of the facilitators. To foster an inclusive learning space, the lead facilitator explained that everyone in the room is learning (e.g., developing ally skills is a continual practice) and should be open to constructive feedback. The lead facilitator encouraged participants to engage in self-reflection and acknowledge how much space one’s voice is commanding (e.g., the extent to which someone may be dominating a conversation).

Part 1—Bias education: What are microaggressions? What harm is done? What effects do microaggressions have on climate?
To raise awareness about microaggressions, facilitators opened with common microaggressions that they have personally experienced in an academic context. The conversation was centered on the facilitators to avoid having participants publicly share personal stories. Each example was framed as a question to the audience with an explanation of how the facilitator interpreted the comment. For instance:

[Question raised to audience]: Have you ever overheard someone with (presumably) good intentions say something dismissing about someone else?
[Audience shown example as facilitator reads aloud]: “Wow... I can’t believe she’s so good at statistics. I can’t believe she taught statistics... to college students!”
[Facilitator explanation of gender-based microaggression experience]: Microaggressions often take the form of things that we say to each other. The person who said this may be impressed by my knowledge of statistics and research; perhaps, the person had good intentions. However, the impact this statement has on me—and many women or people of color who have experienced similar reactions—feels much different from the intention. This statement sends me a subtle message that I don’t look or act like I belong as a professor in academia, especially one that is skilled at math. The person who typically says this to me upon learning about my career typically acts astonished to find out that myself, an young woman, teaches statistics and research skills in a college, not a lower division schooling, setting.

Following these examples, the facilitators further explained various forms of microaggressions, including verbal and nonverbal slights, non-inclusive physical environments (e.g., images of only scholars who are White men), and the valuing of hierarchal roles in academia (Cheryan et al., 2009; Sue et al., 2007; Young et al., 2015). Next, they discussed how macro- and microaggressions were acts of racism and sexism that manifest in different ways (explicit vs. harder to identify; Sue & Capodilupo, 2008).

To provide insight into the lived experiences of targets of microaggressions, the facilitators included images from two consciousness-raising photography projects (Henise, 2015; Kim, 2013). Both photography series captured people holding statements that had been said to them (verbal microaggressions). As part of Kim’s (2013) photo series focused on racial microaggressions, an image of a Black student holding a sign that states: “You don’t act like a normal black person, you
know?" was shown. As part of Transgender Awareness Week, Henise's (2015) photo series at the Gay and Lesbian Alliance Against Defamation organization highlighted microaggressions related to trans and gender non-conforming people. For example, a transgender woman holds a sign that states: “Did you have the surgery?” While this microaggression may appear to be a question based on curiosity, asking a person this question is inappropriate and invasive (Nadal et al., 2012). Finally, we displayed a list of various types of microaggressions to expand participants’ understanding of the different forms of microaggressions (e.g., telling a woman she's too emotional to make a decision, using the phrase “that’s gay”). Workshop participants were encouraged to discuss the extent to which these various forms of microaggressions are witnessed and/or experienced on campus.

Next, we highlighted research that links experiencing microaggressions with negative health outcomes, including anxiety, depression, posttraumatic stress, and substance abuse (O'keefe et al., 2015; Sue et al., 2008; Torres et al., 2010). Further, researchers have argued that the chronic stress associated with microaggressions weakens the immune system and increases the level of risk for cardiovascular issues (Walls et al., 2015), demonstrating the bidirectional relationship between mental health and physical health. We also discussed how microaggressions elicit negative affect and reactions (e.g., anger, energy depletion), which are valid responses to receiving differential treatment based on one’s race and/or gender (Yosso et al., 2009). We ended this discussion with research that links the negative impact of microaggressions on marginalized people's academic performance and work productivity, which can ultimately affect a person’s decision to leave science and engineering spaces (Keels et al., 2017; Salvatore & Shelton, 2007; Yosso et al., 2009).

Ending the first part of the workshop, we drew on two metaphors used by scholars and activists to help participants clearly picture the impact of microaggressions. Alvin Possiant described the cumulative impact of experiencing microaggressions as “death by a thousand nicks” (as cited in Williams, 2000, p. 10). We also described a Fusion Media (2016) video, where microaggressions are compared to mosquito bites. For instance, while most people may get occasionally get “bitten by mosquitoes,” people with marginalized identities can, in one single day, be covered, blistered, and exhausted from being covered in “mosquito bites.” Participants were encouraged to imagine the physical and psychological feeling of being covered in thousands of nicks as well as mosquito bites.

