# Engaging Engineers in Inclusive Cultural Change Through a New Method, Articulating a Succinct Description

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# Engaging engineers in inclusive cultural change through a new method, *Articulating a Succinct Description*

## Abstract

In this paper, we describe *Advancing Cultural Change* (ACC), an action-oriented research initiative that engages undergraduates in ethnographic research to explore university culture and the lived experiences of its community members. Despite continued efforts to broaden participation in engineering programs across the country, there remains significant underrepresentation of racial minorities and women. This lack of diversity is due, in part, to exclusionary behaviors, such as bias and discrimination that pervade the cultures of engineering. Drawing on critical theories including intersectionality and critical methodologies in anthropology, ACC is aimed at making the experiences of underrepresented groups visible while strategizing collectively on ways to reduce cultural biases and to foster a more inclusive campus, specifically in engineering fields. We present preliminary data from a novel method developed during ACC research. The method, called *Articulating a Succinct Description*, uses ethnographic data to create case study interventions facilitated with undergraduate students to disseminate research findings; address problems presented in the case; and collect more data for further analysis. Emerging findings show how bias and discrimination shape the culture of engineering and how discussions around these incidents vary depending on the demographic makeup of the facilitation groups (race, gender, and major field of study). Preliminary analysis of data raises two critical questions: (1) how can the *Articulating a Succinct Description* method promote allyship and cultural change within engineering? and (2) how do students engage differently with case studies about racial and gender bias in an engineering class compared to an anthropology class? We suggest that this innovative qualitative method, which serves both as a means of intervention and a means of inquiry, can provide underrepresented engineering students opportunities for their voices to be heard and to gain support from their peers. Further, it engages majority (white, male) students in efforts to create more inclusive cultures in engineering.

## Introduction

Extensive research and programmatic efforts have addressed the underrepresentation of women and people of color in the fields of engineering. Yet, despite the amount of attention and money that has been put towards diversifying engineering, the field remains homogenous[1, 2]. This lack of diversity within engineering is due, in part, to exclusionary behaviors, such as bias and discrimination that pervade the culture of engineering. Negative stereotypes, bias, and unwelcoming environments have been shown to prevent women and people of color from considering engineering or prevent them from finishing their degrees [3-7].

Our research initiative, *Advancing Cultural Change* (ACC), whose Principal Investigator is a feminist cultural anthropologist, addresses the exclusionary culture of engineering by engaging undergraduates in ethnographic research to explore university culture and the lived experiences of its community members. In alignment with calls to "fix the system, not the student," our action-oriented research seeks to disrupt bias and exclusionary behaviors to transform engineering culture. Our research seeks to empower underrepresented engineering students with opportunities for their voices to be heard and to gain support from their peers. Further, we aim to promote allyship among dominant group members and to advocate for cultural change to powerful agents and leaders within engineering.

Through our ACC research efforts, we have developed a new method called *Articulating a Succinct Description,* an innovative qualitative method, which serves both as a means of intervention and a means of inquiry. The method is iterative and reflexive, enabling us to continually improve upon our understanding of engineering culture and our efforts to interrupt bias and foster inclusive cultural change. The method had four main components that can be seen below in Figure 1.

(1) This method begins with ethnographic fieldwork, which involves interviews, participation observation, and personal experiences to understand engineering culture. Initial ethnographic fieldwork was conducted by undergraduate students in an introductory anthropology course and supplemented by interviews and focus groups conducted by the ACC research team, the authors of this paper. (2) We analyze the ethnographic data using qualitative coding methods rooted in grounded theory to illuminate patterns of power that influence the experiences of underrepresented students in engineering. (3) From this ethnographic data, we create case studies based on the stories of real students. These



**Figure 1**: Articulating a Succinct Description Illustration

case studies, written as film scripts, illustrate accounts of bias faced by students based on gender, race, major, sexuality, and other identities. (4) The case studies are then used in the classroom to increase awareness of bias in engineering and provide students with the skills to engage in discussion about these issues and interrupt exclusionary behavior. In small groups, students engage in discussion guided by specific questions about the case study. The data gathered from the case study facilitations allows us to both assess the effectiveness of our intervention and probe even deeper into engineering culture and enhance our initial ethnographic research.

*Articulating a Succinct Description* is also a response to Geertz's "thick description," which calls for robust, detailed, and meaningful descriptions of culture[8]. While describing voluminous accounts of culture is an important part of ethnography, our method offers an effective way to break down complex cultural phenomena for a general audience.

