Paper ID #25744

The Effects of Infusing Diversity and Inclusion into a Design Problem in Engineering Mechanics: Statics

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Analyzing the Effects of an Innovative Intervention to Infuse Diversity and Inclusion in a Statics Course

Abstract

Engineering educators strive to prepare their students for success in the engineering workforce. Increasingly, many career paths will require engineering graduates to work in multidisciplinary teams with individuals possessing a diversity of skill sets, backgrounds, and identities. Therefore, it is important not only for future engineers to have the opportunity to work in teams as students, but also to have specific instruction that teaches them about teamwork skills and the value diversity and inclusion bring to engineering practice. Furthermore, it is important that this instruction occurs throughout their engineering coursework, giving students an opportunity to grow their skills over the course of their degree program. While engineering mechanics courses are not always associated with student team projects, these courses provide the opportunity to show students how teamwork and diversity are relevant to problem solving. And, as mechanics-oriented courses often dominate the sophomore and junior level of many engineering programs, they can be an important venue for providing continuous instruction to students about working with others and in teams. This paper introduces and examines the effects of a teamwork intervention in Engineering Mechanics: Statics aimed at teaching students about the importance of diversity and inclusion in engineering with specific attention on problem solving in diverse teams. The results from the qualitative analysis of the data show the effectiveness of the approach in making students aware of the importance of diversity in engineering teams and the unique experiences and skills that each student can bring to the table when solving problems. Suggestions to enhance the activity and implications for integrating similar interventions in other mechanics classrooms will also be provided and discussed.

Introduction

Due to ongoing changes in the world economy, working in diverse teams after graduation is a reality for today’s engineering students. More and more scientific innovations have been the result of collaboration in teams (Bear & Woolley, 2011). Preparing engineering students for working effectively in today’s collaborative and diverse environment, therefore, is imperative. However, such preparation involves developing the kinds of skills and knowledge that have not traditionally been included in engineering education.

Infusing the issues of diversity and inclusion in current engineering curricula is challenging for various reasons. The curriculum of engineering often involves the attributes of traditional approaches to education in which students are the passive recipients of knowledge (Freire, 1970; Ochoa & Pineda, 2008; Riley, 2003). Ochoa and Pineda (2008) critiqued the use of traditional classroom activities which reinforce the status quo and suggested that educators should create spaces where students can “enter into dialogue, share their personal experiences, reflect on how they are affected by the course, or critically assess the course curriculum and classroom pedagogy" (p. 46). Moreover, as they argued, in traditional approaches, students' knowledge and experiences are often disregarded and more than not perceived as irrelevant to the course content. Knowledge is treated as static, distant, and disembodied from class members (Ochoa & Pineda, 2008).

Despite the sources of resistance that have been noted, other researchers have pointed out the potential benefits of stretching engineering curriculum beyond technical content. Ochoa and Pineda (2008) raised the importance of creating environments that benefit from collaboration by providing democratic spaces to "enhance learning and challenge exclusionary thoughts and practices" (p. 46). In their study on the effects of problem-oriented educational strategies on increasing the student diversity among community college students, Noravian and Irvine (2014) found that moving from well-structured to ill-structured problem solving is beneficial to students and suggested the restructure of engineering education "so that students experience early in their training what engineers do" (p. 294). As stated by King (2011), the low number of people of color and women in engineering can be attributed to the highly quantitative focus and "the lack of evidence of social impact of engineering in the early engineering curriculum" (p. 1).