5. Part 2—intervening as an ally: What can we do if we overhear microaggressions?
The second portion of the workshop began with contextualizing why people should intervene when microaggressions are witnessed in the workplace. The burden is often placed on people with marginalized identities to speak up for themselves. When women and people of color self-advocate, they are often met with social and economic repercussions, such as being less likely to be promoted for a new position (Livingston et al., 2012; Phelan et al., 2008).

We identified five evidence-based recommendations for people to intervene when observing a microaggression. Of these five strategies, three focused on ways to intervene and shift the person’s (who committed the microaggression) perspective and/or engage them in self-reflection. Two strategies focused on communication strategies for the ally to consider when intervening. A mnemonic device was created to aid in remember the strategies; the first letter of each strategy spells the word “speak.”

**Strategy 1: Share thoughts and feelings using “I” statements.** The first strategy encouraged the use of “I” statements for witnesses to describe how they are interpreting a given comment or action (e.g., “It makes me uncomfortable when I hear X . . . ”) or “I know your intention was a compliment though, to me, it comes off as X . . . ”; Clay, 2017; Nadal, 2014). Use of “I” statements may prevent defensiveness from the speaker and allow for a calm, yet direct confrontation about the microaggression. This strategy also allows the ally to speak
for themselves, rather than on behalf of the individual who experienced the microaggression, which may be further degrading (Southern Poverty Law Centre, 2005).

**Strategy 2: Point of view: Encourage speaker to take another perspective.** The second strategy focused on having the speaker see the situation from another point of view (e.g., “imagine what it would feel like to receive that comment?” or “have you considered how someone else would interpret that comment?”). Asking the speaker to imagine what it might be like to be in the position of the target of their comment may elicit empathy and increase the speaker’s awareness of the microaggression they committed (Albiero & Matricardi, 2013; Nagda & Zúñiga, 2003; Vescio et al., 2003).

**Strategy 3: Explain the situation without blame.** The third strategy encouraged allies to avoid blame and focus on the situation at hand (Devine et al., 1991; Nadal, 2014). Placing blame on the speaker (i.e., attributing blame to one’s character as opposed to the situation), may increase defensiveness in the speaker and, ultimately, thwart behavior change. Moreover, witnessing defensiveness of the speaker can further add insult to the target of the microaggression (Lewis et al., 2000).

**Strategy 4: Ask the speaker questions.** The fourth strategy encouraged participants to ask the speaker questions, such as “what do you mean by X …?” or “could you explain X …?” Asking a question allows the speaker to take a moment and self-reflect on what they said (Brownell, 2013; Southern Poverty Law Centre, 2005). Moreover, this may help the speaker to identify the issue and self-correct their behavior.

**Strategy 5: Keep humor out.** The fifth recommendation focused on avoiding humour, jokes, or sarcasm when intervening as an ally. Use of humour to navigate an awkward situation is a common conflict management style, especially among majority members (e.g., men; Cox et al., 1990; Smith et al., 2000). However, in the case of speaking up for targets of microaggressions, humour may backfire. Specifically, humour can be distorted by cultural barriers and power (Brahnam et al., 2005; Smith et al., 2000), lending to a message to be lost or viewed as passive-aggressive behavior. In addition, humour can elicit positive non-verbal cues (e.g., smiling, laughing), which can indirectly indicate approval of a microaggression—despite a different intended verbal message.

To provide opportunities to practice using the ally intervention strategies, participants engaged in three different role-play exercises. Each scenario described a microaggression occurring between two people (see below for method used to develop ecologically valid situations). Participants were asked to form groups of four and rotate through each role once per scenario: Person A (perpetrator of microaggression), Person B (target of microaggression), Person C (ally), and Observer (e.g., note taker and provided feedback on the effectiveness of the ally intervention); see, figure 2 for an example. Participants in the role of Person C were encouraged to use at least one of the five recommendations in their response as an ally. Groups were given approximately six minutes to work through each scenario and to receive feedback from the Observers. Participants were encouraged to provide constructive feedback to the ally to improve their intervention skills. After each scenario, all workshop participants engaged in a large group discussion; similar and unique intervention strategies and themes were noted by the facilitator. Groups were encouraged to share how their members chose to intervene to provide additional opportunities for participants to learn from each other.