In addition, the *Articulating a Succinct Description* method provides an opportunity for engineers to practice important professional skills such as working on diverse teams and conflict resolution. During the case study facilitation, students practice these important professional skills as they engage in dialogue with their classmates on challenging topics of race, gender, culture, and bias within the context of their engineering education.

In this paper, we present preliminary data from the *Articulating a Succinct Description* method developed during ACC research. As we describe this new method and preliminary research findings, we strive to answer the following research questions:
1. How can *Articulating a Succinct Description* promote allyship and cultural change within engineering?
2. How do students engage differently with case studies about racial and gender bias in an engineering class compared to an anthropology class?
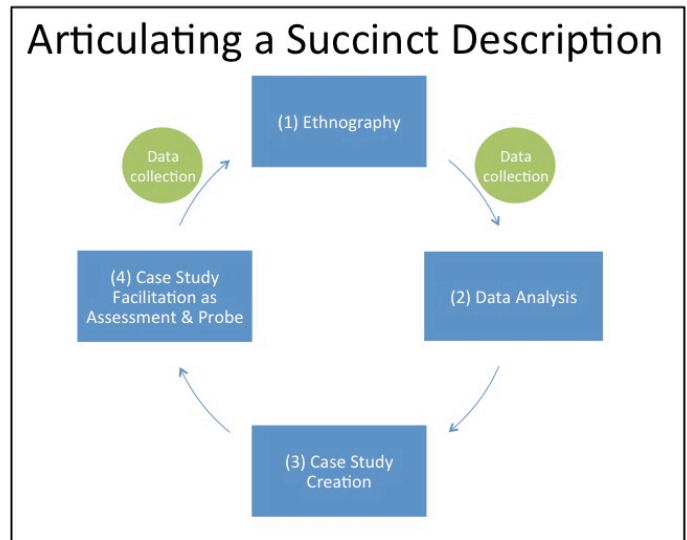
This paper introduces the *Articulating a Succinct Description* with a thorough description of the methodology behind the method in hopes to gain perspective and feedback from the engineering education community. We describe details of this iterative method and present preliminary findings from two case study facilitations from an introductory anthropology course and a senior capstone engineering course. We end with our plans for improvements and future work with this method and the *Advancing Cultural Change* initiative at large.

## Background Literature

Women and people of color remain significantly underrepresented in engineering[2]. The challenge of recruiting and retaining women and people of color in engineering is due, in part, to the exclusionary culture of the field. Engineering culture is perceived as being very competitive and unwelcoming which prevent students, especially those from underrepresented groups, from developing a sense of belonging in engineering. Many students who leave engineering report that this hostile environment and lack of belonging contributed to their decision to leave[9,10].

In engineering classrooms, many women and people of color experience bias while working in teams[11]. Women and racial minorities are stereotyped as being less competent compared to their white male peers, which can lead to explicit acts of racism and sexism as well as more subtle biases[7,12]. This bias pervades STEM classrooms and beyond, as significant research shows how the perceived gender and race of individuals can affect their likelihood of being hired for a job[13-15]. Incidents of bias are most common and severe when a woman or student of color is the only person in their group with that minority identity[16]. Some of the biases that students experience while working on teams include isolation, interruption, limited participation opportunities, and trivial task assignment. Because of the bias experienced in group work, women and students of color are more likely to drop out of their group, the class, and even their major[11].

Efforts to diversify engineering are often met with resistance from "in-group" members, typically white males. Burack and Franks (2004) shed light on this phenomena using a group-psychodynamic approach to group social identity. The discipline of engineering is often held on a pedestal as being superior and exclusive, and some in the field see diversity initiatives as a threat[17] and respond with avoidance or hostility to diversity efforts and discussions[18]. Faculty and other leaders in engineering strive to protect this reputation of elitism and superiority which "reinforces in-group idealization-- 'we are smarter than those outsiders'; 'the kinds of people smart enough to be members of this group are already represented here'-- at the same time that diversity seeks to introduce outsiders into the fold" (p. 88, 89)[17]. This helps explain why "out-group" members, namely women and people of color, face bias, discrimination, and harassment in engineering groups. Interventions have been developed to improve classroom inclusivity and group work dynamics including personal reflection exercises and interactive theatre sketches on the importance of diversity[19,20].