In another effort, Knight et al. (2012) argued for the importance of examining the instructional strategies to recruit and retain women in engineering. They believed that in a less diverse field such as mechanical engineering, theory rather than professional skills are stressed (Knight et al., 2012). Therefore, they suggested that for such fields there should be more emphasis on "thinking from a broad, systems perspective" as their findings suggested that females may gravitate more towards such topics (Knight et al., 2012, p. 55). Their findings also suggested that women students prefer curricula that is focused on real-world activities (Knight et al., 2012). In addition, there is a body of research that supports the positive influence of team experiences in attraction and attainment of under-represented students to engineering. For example, Busch-Vishniac and Jarosz (2004) suggested that integration of team experiences to the curriculum of engineering that traditionally had been left to senior year, in earlier years would improve the reputation of engineering and help students enjoy the academic experience more. Similarly, Gunasekera and Friedrich (2009) argued that the dominant theory-based and not value-oriented pedagogies in STEM "alienate those students who learn best in creative, cooperative settings that consider value and emphasize design and synthesis" (p. 162).

Intentional instruction about teamwork, particularly when it emphasizes diverse teams and inclusive work practices, offers students professional skills they need to be successful, while also providing the groundwork to start to change the culture of colleges of engineering and professional practice. A senior capstone experience is required by ABET for accredited engineering programs, and there has been growth of first-year engineering team design projects as engineering departments seek to introduce students to the profession and promote retention (Knight, Carlson, & Sullivan, 2007). While students are working in groups, it is less clear that they are receiving intentional instruction or scaffolding for successful teamwork. Furthermore, in many engineering programs students might experience teamwork in the first and final years of their degree programs with little instruction or opportunity to team with engineering students in their sophomore and junior years. Direct instruction on diversity and inclusion is even less common in engineering courses, as students are often expected to receive this content as part of their all-university core requirements. We argue that engineering students need to encounter diversity and inclusion within their engineering courses to help them recognize the relevance of diversity and inclusion to engineering practice. In addition, we seek to include activities related to diversity and inclusion in technical courses at the sophomore and junior levels to bridge the gap between first-year and senior year design projects and to demonstrate to students the direct link between technical and professional skills.

This paper describes the results of a pilot implementation of a new assignment for the course Engineering Mechanics: Statics. The assignment required students to complete preliminary work about team problem solving before class, work in teams during class and reflect on the assignment and their learning after class. The assignment is designed to provide content about diversity and inclusion integrated with a technical/computational problem relevant to the course topic. The assignment is also designed to be time efficient – with limited time requirements it is more convenient to adopt and continue into the future. Furthermore, the paper seeks to assess whether and in what ways the designed intervention affects students' learning about diversity, inclusion and problem solving and contributes to the desired outcomes.

Justifications for the intervention

The intention of the intervention we propose here is threefold. First, the intervention has components that fulfill the attributes of non-traditional classrooms raised by Ochoa and Pineda (2008) and therefore should contribute to challenge the status quo for creating a more inclusive environment. For example, students' involvement in reflection assignments can help in creating an authentic learning environment (Ochoa & Pineda, 2008). Second, the content of the provided video with the focus on the importance of diversity in teams, sends the students explicitly the desired message of the assignment regarding the importance of the diversity. This is in line with the findings from previous research on effectiveness of video interventions on diversity issues (e.g., Case & Rios, 2017; Garriott, Reiter, & Brownfield, 2016). Third, as argued by Noravian and Irvine (2014), to increase diversity in engineering, programs should help students learn the process of problem solving. Also, as stated before, there is a body of research on the positive influence of team experiences in attraction and attainment of people of color to engineering (Busch-Vishniac & Jarosz, 2004; Gunasekera & Friedrich, 2009).

Methods

Participants

The new assignment was piloted in a single section of Engineering Mechanics: Statics (hereafter Statics) in the spring 2018 semester. The total enrollment for the semester was 104 students, and 76 students consented to have their responses analyzed. The course is a required course for students majoring in mechanical (38.46% of students), civil (29.8%), biomedical (7.7%), and environmental engineering (7.7%). The course also included students from chemical and biological engineering (6.7%), engineering science (7.7%), and other departments (1.9%). The course is typically taken by students during their second year, with 32.7% qualifying as sophomores, 41.3% as juniors, 19.2% as seniors, 5.8% as second bachelors, and 1% as a master's student.