At the end of the workshop, there was an open question-and-answer followed by a large group discussion in which participants committed to ally engagement in their professional spaces. Attendees were also given the opportunity to discuss microaggressions that they have witnessed and develop a plan to enact the evidence-based strategies in their professional spaces.

6. **Present studies**

To refine and evaluate the effectiveness of the workshop, we conducted an expert feedback discussion group (Study 1) and mixed method post-workshop evaluation (Study 2). In Study 1,
science and engineering faculty members with a background in diversity and inclusion participated in the workshop and provided feedback via focus group and consensus analysis (Delphi method). Changes were made based on feedback and a revised version of the workshop was delivered in Study 2. In Study 2, we delivered the workshop to 107 graduate students and post-baccalaureate students in science and engineering and assessed learning outcomes, effectiveness, and satisfaction. We planned to examine potential differences based on sociodemographic information on workshop perceptions and learning outcomes (dependent on statistical power).

7. Protection of vulnerable populations
Participants in Study 1 were faculty in science and engineering, many of whom identified as women and racial-ethnic minorities. We protected the faculty members’ identities to help ensure they could discuss personal experiences related to microaggressions and provide honest feedback. No personal identifying information was recorded with faculty members’ responses, except for gender and racial-ethnic identity (other characteristics, such as age, rank, and subdiscipline were not recorded). In Study 2, graduate student attendees were asked to provide anonymous responses in a mixed-method format. We chose to anonymise data to ensure that participants could openly discuss their lived experiences as well as information that they learned from the workshop.

8. Study 1: Feedback from diversity and inclusion faculty experts

8.1. Methods and results
Science and engineering faculty members who were a part of a diversity and inclusion committee at a large research-intensive Midwestern University were invited via email to participate in the present study’s workshop-style intervention and focus group. A total of eight faculty members (out of 12 invited) participated (50% identified as a woman, 38% identified as a racial and/or ethnic minority). Participants received a catered lunch as compensation. Following guidelines for expert feedback focus groups (Schäfer, 2006; Shelton & Delgado-romero, 2013), faculty members were asked to provide structured feedback on the workshop content, ecological validity, and feasibility. Faculty attendees were asked to provide feedback at three times points throughout the workshop presentation; specifically, after each of the two main parts (discussed above) and at the end of the workshop. The first author and a graduate student research assistant, who was also trained in
qualitative data methods, led the feedback questions and transcribed notes. To garner consensus among the experts, we implemented a Delphi method approach (Okoli & Pawlowski, 2004; Sekayi & Kennedy, 2017). The Delphi method is a process used to obtain agreement among a group of experts through multiple rounds of feedback and group agreement (e.g., regarding how to move forward, aspects to change).

In general, the feedback from the faculty experts was very positive. Three main suggestions to improve the workshop were identified from the focus group: 1) incorporate additional examples of microaggressions, 2) provide additional copies of handouts (for participants to distribute), and 3) shorten the length of workshop from 120 minutes to 90 minutes. These recommendations were first obtained via open-ended focus group questions then consensus was reached when specific changes were posed to the group (in line with a Delphi method approach). All suggestions were incorporated into the workshop presented in Study 2. To reduce the length of the workshop, we included three role play exercises, instead of the original five.

9. Study 2: mixed method workshop evaluation
To examine effectiveness, learning outcomes, and satisfaction with the Speak Up in STEM! workshop, we delivered the workshop to two groups of graduate students in science and engineering. We developed a post-workshop evaluation using common Likert ratings and four open-ended questions, which were thematically coded (Braun & Clarke, 2006).

10. Participants
Volunteer participants were recruited via a guest lecture in an engineering graduate course and a keynote address at a national science conference. Prior to the workshops, attendees were informed of the content of the workshop and the study design. Twenty-four graduate students enrolled in a technology and engineering graduate course at a large R1 Midwestern university took part in the workshop. One hundred and twelve people attended the workshop at the national science conference; of those, 82 attendees were graduate students or post-baccalaureate research assistants (given the focus of the paper, non-graduate students were not included in the analyses). In total, 107 graduate students or post-baccalaureate student participants were included in the present paper.