## Methodology
*Critical ethnography and Intersectionality*

Ethnography, a primary tool of anthropologists, is a common method used to understand culture from the perspective of insiders of that culture. Ethnographic methods include participant observation, field memos, interviews, and focus groups interviews[21,22]. Our research is rooted in critical ethnography, which "begins with an ethical responsibility to address processes of unfairness or injustice within a particular lived domain" (p. 5)[23]. Critical ethnographers take an active social justice position in making visible oppressive power relations within a culture and applying their findings to have positive impacts on their communities of study. As critical

ethnographers, our intention behind studying our university culture is to uncover and disrupt operations of power and control with the goal of changing culture to be more equitable. Another key element of critical ethnography is the rejection of positivism, which is based on the ideas that reality can be objectively interpreted, that analyses are object, and that universal generalizations are the only measure of truth[23]. Rather, we take an interpretivist approach, which enables researchers to develop theory informed from data analysis by constant comparison.

Our research also draws upon intersectionality, which recognizes that individuals' have multiple social identities that cannot be understood separately[24-26]. People experience oppression and privilege based on their race, gender, sexuality, religion, age, ability and other social dimensions. Therefore it is limiting to only consider one of these social identities when seeking to understand an individual's experience within a particular culture.

*Qualitative research methods and grounded theory*
Qualitative research has increasingly been used within engineering education to understand and improve engineering culture, classroom experience, and student success. In comparison to quantitative research, qualitative research provides a deeper understanding of the human and social aspects of engineering that impact institutions, programs, and individuals[27,28]. Grounded theory is a research methodology commonly used with qualitative data that allows researchers to develop theory informed from data analysis by constant comparison[29]. Grounded theory methodology involves "generating theory and doing social research [as] two parts of the same process" (p. 2)[30]. Grounded theorists "do not believe it sufficient to merely report or give voice to the viewpoints of the people, groups, or organizations studied"; rather they "assume the further responsibility of interpreting what is observed, heard, or read" (p. 274)[31].

*Case study method*
Case studies have long been used in the field of anthropology as a means of data collection and research[32]. Anthropologists can use case studies to describe a particular event or phenomena and then inductively draw theories and general concepts from them. Case studies contrast from Geertz's "thick description" which calls for very detailed accounts of a culture, accompanied by the anthropologist's own interpretations[8]. Case studies offer a succinct view into a particular culture, and when paired with a facilitated discussion they prove to be an effective, original way to share one's ethnographic findings. We use case studies within the *Articulating a Succinct Description* method in order to make large and complex cultural phenomena more digestible and to engage our audience as potential cultural change agents. The facilitated skill-building interventions are constructed from everyday practices and relationships, creating common experiences with verisimilitude to enhance participants' engagement with the material, with the practical goal of transforming culture.

The case study teaching method involves the presentation of a case study, which is a narrative or description of a problem and then group discussion that engages students in problem solving on the situation presented in the case [33]. Case studies present information and ideas in a specific and detailed manner which can "be far more appropriate media for learning than the more abstract and decontextualized lists of propositions or expositions of facts, concepts, and principles" (p.24)[34]. Case study teaching methods engage students in higher levels of understanding-- analysis, synthesis, and application-- rather than focusing only on knowledge transfer[35]. Case studies are "contextually based; that is, students must understand contextual nuances and make references and analyses accordingly"(p.10)[33]. They also encourage students to challenge their own assumptions and to be open to the wide variety of perspectives and solutions that may be

presented by their fellow classmates[33]. In engineering classrooms, case studies can help develop students' critical thinking skills by requiring students to integrate technical, ethical, and societal knowledge to address the problems presented in the case study[36].

*Case studies as Cultural Probes*
The *Articulating a Succinct Description* method draws upon Cultural Probes, an idea first employed by Gaver and his colleagues as an experimental approach to design research that captures insight into the daily lives of their participants[37]. Cultural probes involve "probe kits" composed of items such as notecards, journals, cameras, and maps. They are given to participants to engage with and then are collected by researchers for inspiration and analysis. Since Gaver and his colleagues first shared their novel approach to design research, Cultural Probes have been adapted and utilized by a variety of researchers across disciplines[38-40].

In our adaptation of Gaver's method, our case study intervention serve as Cultural Probes, an innovative way to simultaneously enhance and disseminate ethnographic findings. Our adaptation of Cultural Probes for the *Articulating a Succinct Description* method strongly resonates with Gaver's value of uncertainty, dialogue, and empathy[41]. We recognize and embrace that the responses to our probes do not provide a comprehensive view of participants, but rather that it reveals "fragmentary clues about their lives and thoughts" (p. 53)[41].