The intervention

The intervention was conducted with the aid of the course learning management system, Canvas. Before class students were assigned to watch and reflect on a short video about the role of diversity in the knowledge-based economy and its impact on team problem solving. The video is available on YouTube[1] and features Professor Scott Page, author of *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies.* Students were asked to respond to the following reflection questions about the video:

1. In the video (around the 3:45-3:50 mark) Professor Page describes people as a "vector of skills, experiences, and talents". What are some of the skills, experiences and talents that make up your vector?

2. What is one aspect of your identity that might lead you to approach problems in a different way from your peers (i.e. something that makes you cognitively diverse from other engineering students you know?), and why?

3. What type of group is best suited to solving complex problems? Why is this type of group particularly important in the modern world?

4. At the end of the video, Professor Page talks about how diverse teams can produce the best work, but in some cases can also produce very poor work. The diversity of the team will only benefit the product if the team members can work together effectively. How can we set up environments so that there are optimal interactions among group members?

[1] https://www.youtube.com/watch?v=wULRXoYThDc

In other words, what can professors do in the classroom or what can YOU do in a group setting so that your team is making the most of group work?

In class students were asked to self-select into teams of four. In these teams students were assigned a “stretch” problem asking them to apply previously-learned content about shear and moment diagrams to design of a crane-rail for a moving crane (see Figure 1). Although students had most of the technical/computational knowledge needed to solve the problem, the design context was completely new and students needed to think carefully about how to apply their knowledge. At the beginning of class, students were shown a small mock-up of the frame constructed with Tinker Toys. Each team was given about ten minutes to think about the problem and ask questions. During this time two instructors circulated to answer questions. Partway through the class period each person on the team was given a unique hint meant to simulate the role of different perspectives on problem solving. For example, one hint asked students to consider the effect of the moving crane load on the maximum shear and moment experienced by the crane rail. Another hint gave students design tables from the AISC Manual of Steel Design and guidance to help them pick an appropriate shape. Teams completed the assignment outside of class as homework.