In terms of sociodemographic characteristics, 58.49% of participants identified as a woman and 38.67% identified as a man (the remaining did not indicate their gender). Nearly two-thirds (62.26%) identified as White/European American. Few participants identified as non-White: 8 people identified as Asian, 8 identified as bi- or multi-racial, 2 identified as Middle Eastern, and 2 identified as Black/African American (the remaining 21 participants did not indicate their ethnicity). Most participants identified as heterosexual (66.98%) followed by 6 participants who identified as bisexual and 2 participants who identified as queer (the remaining participants did not indicate their sexual orientation).

Participants were provided waived informed consent with the authors’ Institutional Review Board information. All responses were anonymous, and participants were informed that their participation was voluntary and they could leave the workshop at any time.

11. Measures
We developed a 12-item post-workshop evaluation, which consisted of eight Likert ratings and four open-ended items. Consistent with academic climate change interventions in science and engineering fields assessments (Carnes et al., 2012; Stewart et al., 2004), we adapted items to assess knowledge regarding the concepts taught, if the workshop was useful, and if participants would recommend the workshop to a colleague. Research has demonstrated that self-report assessments of learning and skill development are similar to third-party observation of outcomes (D’Eon et al., 2008). In addition, we created items to assess the extent to which participants felt the workshop was well-paced and provided sufficient time to practice skills. Participants rated the extent to which they agreed with the close-ended items, on a scale ranging from 1 (strongly
Table 1. Descriptive statistics of post-speak up in STEM! workshop evaluations

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>This workshop lived up to my expectations.</td>
<td>4.41</td>
<td>0.58</td>
</tr>
<tr>
<td>The workshop activities stimulated my learning.</td>
<td>4.47</td>
<td>0.57</td>
</tr>
<tr>
<td>The activities in this workshop gave me sufficient practice.</td>
<td>4.21</td>
<td>0.72</td>
</tr>
<tr>
<td>The pace of this workshop was appropriate.</td>
<td>4.56</td>
<td>0.57</td>
</tr>
<tr>
<td>The workshop facilitator(s) were well prepared.</td>
<td>4.80</td>
<td>0.45</td>
</tr>
<tr>
<td>The workshop facilitator(s) were effective.</td>
<td>4.72</td>
<td>0.51</td>
</tr>
<tr>
<td>I will be able to use what I learned in the workshop moving forward.</td>
<td>4.53</td>
<td>0.61</td>
</tr>
<tr>
<td>I would recommend this workshop to colleague.</td>
<td>4.61</td>
<td>0.56</td>
</tr>
</tbody>
</table>

disagree) to 5 (strongly agree); see, Table 1 for item wording. We also used four open-ended items to examine strengths of and improvements for the workshop (consistent with previous research; e.g., Carnes et al., 2012; Hood & Neumann, 2013); for survey instrument, see: https://osf.io/25pz3/.

12. Results

12.1. Descriptive information

Overall, participants rated the workshop highly. All mean scores were 4.21 (out of 5.00) or higher; see, Table 1 for means and standard deviations. Participants rated the workshop facilitators' preparedness and effectiveness the highest, followed by recommending the workshop to a colleague, and the appropriateness of the pace of the workshop. The lowest rated item (although moderate-high on a 5.00 scale) was related to sufficient time to practice ally skills.

13. Gender-based comparisons

Power analyses showed that there is sufficient power at 80% (at $\alpha = 0.05$), to detect gender difference effects at 0.5 and larger. Across all eight close-ended questions, results showed no differences between women's and men's perceptions of or satisfaction with the workshop, range $(98) = -0.026$–$0.772$, $p$ values $= 0.384$–$0.979$. There was not sufficient power to conduct comparisons based on other sociodemographic characteristics (e.g., race, sexual orientation).

14. Thematic coding of open-ended responses

To understand learning outcomes, strengths of the workshops, and areas for improvement, participants responded to four open-ended questions. Specifically, we asked participants to 1) “describe one or two aspects of the workshop that you enjoyed the most,” 2) “if applicable, describe one or two aspects of the workshop that you found the least useful,” 3) “please describe one or two things that you learned,” and 4) “if applicable, please provide one practical suggestion for how we could improve this workshop?”