We value Cultural Probes not only as an innovative method of data collection and source of inspiration but also as a means of engaging our participants in critical consciousness-raising. Cultural Probes can have a certain amount of "'ambiguity' and 'strangeness' [that] forces participants to make something of them through fitting them into their lives (or not), and to respond to them and gain a new perspective through that response" (p. 34)[39]. Cultural Probes also spark dialogue between participants and researchers, promoting an increased awareness of participants' own lives and actions, and have the potential to "disrupt the everyday practices of participants through enforcing an awareness and visibility of action previously absent" (p. 35)[39].

## Methods
In this section, we describe the *Articulating a Succinct Description* method. While we provide a brief overview of the initial ethnographic research that launched the ACC project, for the purposes of this paper we will be focusing on the participants, data analysis, case study creation, and cultural probe intervention from the preliminary study that was conducted in Fall 2016.
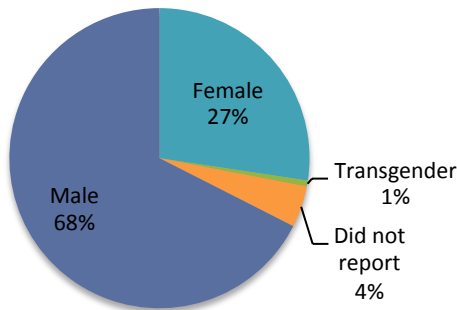
*Participants*
Over 565 students have been involved with the *Advancing Cultural Change* (ACC) project through assignments in an introductory cultural anthropology class: collecting ethnographic data, participating in focus groups, and engaging in the cultural probe case study facilitations. Eight undergraduate researchers and one Americorp VISTA associate have been members in the ACC lab, collecting and analyzing data and disseminating findings under the mentorship and supervision of the Principal Investigator, a professor of cultural anthropology.

In Fall 2016, we conducted two cultural probe facilitations with an introductory anthropology class and an engineering senior capstone course. The anthropology course was made up of 120 students from a variety of majors across our university, and most of the students were first years and sophomores. The engineering capstone class was made up of senior-level engineering students. The capstone class was also joined by a smaller group of students from a professionalism course, which had a large number of transfer and first-generation students. There
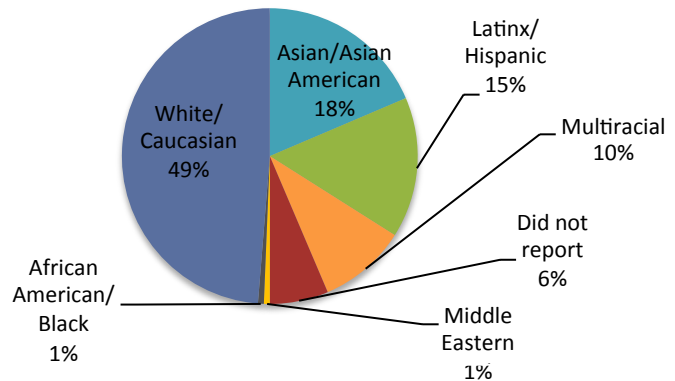
was a total of 157 engineering students, all juniors or seniors. Between the two classes, 277 undergraduate students participated in our preliminary study.

Below is the race and gender breakdown of each class which students anonymously self-reported. Demographics for the engineering and anthropology classes can be seen below:
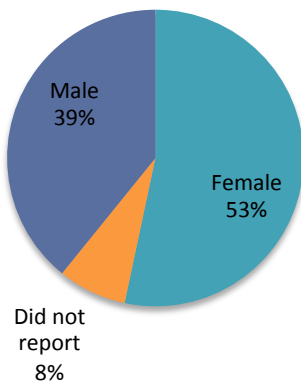
Gender breakdown for
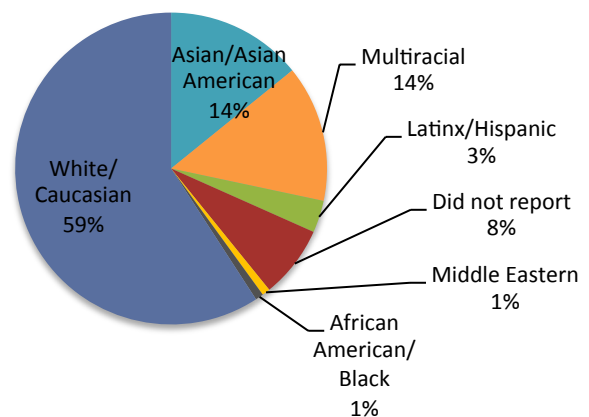**engineering capstone class** (n=157)