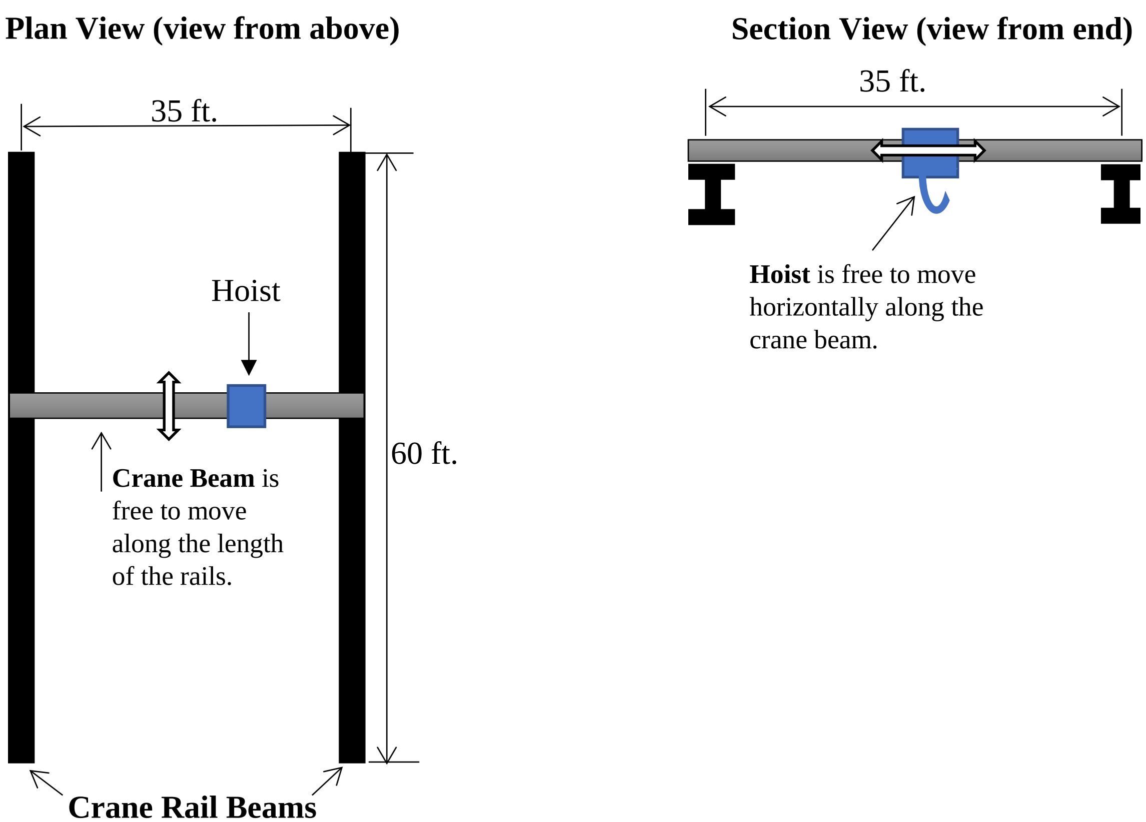

Figure 1: Diagram of crane rail design problem schematic. Note that students had to find the minimum size ‘crane rail beam’ given a specific loading, lengths, and other constraints.

After the assignment students were asked to complete the following five questions to evaluate the impact of the assignment:

1. What did you learn from this assignment?
2. Think about interacting with other engineering students, especially those who are different from you. How can you apply what you learned to your interactions?
3. Did what you learned in this assignment change your views on the roles and responsibilities of engineers? If so, how?
4. What did you like about this assignment?
5. What would you change about this assignment to make it more engaging for you?

Responses to both surveys were collected via the learning management software. The responses of those students consenting to have their assignments collected by the research team were then organized by question (instead of by respondent) and anonymized before analysis.

Data Analysis

We took a qualitative approach to analyze the data. Data analysis in qualitative inquiry involves making "sense out of the data ... [through] consolidating, reducing, and interpreting what people have said and what researcher has seen or read" (Merriam, 2009, p. 175-6). To be more specific, we used thematic analysis which "is a method for identifying, analyzing, and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79).

We started the process with initial coding by attaching "labels to segments of data that depict what each segment is about" (Charmaz, 2006, p. 3). In the next step, following the thematic analysis approach described by Braun and Clarke (2006), by collating codes we developed the themes and sub-themes. Later, these themes were reviewed including checking if they would work in relation to the text. During this process, the themes and their names were refined. Moreover, representative examples were selected for each theme to be included in this paper (Braun & Clarke, 2006).

Results

Diversity-focused assignment

The results of the diversity assignment, which students performed prior to the in-class activity, were analyzed from the 76 consenting students. Students' responses to the reflection questions provided us with a better understanding of students which in turn helped us interpret their responses to the questions posed after they had completed the team assignment.

From an instructional perspective, the first two questions (listed in ‘The intervention’ above) aimed at making students more aware of the unique skills, talents, and experiences that they individually possess and therefore implicitly, more aware of other skills, experiences, and talents that they lacked, and their peers might bring to the table. Although the detailed analysis of the responses to these two questions is not the aim of this manuscript, some examples of students’ responses to these two questions provide a better understanding of the context of the study.

Students’ responses to questions in this section helped them recognize the unique perspectives they bring to groups, as well as how different identities influence group dynamics. Through reflection on their background and talents, some students were able to recognize the possible roles they can play considering their unique talents. For example, one of the students stated that:

> *Many of people I have met in engineering have very technical and scientific backgrounds, often coming from STEM high schools and the like. However, the school I attended was more focused on liberal arts, humanities, and service in surrounding communities. I think this gives me a slightly different perspective when approaching an engineering problem, such as developing affordable housing for a low-income community. Rather than setting a financial goal and attempting to achieve it with use of materials and design, I would first want to make connections with community, identify wants and needs, [and] then work around those constraints first and foremost.*

