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Using Interactive Theatre to Promote Inclusive Behaviors in Teams for First Year Engineering Students: A Sustainable Approach

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(Work in Progress)

Working in teams is essential to being a successful engineer (Accreditation Board for Engineering and Technology [ABET] Engineering Accreditation Commission, 2016). For engineers to address the grand challenges facing our society, all engineers must learn to work effectively in teams of people who are different from them, not only different in gender or race, but also different in background, experiences, and culture. When facing complex problems, diverse teams can outperform higher ability homogenous teams if they can successfully work together (Hong & Page, 2004; Page, 2008). If individuals are not prepared to work in diverse teams and teams fail capitalize on the unique catalyst of diversity, teams are less likely to produce unique solutions and products. Thus, providing team assignments alone is not adequate. Engineering programs must be intentional in how they facilitate teamwork and prepare students to use differences as a strength.

Even as more companies and organizations recognize the need for diverse teams in engineering, underrepresentation of women and minorities is still a well-established problem in engineering (e.g., U.S. Department of Education, 2016). Many much-needed programs exist to recruit, support, and retain those who are from the underrepresented groups. However, even with increased recruitment, those from underrepresented groups still make up incredibly small percentages of the engineering workforce (U.S. Department of Education, 2016).

There are many reasons why, once recruited into engineering, diverse talent does not persist (Seron, Silbey, Cech, & Rubineau, 2016; Singh et al. 2014). For example, several researchers have documented dysfunctional team behaviors that are particularly problematic for female engineers, such as: (a) men relegating women to helping roles (Seron, Silbey, Cech, & Rubineau, 2016), (b) men creating team environments in which women do not speaking up when they are in the minority (Dasgupta, Scircle & Hunsinger, 2015), and (c) men ~~on teams~~ being more likely to present technical content and answer audience questions (Meadows & Sekaquaptewa, 2013). Programs and specific interventions targeted to help all engineers and engineering students work in diverse teams may support efforts to retain diverse talent in engineering. Because program and specific interventions targeted to help all engineers and engineering students work in diverse teams may support efforts to retain the diverse talent in engineering, the need exists to help all engineers work on diverse teams (Atadero, Paguyo, Rambo-Hernandez, and Henderson, 2017).

One such intervention was led by Finelli & Kendall-Brown (2009) and addressed some of the issues students encounter when working in teams by incorporating a professional theatre troupe sketch into an introductory engineering course at the University of Michigan. In this study, there were 17 study sections of which nine participated in the interactive theatre sketch. Results indicated students who participated in the interactive theatre sketches demonstrated increases in the appreciation for diversity on teams and in being prepared to address conflict on teams.

The current study sought to build on prior work by transferring, augmenting, and adapting previously developed curriculum (which included a theatre sketch) targeted to improve first year engineering students' appreciation for diversity in engineering, to increase inclusive behaviors

enacted by first year engineering students, and help all students better identify with the engineering profession.

The Current Study

To address these issues of inequity and supplement existing programs that provide support and training for women and other underrepresented populations, a different, holistic approach, was taken in this research. As part of an National Science Foundation (NSF) supported initiative, multiple activities intended to develop an appreciation for diversity in engineering and promote inclusive behaviors in teams were integrated into four first year engineering courses at a large mid-Atlantic university. An additional four sections received the course as typically taught. Intervention and comparison classes were balanced across instructors. All eight classes participated in regular surveys throughout the semester to assess the impact of the interventions.

This manuscript assesses the impact of these intervention activities (see Authors, 2015, 2017, for full description of each activity), with attention paid to one of those intervention activities, an interactive theatre sketch. In the interactive theatre sketch, students in the intervention sections watch a scene of a three-person engineering team that demonstrates some dysfunctionality, such as being unable to move past a small mistake the woman made during the previous assignment and accusing her of becoming “too emotional” when she defended her work in the current lab. After the scene, students from the audience volunteer to be the fourth person on the team to try to intervene to help the team to function better. Trained facilitators review what worked well in the intervention and how to improve the team’s functionality, with a particular eye toward issues of gender and inequity.

Unfortunately, professional theatre troupes are expensive and therefore using interactive theatre sketches may be difficult to sustain aside from grant support. So, unlike the Finelli and Kendall-Brown (2009) study which incorporated a professional theatre troupe, as a part of this NSF-funded project, a professional theatre troupe trained student actors to perform the theatre sketch and faculty/staff to facilitate the sketch. This professional theatre troupe wrote a script specific to the needs of the project and trained the student actors and faculty/staff on the script. The upfront cost of the training was expensive but would make the long-term cost of incorporating theatre sketches into the curriculum much more sustainable after the grant funding has expired.

The goal of this study was to determine whether the students and faculty/staff who were trained by the theatre troupe were effective in influencing engineering students understanding of why diversity is important to engineering and how effective engineering teams work. Answers to three specific questions were sought to answer the larger question:

- 1) How do students enrolled in classes receiving the intervention describe their experiences when compared to peers in comparison courses?
- 2) How do intervention students who did not experience the theatre troupe describe their course experiences when compared to counterparts who did?
- 3) When compared, how do intervention students who attended one of the two theatre troupe sessions describe their respective course experiences?

Method

Three instructors taught ~~of~~ the eight sections and each instructor had equal numbers of intervention and comparison courses. A total of 326 students enrolled in eight sections (four comparison and four intervention sections), of which 270 provided consent to have their data included in the research study, 15 chose not to have their data included in the study, and 41 failed to respond to the survey. Roughly half of the students were in comparison classes. Of students who provided consent, 89% were first year engineering students; 73.5% were male; and 2.4% were of Latino/a ethnicity, 5% indicated an Asian race, 0.8% indicated Native Hawaiian or other Pacific Islander race, 2.4% indicated a Black or African American race, 92.5% indicated a White race. Students could select multiple races; thus the percentages do not sum to 100%.