Female 27%
Male 68%
Transgender 1%
Did not report 4%

Race breakdown for
**engineering capstone class** (n=157)

Asian/Asian American 18%
Latinx/Hispanic 15%
White/Caucasian 49%
Multiracial 10%
Did not report 6%
African American/Black 1%
Middle Eastern 1%

Gender breakdown for
**anthropology class** (n=120)

Male 39%
Female 53%
Did not report 8%

Race breakdown for
**anthropology class** (n=120)

Asian/Asian American 14%
Multiracial 14%
White/Caucasian 59%
Latinx/Hispanic 3%
Did not report 8%
Middle Eastern 1%
African American/Black 1%

*Articulating a Succinct Description*
Figure 1 illustrates the iterative process of the *Articulating a Succinct Description* method. The four primary aspects of the method are (1) ethnography, (2) data analysis, (3) case study creation, and (4) case study facilitation as cultural probe. Data collection occurs at two distinct moments, during ethnography and the case study facilitation. Each component of *Articulating a Succinct Description* is described in detail in the sections below. Note that data collection occurs during (1) ethnography and (4) case study facilitation, and the data analysis is described in section 2.

*(1) Ethnography*
In a cultural anthropology class, taught by ACC's Principal Investigator, students were asked to conduct ethnographic fieldwork on the culture of their major. Students participated in participant observation, conducted interviews, observed the built environment, analyzed systems of power, and drew from their own personal experiences to understand the culture of their major. A primary focus of these ethnographies was to uncover systems of power that influence the daily experiences of students, taking careful notice to any exclusionary behaviors and inequalities. Not only did this assignment serve as a meaningful exercise for students to learn the elements of

ethnography, it also provided us with rich data on the culture of our campus. Of all the ethnographies, 20% were from the college of engineering. Throughout the course, the quality of students' ethnographic assignments were evaluated by the project's Principal Investigator, a feminist anthropology professor, to assess the quality, accuracy, detailed analysis, sources of evidence, and methods.

In addition to the student-led ethnographies, our research team conducted focus groups and interviews to dig deeper into engineering culture. We sought out student voices that were either absent or underdeveloped, in particular underrepresented students in engineering. We facilitated two focus groups with students from various engineering clubs that had significant numbers of underrepresented students. The discussion from these focus groups illuminated the varied experiences of underrepresented students and how majority students maintain the status quo.

### (2) Data Analysis
*Student ethnography data analysis*
Initial data analysis of the student ethnographies provided us with clues of what concepts and themes are prevalent in the culture of our campus. The student ethnographies were open coded and then used to develop a codebook which helped organize and articulate emerging issues and themes. The ethnographies were then closed coded using Dedoose, an online coding software, allowing all themes, issues, and findings to be categorized and collected within a data base. Within Dedoose, the data was extracted by each code and analyzed along side each other allowing recurring themes and patterns to be collectively analyzed. Researchers first separately and then collaboratively looked at the data correlating to each code and memoed the findings to draw connections between the emerging findings and to uncover and explain these issues, operating within higher education, to larger cultural domains operating within our society.

*Case study facilitation notecard data analysis*
The data collected from the case study facilitations (described in the section 4 below) was analyzed through Dedoose in a similar fashion as the student ethnographies. Two research assistants, in collaboration with the PI, open and close coded the case study facilitation notecards for emerging themes and patterns, creating a codebook to ensure inter-coder reliability. The notecard responses were then coded into broad themes using codes for emotional state, specific phrases, critiques of the activity, and identity (race, gender, major) of respondent. In addition to assigning broad "parent" codes to the notecard responses, we also assigned "child" codes to provide more detail. For example, a notecard response stating that a student was less conscious of diversity and bias issues prior to the case study facilitation but is now more aware was coded as "Ignorance to Awareness". If the student expressed this sentiment and then pledged to take action in fostering inclusivity, it was also coded as "Ally". Two other common codes were "Positive Empathy" and "Negative Empathy." These codes were assigned to responses if they related to issues of bias articulated in the case study or if they denied the existence or significance of bias, respectively. After the notecard responses were coded, three research assistants analyzed individual codes and then memo-ed the emerging patterns based on social identity and focus group. Themes were discussed between five research assistants and the project's Principal Investigator for trends and relation to intersectional identity of the respondent.