The reflection questions helped some students reveal ways they may approach the problem differently than their peers. Discussion of differences also brought to light some of the barriers that can limit participation in group work. A woman student, in response to the aspect that made her different from her peers stated that: *“I’m scared of not being listened to partly because I’m a girl and partly because I’m scared people think that I’m not smart enough. Therefore, I might not make a suggestion based on if I feel like that in the group”.*

After the students were primed to think about their own identities in relationship to group work, students responded to questions that addressed two general characteristics of groups: characteristics that help groups solve complex problems, and characteristics of environments that optimize interactions (Tables 1 and 2). As one might expect after being primed by the video, students’ responses most frequently focused on diversity and cultivating an inclusive environment.

Table 1 - The groups which student believed are best suited to solve complex problems

Type of group	Reasons	Freq.	Examples
Diverse	Bring different perspectives/ viewpoints/ thoughts; bring different set of skills/experiences; more potential for innovation/adapt to changes or opportunities; more ideas/diverse solutions; other reasons.	48	"…no one person, or one group of people who have the same mindset and background are capable of knowing all there is to know." "A diverse group is better … because they have a larger pool of information and experiences to pull from in order to formulate a solution." "A variety of opinions and perspectives will contribute to more routes to for success."
A group that gets along	Innovation, efficiency	3	"Diversity is important … [but] it is more important to have a group of people with positive attitudes who all wish to achieve the same goal. This may include diversity but if there is no chemistry on a diverse team I don't think they will be as efficient as a team that gets along and has fun during the process."
A group with members with different knowledge/ skills level or different areas of expertise	More dynamic group	3	"[A group] that consists of individuals with different areas of expertise…. This allows for a more dynamic group to bring multiple views to solve a common issue". Ex. "…the best group is to have everyone at a different knowledge level. I think it is important because sometime people who are smarter than others think way too hard and don't notice the answer is right in front of them."
A group with flexible leader	There is no constant battle for power	2	"A well balanced group with a flexible leader is best for solving complex tasks. Each group member should add new elements to problem solving."
Any type of group	Seeing different aspects of a problem	2	Ex. "I think any group, composed of whoever, is best suited to solve complex problems, because you can only talk to yourself so much before you need someone else's input to really make a breakthrough on a problem."

Table 2 - Students' suggestions for setting up environments to create optimal interactions

Suggestion	Freq.	Example(s)
Creating an inclusive environment, including expressing ideas equally, respecting each other, and open communication	22	"I think that setting up an environment that doesn't just cater to one "type" of person is the most important aspect of this. Not every person fits into the same box, so why should they have to work in an environment that isn't suited for them?" "…it is important to let everyone say what they are thinking out loud because sometimes a little bit of what they said is right and then other people can expand on that thought and it can end up being a great idea".
Having a clear, unifying goal	7	"…you need everyone in the group to agree with a unifying cause, because a diverse group will not unify unless you have a mutually agreed upon reason".
Different approaches for assigning groups	6 Random 4 Students select 4 Based on individuals' characteristics.	"I think that randomly selecting people into groups is the best way to ensure diversity because it will teach people how to work in a team effectively". "Allow the individual members to choose their respective group members [and] allow group members to change, perhaps for a limited time, therefore allowing different members to find others more cohesive to their learning". "Find which students are good at doing things one way and group them with students who do it differently".
Interpersonal connections	5	"People communicate better when they connect in a deeper level… Make them friends first and they will work better as a team."
Require group work	5	"Require group work every week [and] assign group projects".
Division of work and setting goals for each member	3	"Division of work will give a solution to help a team work better".
Others	14	A range of other suggestions included overcoming language barriers, motivation working on team-building skills, giving teams applicable and interesting tasks, along with stating that it is not possible to optimize interactions.

Students who discussed diversity believed that having diverse groups would lead to better outcomes by brining diversity of thoughts and perspectives. However, the reasoning of students and their level of engagement with the issues of diversity were different. Moreover, although most students focused on diversity of thoughts, there was one student who specifically discussed the diversity of identity:

> *The type of group best suited to solving problems is one that has identity diversity. With the global economy today, products and technology have a far reaching effect and this requires a team with diverse backgrounds to inspect these problems from all sides*

There were also students who provided examples of diversity without using the term. For example, one student mentioned that: "a member from a low income background may have ideas that someone from a high income may not have thought of".