Two independent coders (undergraduate research assistants) were trained on qualitative data analysis and performed a thematic analysis for each question (Braun & Clarke, 2006; Hesse-Biber & Leavy, 2010). Thematic analysis allows researchers to identify, analyse, and understand patterns within open-ended text. The research assistants were trained by the first author who has substantial evaluation and qualitative coding experience, including grant-related institutional transformation projects. Multiple readings of the participants' data were undertaken to become immersed in the data and identify portions of text that were related to each question.

Next, the coders identified key words and phrases that could serve as initial codes (Braun & Clarke, 2006). These initial coding categories were then reviewed and further refined in an in-
Table 2. Major and minor themes of post-speak up in STEM! workshop open-ended evaluations

<table>
<thead>
<tr>
<th>Major Themes % Mentioned</th>
<th>% of Major Theme Mentioned</th>
<th>Example Responses</th>
<th>Minor Themes</th>
<th>% of Minor Theme Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Describe one or two aspects of the workshop that you enjoyed the most (N = 92)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SKILL DEVELOPMENT</td>
<td>67.39%</td>
<td>“I enjoyed the relevant scenarios. I feel I am much more prepared to tackle similar microaggressions in the future”</td>
<td>no minor themes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Role play and learning new skills in an inclusive, safe environment in which to express and explore”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAINING NEW KNOWLEDGE/CONSCIOUSNESS RAISING</td>
<td>38.04%</td>
<td>“The examples of microaggressions were really helpful and I think are useful to help identify more advanced forms of microaggressions”</td>
<td>Learning about microaggressions 17.39%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Discussions on what microaggressions are/acknowledging when they happen opened up my eyes and other people’s minds to the experiences of others”</td>
<td>Learning specific strategies to be an ally 7.61%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“The clear and simply stated recommendations for dealing with and countering microaggressions”</td>
<td>Learning from other people’s experiences 7.61%</td>
<td></td>
</tr>
<tr>
<td>GROUP DISCUSSIONS</td>
<td>17.39%</td>
<td>“The discussion after the role play exercises and hearing from others was really important.”</td>
<td>Small group discussion (breakout groups of 3–5 people) 7.60%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Was great to discuss with colleagues about how we can better allies”</td>
<td>Discussion with colleagues about how to be better allies 3.26%</td>
<td></td>
</tr>
<tr>
<td>SPEAKER’S ABILITIES</td>
<td>14.13%</td>
<td>“The speaker’s preparedness, empathy, knowledge and ability to connect”</td>
<td>Speaker’s expertise and knowledge 6.52%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“The speaker was phenomenal! Great energy and effective delivery and knowledge!”</td>
<td>Speaker’s empathy/ability to connect 4.34%</td>
<td></td>
</tr>
<tr>
<td>Q2. If applicable, describe one to two aspects of the workshop that you found the least useful (N = 35)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSITIVE RESPONSE</td>
<td>91.42%</td>
<td>“nothing!”</td>
<td>no minor themes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“It was all good!”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Don’t change anything!”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASPECT OF ROLE PLAYING EXERCISES</td>
<td>31.43%</td>
<td>“I found that some of the scenarios were a bit unrealistic”</td>
<td>Repetition of role playing scenarios 8.82%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“The scenarios were a little repetitive”</td>
<td>Role playing exercise(s) unrealistic 8.82%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Spend too much time in one scenario.”</td>
<td>Role playing exercises were challenging/uncomfortable 5.71%</td>
<td></td>
</tr>
</tbody>
</table>

Q3. Please describe one or two things that you learned (N = 86)

(Continued)
<table>
<thead>
<tr>
<th>Table 2. (Continued)</th>
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</table>