### (3) Case Study Creation
From our large set of ethnographic data, we identified stories that captured moments of power and oppression within engineering culture. The stories were not full narratives, but rather they offered a glimpse into the lives of marginalized students in engineering.

In effort to make the case studies engaging and true to real life, we wrote them as film scripts. We strived to create a realistic dialogue that students could relate to. A shortened description of the case study that we used for the anthropology and engineering classes can be seen below:

> *Greg is an African American mechanical engineering student who is working on a group project for one of his design classes. Greg tells his roommate Sarah, a white woman and civil engineering student, that his group has repeatedly delegated the less-technical tasks (presentation making, project organization, etc.) to him, despite his strong grasp on the class material. He also notices that they talk to him a lot about sports rather than the contents of the project at hand. Sarah says that she can relate to some of what Greg has experienced because of her gender, and then she asks if he has approached his professor about the situation. Greg explains that he already tried to talk to his professor about it, but he receives little support and is told to that he has to work hard to be successful in his major. Sarah is empathetic to Greg, and encourages him to talk to his teammates about how he feels.*

This case study was designed to illuminate how many students of color experience exclusion in group settings and are presumed less competent than their peers. Through Sarah's character, we also demonstrated how to practice empathy and allyship. We intentionally did not provide excessive details in these case studies and left room for interpretation. We so rarely have all the facts ourselves in these situations, which is what makes the challenge of identifying and intervening instances of bias.

*(4) Case Study Facilitation as Assessment and Probe*

The overall structure of case study facilitation was very similar for the introductory anthropology course and the engineering course; however, adjustments were made to situate the intervention within the context of these very different classes. Both classes began with a presentation on identity, unexamined bias, microaggressions, diversity, and inclusion which included empirical research studies about the impact of bias in academia and the professional world[14,15]. We also described our ACC research efforts to learn more about university culture while actively working to disrupt bias and empower student change agents.

For the engineering class, we added context to the presentation about the lack of diversity in engineering at our university and beyond. We discussed how important it is for engineers to be able to work in diverse teams, as this is something employers are looking for.

In both classes, students organized into small groups of 4 or 5 students after the presentation. The engineering class worked in their senior design groups. The anthropology class was randomly assigned to groups by counting off. Printouts of the case study and discussion questions were given to each student. Students read the case study on their own and then were given about 20 minutes to discuss in their small groups. Students addressed the following questions:

1. What is your assessment of what's happening in Greg's group?
2. If you were in his group, would you try to change or say something?
3. What further advice could Sara offer Greg?
4. How are other ways Greg's professor could have responded in this situation?

Each group had to choose a person to serve as a "scribe," someone who would record and synthesize the group's discussion, and a facilitator to guide the conversation. The groups were asked to come to some level of consensus for each question, which was recorded by the scribe. Following the small group discussions, students engaged in a large discussion with the whole class. Each group was asked to contribute to at least one of the questions. We (the researchers)

took memos during the small and large group discussions to capture the dialogue as well as any body language or other reactions from the class.

At the end of class, students were given blank notecards and asked to provide the following: (1) race, (2) gender, (3) major, and (4) description of their experience with today's case study activity. We did not ask for students' names in effort to encourage an honest reflection of their experience. These notecard responses to the case study facilitations allowed us to probe into the culture of engineering around diversity and inclusion while also assessing the effectiveness of the facilitation. The analysis of these notecard responses is described above in section 2.

**Preliminary data and findings**
In this section, we dive into the preliminary data obtained from the student notecards collected from the two case study facilitations in Fall 2016, describing themes that were uncovered during data analysis. As critical qualitative researchers, we strive to uncover patterns across our large data set, with the goal of understanding our institutional culture rather than making generalizations about different groups of people[23,42].