Some students found other issues more important than diversity (Table 1). Three students raised the importance of the ability to get along as the most important attribute of groups and discussed how positive attitudes have a big influence on group function. A student who self-identified as a Person of Color attend to both diversity and group cohesion into her response:

> *While I strongly advocate for "diversity of thought", there are two factors that are pivotal in determining the success outcome of a group. The first is different perspectives due to different experiences… Humans are not monolithic, nor our experiences, so problem solving settings should reflect this. The second piece that is important is cohesion. This is something that can only be taught/facilitated to a certain extent; the reality is that not everyone can get along.*

The same student, in her suggestions, discussed the way interpersonal relationships in the group influence how under-represented students need to think more about group dynamics when working in teams.

> *For marginalized groups, there is a heightened sense of awareness when entering collaborative settings, because we do not always know the group that we are working with. Taking time to gauge the group, understanding each other as humans, and being willing to at least briefly consider all different suggestions and feedback are all facilitating aspects that minimize the threat of group failure.*

In this quote the student brings up the importance of how group characteristics interact; diversity is not beneficial if the group does not create an inclusive environment.

The importance of an inclusive environment was brought up more broadly in students' responses to the qualities of an environment that creates optimal interactions (Table 2). A nontraditional student with several work experiences in different positions, explicitly suggested inclusion as a strategy:

> *Being inclusive is probably the most important thing. What I have experienced in professional life is that groups of a similar majority mindset people get together and make decisions without the input of those who may have different ideas. Also, these groups will often display negative behavior to people who they don't perceive to be just like them.*

This student not only states the importance of inclusivity, the details of the response reveal more nuanced reasoning behind the importance of being inclusive and how environments are often exclusive.

Another student, who was raised in a small town "without much money or technology", discussed how the lack of diversity at the institution was problematic:

I wish I had a better answer for this. The lack of diversity at [the name of institution] makes it pretty hard for these interactions to occur. Most everyone that I interact with is white and from [a community college in the state] and [one of the western US states] … and that is not by choice.

Other topics of focus in student responses included having a shared goal, dividing up group work, focusing on relationship building beyond the class assignment, and suggestions about how to assign groups. Most of the characteristics that are not explicitly diversity oriented, are still important components of group function, and arguably part of building an inclusive environment.

One particularly interesting division between students was their preference regarding random/non-random assignments of group members. The 14 students who discussed group assignment were fairly evenly divided between randomly assigning groups (6), allowing students to pick their own groups (4), and assigning groups based on students' characteristics (4), such as background knowledge or approach to completing tasks.

Students' perceptions of the assignment

Students' responses to the questions after completing the assignment provide insight into students' perceptions of the activity. While students' perceptions of what they learned or the quality of the assignment do not necessarily reflect what they actually learned or the actual quality of the assignment, they do give us insight into the quality of their experience with the activity and may tell us something about what students learned.

Students did perceive that they learned about benefits of inclusion and diversity, as well as about teamwork, inter- and intra-personal skills, and technical application of what they are learning (Table 3). Students most frequently wrote about benefits of teamwork and inter/intra-personal skills, which are both important building blocks of valuing diverse teams. Based on students' perceptions, it appears that the intervention was successful in providing the students with the experiences that contributed to their understanding on issues of diversity and inclusion as well as the importance of these issues in working in teams as an engineer.