<table>
<thead>
<tr>
<th>Major Themes % Mentioned</th>
<th>% of Major Theme Mentioned</th>
<th>Example Responses</th>
<th>Minor Themes</th>
<th>% of Minor Theme Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRATEGIES TO CHALLENGE MICROAGGRESSIONS/ INTERVENE AS AN ALLY</td>
<td>66.28%</td>
<td>“Some good recommendations for responding to microaggressions, and especially why to avoid humor (which would have been my instinct)” “The use of ‘I’ statements and question asking as ways to be an ally and promote an inclusive environment” “I now have a blueprint for how to be an ally in work situations”</td>
<td>Mentioned one or more of the five specific strategies</td>
<td>26.74%</td>
</tr>
<tr>
<td>PERSONAL GROWTH AND POSITIVE MINDSET</td>
<td>53.49%</td>
<td>“I feel more confident about speaking up and intervening” “New ways to address microaggressions in non-confrontational ways. I feel really good and need to reflect more”</td>
<td>Feeling of being an effective ally</td>
<td>12.76%</td>
</tr>
<tr>
<td>INFORMATION ABOUT MICROAGGRESSIONS</td>
<td>27.91%</td>
<td>“I haven’t thought about physical spaces being a part of microaggressions. This was new eye opening information to me.” “Microaggressions are like mosquito bites—this was helpful to understand impact and harm.”</td>
<td>Specific information related to microaggressions mentioned (e.g., metaphors, research)</td>
<td>16.27%</td>
</tr>
<tr>
<td>ACTION-ORIENTED PERSPECTIVES FOR DIVERSITY AND INCLUSION</td>
<td>9.30%</td>
<td>“I learned a few ways on how to intervene. It also made me think of the importance of creating policies in the workplace.” “There is always a way of being an ally to eliminate or reduce aggressions.”</td>
<td>no minor themes</td>
<td></td>
</tr>
</tbody>
</table>

Q4. If applicable, please provide one practical suggestion for how we can improve this workshop (N = 23)

<table>
<thead>
<tr>
<th>Minor Themes</th>
<th>% of Minor Theme Mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEGRATE MORE ROLE-PLAY SCENARIOS</td>
<td>65.22%</td>
</tr>
<tr>
<td>LENGTHEN TIME OF WORKSHOP</td>
<td>47.83%</td>
</tr>
</tbody>
</table>
person meeting of the coding plan. The coders reached consensus on the initial codes for each question. Next, the coders identified two to four major themes and several minor themes within the coded data; see, Table 2. Each of the coders read the participants’ responses and coded the theme as “1” if the theme was present and “0” if the theme was absent. The percentage of minor themes mentioned does not necessarily sum to the total of a given major theme, as minor themes were specific clustered responses. Inter-rater reliability was established to define the level of agreement between two coders using the same codebook (Gwet, 2014). Discrepancies between the two coders were resolved by the first author after the coding was completed. The average interrater reliability across all themes was 93%.

15. Aspects of the workshop: Enjoyed the most
Of the 92 participants who reported aspects of the workshop they enjoyed the most, two-thirds (67.39%) mentioned skill development (e.g., “… learning new skills in an inclusive, safe environment in which to express and explore”). Responses often focused on learning evidence-based strategies to intervene as an ally, including acting out the role play scenarios and practicing how to intervene as an ally. The second most commonly enjoyed aspect of the workshop was gaining new knowledge, mentioned by 38.04% of participants (e.g., “discussions on what microaggressions are/acknowledging when they happen opened my eyes and other people’s minds to the experiences of others”). Minor themes included learning about microaggressions (17.39%), learning specific strategies to be an ally (7.61%), and learning from other people’s experiences (7.61%). Another major theme identified was enjoyment of the group discussions (mentioned by 17.39% of participants), including statements like: “[it] was great to discuss with colleagues about how we can be better allies.” Of those who mentioned group discussions, 7.60% specifically mentioned the benefit of small group discussions and 3.26% mentioned conversations with colleagues about how to be better allies to their colleagues. The final major theme that was identified focused on rating the speaker’s abilities (mentioned by 14.13% of participants), such as positively commenting about the speaker’s expertise and knowledge (6.52%) as well as the speaker’s empathy (4.34%).