*Increased awareness and empathy*
A significant finding was that students demonstrated an increased awareness of and empathy for the experiences of underrepresented students on our campus. The majority of students in the engineering class articulated that their experience with the case study was transformative or eye-opening. For many white male engineering students, the facilitation exposed them to the privilege they have as dominant group members in their major compared to women and people of color. The two responses below from the engineering class illustrate the eye-opening experience that many students shared:

> *I've realized that this is not really something I've thought about before, but I'm sure that I've unintentionally been biased at some point in my life. This session has made me more aware of my actions and word choice and I will definitely pay more attention to it now.* - White male engineering student

> *Eye opening. Was defensive at first, but in the end realized it was important because it helps us perform better. Helped me understand that the world is not necessarily as safe for others as it is for me.* - White male engineering student

For these two students and others, Greg's story offered them a new perspective on the experience of underrepresented students in engineering. Even if they could not personally relate to Greg's experience, they showed empathy, and some students articulated a commitment to be more aware of bias in the future. This shows great potential for increased allyship among dominant group members in engineering, which could lead to inclusive cultural change in engineering. As more engineering students recognize and empathize with the significance of bias, we may see a shift in engineering culture from one that embraces individualism and meritocracy towards a more collective culture that recognizes the importance of diversity and inclusion.

*Visibility to the experiences of underrepresented students*
Many white women and students of color expressed positive responses to the case study facilitation, sharing their own experiences with bias and gratitude that these issues are being addressed at our university. Compared to the responses from dominant group members, many underrepresented students did not have an "eye-opening" experience since many of them have

had similar experiences with bias as Greg's. A white female engineering student related to the case study sharing that "[sometimes] it is hard being a minority in my major because I feel like I have to prove that I am good/smart enough." Another student reflected on his own experiences with bias and how this case study facilitation increased his empathy for other students:

> *I have had experiences that can be seen as discriminatory and I have felt*
> *out of place. This actually has made me realize or relate my experiences*
> *with the experiences of women and has made me more empathetic*
> *towards women in engineering.* - Latino mechanical engineering student

Some students expressed gratitude for the case study facilitation. One student reflected:

> *I am glad that there is work being done about diversity and inclusion*
> *because I have felt bias, racism and noninclusion through my journey*
> *at  [university]. I am happy to know that there is an attempt to make the*
> *problem better.* -Latina engineering student

For some underrepresented students, this case study facilitation helped to validate their experiences with bias. Allocating class time for this activity demonstrated a commitment from the professors that diversity and inclusion is important, which unfortunately is rare especially in engineering classrooms. The responses from underrepresented students showed that this activity was beneficial to them, even if it did not provide them with very much new knowledge. We also noticed that more underrepresented students gave constructive criticism on the case study facilitation compared to dominant group member peers. Some of these students expressed a genuine interest in improving the case study facilitation, which provided us with great feedback and insight that can be implemented in future iterations.

*Resistance to diversity*
Along with the promising number of positive responses to the case study facilitation, it is important to also describe themes among students who were less receptive to the facilitation. While these responses can tell us something about individual students, we sought to focus on engineering culture and how it might foster resistance to diversity and inclusion.

Some students exhibited victim-blaming, suggesting that Greg is responsible for ameliorating the situation, most of who were from the engineering class. These students did not see Greg's group members as responsible for addressing group dynamics and bias when working on teams. One student reflected:

> *I feel like the White males in the group tended to put the blame/pressure*
> *on Greg that he was doing something wrong in communication or*
> *behavior, not really understanding how microaggressions doesn't allow*
> *those avenues to work like they do for majority groups. Just an interesting*
> *observation.* -White female engineering student

This female engineering student sheds light on the pervasiveness of individualism in engineering culture, and how this perpetuates victim blaming. We also observed some engineering students resisting the case study facilitation, either because they felt that the topic was unimportant or that the activity was "unrealistic" or "exaggerated". These students did not see bias as something they need to pay attention to as engineers, nor did they recognize Greg's situation as potentially connected to larger patterns of bias and oppression. This speaks to engineering culture's emphasis on facts and numbers and the purported apolitical nature of the field. One student reflected:

> *[I] believe it's important to be inclusive of all people. The topics
> discussed here were a waste of time. Competence is earned by all in
> engineering, regardless of gender/race/major. I don't disagree that these
> "injustices" occur, but they are so unimportant in the grand scheme of
> life.* - White male engineering student

Critiques of the case study activity itself included concerns that "the situation presented did not have enough detail to accurately diagnose any biases or aggressions." While we recognize that the case studies can continually be improved upon, we interpreted these critiques as denying that bias exists. Instances of bias are not always clear cut; rather, they can be ambiguous, messy, and often invisible to dominant group members, which is what we strived to emulate in our case study. This theme of resistance to diversity among engineering students shows us the importance of embedding diversity and inclusion topics throughout engineering curriculum as we realize that a single class period is not enough to promote allyship and improve culture.