Table 3 - Learning outcomes based on students' self-report

Themes	**Sub-themes**	**Freq.**	**Examples**
Issues related to inclusion	The importance of listening to everyone, actively seeking individuals' ideas and thoughts and helping them to work through the ideas, considering all input, and avoiding biases.	26	"I learned the importance of having a team that listens to everyone, for everyone can contribute in a different way." "…actually help them through their ideas rather than just listen and move on". "Everyone should … decide as a group whether it [an idea] would work or not based on the math and science rather than being bias[ed] against someone because they are different."
Benefits of diversity	More effective solutions and a greater pool of ideas.	10	"I learned that when dealing with a problem that seems very difficult with a lot of things that I don't understand, it helps to have a group with different perspectives share those perspectives to work through the problem."
Benefits of teamwork	The helpfulness of different skill sets/ thought processes, solving complex problems, more efficient problem solving, learning from others, correcting mistakes, and realizing engineers work in teams in the 'real world.'	38	"I feel all engineers can work together and help each other in different aspects such as Chemistry, Physics, and Biology." "You can discuss and solve problems more efficiently with multiple minds working …rather than just one." "We were able to break down a complex problem into very manageable pieces." "This was a good reminder that in the real world I will be able to interact and collaborate with many different engineers."
Understanding the challenges of teamwork	Difficulty working with people who one does not know and team function complexity.	4	"I learned that if you do not already know the people you are teamed with, you cannot let that stop you from making contributions to the group."
Intra-personal and inter-personal skills	The importance of communication, being open to others' ideas, leadership, teamwork, respect, patience, knowing one's own and others' skills, and realizing there are multiple perspectives and approaches to problem solving.	44	"Our shortcoming came from no leadership within the team… and conflicting directions to go." "…If I wish my voice to be heard then I must respect others when they desire the same." "I learned that not to keep quiet myself, because I can put forth input of value." "… we have to have patience and give space and time to adjust to the situation, so we can effectively communicate on the task at hand."
Technical application	Learning the concepts, applying concepts to the real world, and the difficulty of real-world problems.	14	"I learned how to actually apply what we have been learning". "I learned that real-life engineering problems aren't as straightforward as engineering homework problems."

While it is important to avoid linking student satisfaction with an assignment with the quality of the assignment, looking at students' preferences may be helpful in designing assignments in the future, as long as the overall learning goals are still met. The four main things students liked about this assignment were the different opportunities it provided, the nature of the problem, that it enhanced learning, and that it changed attitudes about diversity and teamwork. Two students were largely critical of the assignment even when asked for what they liked. One student raised important inclusivity and teamwork concerns regarding the structure of the assignment:

> *The assignment was very hard for me on so many different levels. I wasn't able to have time to digest the assignment alone in a quiet place at all beforehand. I had to find a group of people I've never met before to work with and they didn't listen to me when I had ideas to contribute. I did not feel comfortable asking for help or for tips when I got stuck… It was hard to like anything about this assignment for me.*

In the future, if we provide assignments ahead of time and provide more structure for both forming groups and working in groups we can help students work more successfully on the project. While we do not know about this student's identity, providing assignments ahead of time can be an important accessibility issue for some students, particularly those that are neurodiverse. Even though few students may take the time to review class materials prior to class, this student's feedback is an important reminder that material access can have a significant impact on some students' ability to participate.

Students' main suggestions for improving the assignment related to providing more explanations, changing the problem to be more or less complex, changing the scope/time of assignment, providing the information differently, and modifying the group formation/ organization. Most of these suggestions were minor to moderate. Some of the suggestions were conflicting, such as the students who thought the assignment was too hard and those that thought it was too easy. Approximately one-third of the participants didn't have any suggestions for improvement, which indicates that they were largely satisfied with the activity. While students quantitatively rated the intervention class ($M=6.98$) lower than an average day of instruction ($M=7.87$; $t(57)=3.9802$, $p=0.0002$), their average rating was still higher than a neutral 5. Additionally, as discussed in the literature, learners' satisfaction does not necessarily relate to their learning (Stolovitch & Keeps, 2011).