16. Aspects of the workshop: Least useful
Of the 106 participants, only 35 provided feedback on the aspects of the workshop that they found not useful. This low response rate is often indicative of finding a task useful and not being able to identify weak points (Hood & Neumann, 2013). For instance, the most common theme that was identified and mentioned by nearly all of the participants who provided feedback (91.42%) was positive feedback, including comments such as “don’t change anything” or “it was all good!” One-third of participants who responded to this question (31.43%) mentioned issues related to the role-play exercises. Specifically, three minor themes were identified, indicating that the role-play exercises were repetitive (8.82%), unrealistic (8.2%), or challenging/uncomfortable (5.71%). Of note, of the people who specifically mentioned that the scenarios were unrealistic and/or challenging, all except for one identified as white men.

17. Lessons learned
A total of 86 participants described at least one thing they learned from the workshop. The most frequently mentioned learning outcome was developing new strategies to challenge microaggressions (mentioned by 66.28% of participants). Two minor themes were identified; one-quarter of participants (26.74%) mentioned one or more of the five strategies described in the workshop (e.g., “some good recommendations for responding to microaggressions, and especially why to avoid humour (which would have been my instinct).” Other participants mentioned that they felt like they had a blueprint or template for how to be an ally (mentioned by 5.81% of participants). The second most commonly mentioned aspect was personal growth, mentioned by 53.49% of participants (e.g., “new ways to address microaggressions in non-confrontational ways. I feel really good and need to reflect more”). Minor themes reflected feeling effective as ally (mentioned by 12.76%) and new confidence to intervene (mentioned by 4.65%). More than one-quarter of participants (27.91%) indicated that they learned new information about
microaggressions. Two minor themes were identified that described specific content, including metaphors and research related to microaggressions (16.27%) and types of microaggressions (e.g., verbal, physical space; 9.30%). The final major theme was holding an action-oriented perspective for diversity and inclusion (mentioned by 9.30% of participants). Participants described how they may move forward (e.g., “I learned a few ways on how to intervene. It also made me think of the importance of creating policies in the workplace.”)

18. Workshop improvements
A total of 23 participants provided suggestions to improve the workshop; two major themes were identified. The most frequently mentioned suggestion was to incorporate more role-play exercises (mentioned by 65.22% of participants). Two minor themes were identified (mentioned by 13.04% of participants each), which highlighted exercises focused on identities beyond gender and race as well as exercises focused on power dynamics in academia. The other recommendation was to increase the length of the workshop (mentioned by 65.22% of participants). However, the main feedback from Study 1 was to reduce the length of the workshop. Specifically, participants requested more time for questions and role play exercises.

19. Discussion
Despite encouraging trends showing increased representation of women and people of color in science and engineering, widespread evidence shows that persistent inclusion disparities remain (Barthelemy et al., 2016; Hurtado et al., 2011). Over the past two decades, a growing body of evidence suggests that microaggressions are a particularly insidious aspect of climate and linked with a host of negative mental health and academic outcomes (Gallagher & Pearson, 2000; Keels et al., 2017; Sue et al., 2008). As a step toward institutional transformation, we designed an educational intervention aimed at combatting microaggressions and ally engagement for graduate students in the male- and White-dominated space of science and engineering. In the present paper, we describe the development, implementation, and early findings of the workshop; for workshop slides, see: https://osf.io/25pz3/.

Educational trainings aimed at promoting diversity and inclusion often lack of theoretical basis and can unintentionally exacerbate issues (Apfelbaum et al., 2012; Cundiff & Murray, 2020). We remedied this issue by developing an intervention grounded in contemporary theories of prejudice and conflict resolution to foster ally engagement when witnessing gender- and race-based microaggressions. As such, this is a novel intervention for ally engagement because it is evidence-based, tailored for scholars in STEM, and addresses how people can progress through stages of learning to combat microaggressions. Results indicate that graduate students in science and engineering fields found the workshop valuable, developed new ally engagement skills, and planned to engage as an ally moving forward. As illustrated in attendees’ qualitative responses, themes mapped onto learning objectives such as raised awareness about microaggressions, sufficient practice, and confidence to improve one’s climate. When asked to describe what attendees enjoyed the most, two-thirds of attendees mentioned that they enjoyed developing new evidence-based skills and practicing these skills with role-play exercises.