*Differences between engineering and anthropology class*
We noticed many differences between the responses from the anthropology and engineering class. Overall, in both classes, a significant number of students found the case study facilitation useful and showed increased empathy. It was interesting to note that actually a higher percentage of engineering students demonstrated increased awareness of and empathy for issues of bias, perhaps because they had not been exposed to diversity issues very much prior to the case study facilitation. We recognize that the anthropology course had already been engaged in topics around racial bias and diversity prior to the cases study facilitation, so they were likely more prepared for the discussion. This also prompts us to question if underrepresented students' voices are less visible in engineering, which would help explain why this was an eye-opening experiences for so many dominant group members in engineering.

The responses indicating a lack of empathy and critique of the case study facilitation were predominantly from the engineering class. The higher number of victim blaming responses from engineering seems to indicate a more hostile, competitive culture in engineering. Is it possible that engineering students become less concerned with issues such as bias as their engineering programs deemphasize diversity, public welfare beliefs and communal well-being as professional responsibilities?[43] Students in the anthropology class (a quarter of whom were engineers) did not demonstrate victim-blaming attitudes. None of the students stated Greg's need to take responsibility or "buck up." However, several anthropology students did report that some of their classmates engaged in this sort of conversation during the small group discussion, and they felt that it was an inappropriate response to Greg's situation.

We saw that the engineering students who were in the anthropology class were very receptive to the case study facilitation compared to their peers in the engineering class. This suggests that mixed major groups can influence an engineering student's openness to issues surrounding diversity and bias. One engineering student in the anthropology class reflected:
> *I felt like this is a good thing to talk about because I don't get this "exposure" to race
> discussion in engineering classes. I think it's really interesting how people acknowledge
> that race doesn't impact them, but in reality it shapes so much of everybody.*
> -White male environmental engineering student

The mix of majors and perspectives in the anthropology course may contribute to engineering students' openness to inclusivity activities. Also, the week prior to the case study facilitation,

ACC's Principal Investigator taught students about the cultural and historical legacies of institutional racism, which could have primed them to be open to conversations about interpersonal racism in their own communities.

**Future Work**

There are a variety of improvements we would like to make to the *Articulating a Succinct Description* method in regards to data collection. In addition to collecting students' race, gender, and major on their notecards, we would like to ask for their year in school. This would allow us to explore how students openness to diversity and cultural change efforts fluctuate from the time students begin their college career through graduation. For the group responses, we did not ask students to record the gender, race, or major make-up of their small group. Going forward, we would like to capture this information in order to see how the diversity of the small groups impacts the discussion. This would enable us to explore questions such as:  *Are white males more receptive to the case study when they are in a group with multiple women or people of color? How do the experiences of women and people of color change when they are the only underrepresented minority in their group?*

We plan to continually develop new case studies that capture different experiences of students in engineering. We have already begun creating additional case studies that explore different experiences of bias based on gender, race/ethnicity, sexuality, and major. We also plan to turn the case study scripts into films, since seeing and hearing these scenarios acted out will help make them feel even more true to life. Accompanied by facilitation guides, these filmed case studies could be used across our college and even other universities to reach a wider audience. We would follow a similar model as University of Washington's ADVANCE Center for Institutional Change by making the film scripts available via a website, so they can be used by facilitators across the country[44,45].

**Conclusion**

The *Articulating a Succinct Method* shows great potential to transform engineering culture into one that is more inclusive and that supports the success of underrepresented students. In addressing our first research question, (1) how can the *Articulating a Succinct Description* method promote allyship and cultural change within engineering?, the preliminary data analysis shows that this method has helped to promote an increased awareness of and empathy for issues of bias among dominant group members. This method has also comforted and empowered women and scholars of color by helping to legitimize their experiences with bias and by prioritizing diversity and inclusion in the engineering classroom. In regards to our second research question, (2) how do students engage differently with case studies about racial and gender bias in an engineering class compared to an anthropology class?, we found a majority of engineering students expressed a positive eye-opening experience. The anthropology class was overall receptive to the activity, however less anthropology students described their experience as new or transformative, likely because students had already been immersed in topics of racial bias and culture prior to the activity. Most of the critical and resistant responses came from the engineering class. These patterns indicate significant differences between classroom culture and prompt us to look more into the impact of courses such as an introductory anthropology course on student perception of bias and diversity.

Our findings from the preliminary data and feedback from the engineering education community will support the improvement of the *Articulating a Succinct Description* method, so we can

continue building upon existing knowledge of engineering culture while promoting transformative institutional change.

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