Discussion

The goal of the intervention was to help engineering students see the relevance of diversity and inclusion to engineering problem solving within the context of a technical/calculation oriented course. Thematic analysis of students' responses indicated that the assignment was generally well-received by students and that most students' responses were in line with the desired diversity and inclusion-related learning outcomes. For example, the assignment helped students understand the ways in which their own and their peers' knowledge and experiences contribute to the problem solving process and why it is important to listen to others' ideas and also to solicit ideas from others. It also encouraged some students to rethink their assumptions towards engineering work and team dynamics. This finding confirmed what Noravian and Irvine (2014) argued about the benefits of shifting to ill-structured problems to enhance students' understanding about the nature of engineering work. Moreover, students became more conscious of the importance of reliance on the contribution of other teammates in their learning.

While most students drew directly from the video to identify diverse groups as the type of group best suited to solving complex problems, there was a much greater variety of answers when students were asked to identify ways to establish environments for optimal team interactions. Many of the suggestions students gave were valid and important characteristics of functioning teams which suggests that students know quite a bit about teamwork and the act of reflecting on that knowledge is valuable. The variety also suggests that students might be well positioned to teach and learn from each other about team or group work. There is also the opportunity for an instructor to supplement student knowledge about team work to address other important characteristics of successful teams, for example a willingness for individuals to take risks within a supportive environment (Edmonson, 2012).

Students' responses about what they liked about the assignment lay under four main categories: (1) different opportunities (e.g., critical thinking, working as a team, etc.), (2) nature of the problem (e.g., complex but solvable), (3) enhance learning (e.g., refining and improving skills), and (4) change attitudes (i.e., regarding teamwork and inclusion). This finding further indicates the effectiveness of the approach in communicating the objectives of the designed assignment to students. Moreover, students' thoughts were in line with what expected from previous work such as Ochoa and Pineda's (2008) arguments about the benefit of integrating collaboration opportunities in enhancing learning and challenging "exclusionary thoughts and practices" (p. 46).

The one quantitative feedback question indicated that students were less satisfied with the session with the problem solving group activity than a typical day in class. This could be attributed to the students' resentment of a full class period of active learning where they are more used to a balance of active and passive learning styles (Gunasekera & Friedrich, 2009). In other words, it can be attributed to "suddenly participating in a student centered classroom" that can be intimidating for some students (Ochoa & Pineda, 2008, p. 55). Another factor could have been that the activity was designed to be a stretch assignment which was beyond their capacity without the use of the provided hints. Additionally, where a typical class day was scored as being a 7.9/10 on the scale "where 1 is equivalent to getting a dental filling and 10 is the most amazing educational experience you can imagine", the group problem solving activity landing at a 7/10 on the overall scale is quite successful. Note that one of the considerations in design of the assignment was to make it compact and not something that would require disruption of the whole course. The fact that the group assignment was new and atypical might have also contributed to student attitudes about the assignment. This is a difficult balance for instructors who might want students to engage in new types of assignments and with new types of content, but not having the time to rework an entire semester.

Conclusion

After taking part in the group problem-solving activity, many students were able to recognize and reflect on their assumptions related to the nature of engineering work and also the required skills to work on complex problems in collaborative environments and on diverse teams. The current research showed the existence of such assumptions (e.g., engineering is an individual attempt which only needs math skills to be accomplished) and at the same time the possibility of using interventions to debunk these assumptions. The intervention introduced and evaluated in this paper seems promising and we encourage engineering educators to infuse activities similar to this in their curriculum. The problem-based nature of the intervention makes it an appropriate model to be adapted and customized not only for Statics courses but also for other courses in a variety of engineering disciplines and also courses in other STEM fields. Educators can use the suggestions provided by students in this paper to improve the original intervention and also seek their own students' feedback to better the intervention each semester based on their specific context. Moreover, educators and future researchers can contribute to the literature by conducting similar evaluative studies to gauge the effectiveness of the improved version of the discussed intervention which can contribute to the engineering education literature. As stated earlier, engineering educators have an important role in clarifying the collaborative nature of engineering work in today's diverse climate for students. Using interventions similar to the one proposed here can have important outcomes for today's engineering students and the future engineering workforce.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 1726268. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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