Many attendees spontaneously reported that they enjoyed gaining new knowledge about microaggressions, many of whom shared that this information was new. Although microaggressions are common in science and engineering spaces (e.g., Johnson, 2012; Moors et al., 2014), the finding that information about microaggressions was new to many attendees illustrates that not all people are aware of these forms of sexism and racism in professional spaces. One step toward inclusion in science and engineering spaces includes having shared language and information about common barriers and acts of exclusion that affect women and people of color (e.g., Harrison & Tanner, 2018; Wright & Tolan, 2009). Similarly, two-thirds of attendees described that they learned new ally engagement strategies and plan to implement these skills in the future. Another key finding is that one-half of the attendees indicated that experienced personal growth by attending the workshop. Understanding one’s own biases and developing confidence to intervene
as an ally when confronted with microaggression is an important component to creating future change (e.g., Devine et al., 2012).

Overall, this pattern of results dovetails the present study’s theoretically grounded conceptual model for the intervention, in which people progress through consciousness raising, ally skill development, and commitment to engage as an ally. Moreover, these findings show that students who attended the workshop enjoyed it and, most importantly, learned valuable skills they plan to implement as allies for women and people of color in science and engineering. Thus, attendees appeared to engage in an intentional integration of microaggression literacy concepts and conflict mitigation strategies, which are prerequisites to changing norms (Carnes et al., 2012; Sevo & Chubin, 2008).

20. Limitations and future directions
Although the early findings of the present study’s theoretically grounded intervention aimed at reducing microaggressions are promising, future research should examine the extent to which behaviors change over time. Gaining awareness about biases and prejudice are prerequisites for taking action (Devine et al., 2012) and understanding the extent to which new knowledge and skill development manifest into repeat committed action is an important next step. For instance, researchers could assess the extent to which attendees recall and implement the evidence-based ally engagement strategies and if these behaviors are linked with a more inclusive climate over time (e.g., months later). As one example, Carnes et al. (2012) developed a large-scale workshop intervention for faculty members focused on implicit biases (unconscious processes that may contradict one’s conscious beliefs). Compared to before attending the workshop, the majority of faculty members report increases of knowledge across all domains covered and satisfaction with the workshop. Similar to results of the present study, in follow up interviews with a subsection of the faculty members, themes of raised awareness and preparedness to take action to improve inclusion at their institution were identified.

In the present study, we focused on improving the climate for early career scholars in science and engineering fields because this time period research is a critical point to implement retention efforts for women and racial-ethnic minorities (Brown et al., 2016; Espinosa, 2011). Future researchers could tailor the workshop for other academic pathway stages (e.g., among undergraduates, faculty). Further, this workshop may be adapted to benefit the broader academic programs represented within STEM. Efforts to change the climate for women and people of color at any junction of the academic trajectory are important and likely to influence points down- and up-stream of the academic pipeline (Stewart & La Vaque-Manty, 2008). Therefore, providing an intervention such as Speak Up in STEM! may help to address the issues that often negatively impacts women and/or people of color within science and engineering spaces.

Next, we provide a few recommendations for delivering this workshop, based on open-ended feedback and on our experiences as facilitators. When delivering this intervention to participants, we emphasize working directly with graduate students (or the population of target) to foster trust and engagement with the material (Gómez et al., 2011). One theme identified from attendee feedback on how to improve the workshop was to include more role-play exercises. We recommend co-developing additional role-play exercises, such as ones that focus on microaggressions that transgender or nonbinary identified people or lesbian, gay, and bisexual people endure in science and engineering. Developing relationships with staff and faculty who directly work with graduate students may also be useful, particularly as faculty and/or staff may sponsor such diversity and inclusion workshops or could serve as co-facilitators. When conducting the workshop, we found that the presence of two co-facilitators is helpful, as facilitators can take turns leading the workshop, allowing for each person to help with all aspects of the workshop. Finally, we recommend that facilitators of this workshop acknowledge their own biases, anxieties, and fears related to race, ethnicity, gender, sexual orientation, ability status, and other visible and invisible
identities (e.g., Goodman, 2011). This is particularly important if facilitators hold one or more privileged identities (e.g., White, man).

21. Conclusion
The present research offers a theoretically grounded workshop that facilitates behavioral changes that can help graduate students change cultural norms to support the advancement of women and people of color in science and engineering. As this article suggests, combating prejudice is not a simple process. Our goal in making the present studies’ material openly available is that future researchers can implement this workshop to augment their institution’s current diversity and inclusion efforts.

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