Students in the intervention sections participated in up to seven intervention activities (e.g., a diverse panel of practicing engineers, a welcome talk by the dean to establish egalitarian norms, and a response to a reading related to the Campus Reads program to elucidate implicit bias and its impact on engineering). The interactive theatre sketch was one of the last interventions of the semester and was offered in the evenings at two time slots, Monday or Wednesday evenings from 7 to 9. Two of the actors were the same on both nights and one changed. The same faculty member and university administrator facilitated the sketches on both nights. The theatre sketch and subsequent facilitation was intentionally in a neutral space (a large lecture hall in one of the university agricultural buildings). The theatre troupe that led the training suggested the engineering students be taken out of their educational space but not put them in a space which might be perceived as the opposite of engineering, performing arts. Additionally, the student theatre students may feel uncomfortable performing in the engineering space. Engineering students earned course credit for attending the activities.

Qualitative data was collected in fall 2017 on the final survey (#4) to assess what students learned about working in teams. Students in both the intervention and comparison sections were questioned about what they learned about working in teams and what activities helped them learn about working in teams. All students were asked to respond to the questions,

- What specific in or out-of-class activities helped you learn about working in teams, especially with people who are different from you?
- What did you learn through those in class or out- of class activities about how to work on teams, especially with people who are different from you?

Additionally, students were randomly assigned to respond to one of three sets of questions:

- Do you think implicit bias impacts how teams function? Why or why not?
- What does diversity in engineering mean to you?
- Do you see yourself as an engineer? Why or why not? Were there any activities during the semester helped you see yourself as an engineer? If so, which ones?

To address each of the three research questions, we compared student responses to the open-ended questions in three groups (Figure 1).

Question 1	Comparison sections	Intervention sections	
	Question 2	Students who did not attend a theatre sketch	Students who attended the theatre sketches
		Question 3	Students who attended Monday theatre sketch
			Students who attended Wednesday theatre sketch

Figure 1. Illustration of the comparisons for each research question.

An exploratory scheme was added to the existing explanatory framework to analyze the data. In this two-tiered process, a group of a priori codes, used as indicators of well-defined inclusion-exclusion criteria for a thematic analysis of the response data, were determined by outcomes of studies found in an exhaustive literature review of similar initiatives, primarily existing outside of engineering. Independent of the pre-set codes, response sets were independently coded by two different raters to determine emergent themes.

Student responses were coded using MAXQDA 2018. An initial list of codes was created to view the response structure using distinctions outlined within the evaluation questions as comparative groups. First-level codes, or separate categories within the data known as master headings were then constructed. This was accomplished by utilizing themes (1) derived from student responses and (2) between students from differing groups. Using a tree-node format with high-level processing, all similar codes, or first-level codes were either merged or absorbed into larger categories to reduce the extensive number of existing classifications. The classifications were then agreed upon or rejected by the two coders. Interrater reliability measures using Cohen's Kappa indicated a high agreement between themes ($\kappa = 0.80$). The remaining classifications served as second-level codes, or categorical subheadings within the final framework for organizing and describing feedback.

Outcomes

Comparison and Intervention Groups

In this comparison, participants indicated that engineering projects associated with the intervention activities provided the best mode for understanding diversity. However, responses regarding the inner workings connected to those activities yielded two primary themes: knowledge and challenges of teamwork and an awareness of the effects of bias.

Knowledge and Challenges of Collaboration. Generally, across students both in the comparison and intervention sections, teamwork was viewed as a positive method to complete a given task. Students who did not indicate previous involvement within a team setting tended to describe the experience as a collection of learning moments primarily oriented toward an understanding and consideration of team logistics in addition to acquiring any process oriented skills needed to

succeed. Some described that personal growth came in the form of leadership opportunities whether they were intended to be in that role or not.

Further, students in the comparison and in the intervention who did not attend the interactive theatre intervention specified that effective communication, whether already existing or developed within groups, was crucial to managing the team structure while progressing towards a goal. However, this sentiment was not indicated by the intervention sections that did attend the theatre sessions.

An Awareness of the Effects of Bias. The relationship between an understanding of bias and how in turn, it could affect a team’s structure were explained in detail within the three experimental subgroups (comparison, intervention without theatre sketch, intervention with theatre sketch). While initial responses between the comparison and intervention sections (with and without the theatre sketch) were similar, justifications for the intervention group were generally cohesive and well defined. The following provides a general indicator of the differing response sets in the situation where students were asked if they believed that implicit bias impacted a team’s capabilities to function as a unit.

Examples of Control Group Responses	Examples of Experimental Group Responses
“Yes, because of cooperation”	"Absolutely! Certain individuals may not even get opportunities to excel in certain areas because of the perceptions about them”
“I think it can affect how a team functions, but it does not have to.”	“Yes, I think they affect somewhat because everybody judges slightly without even knowing that they are and it can affect the way a team communicates over ideas and how they work on projects together.”
“No, I think it has no impact because they're not correlated”	“I do not because I do not believe in implicit bias”

Comparison of Intervention Subgroups

Following previous findings, those in the intervention subgroups tended to identify intervention activities as learning activities. However, unlike prior outcomes, students across the intervention subgroups also acknowledged that engineering panels were helpful in studying diversity. Moreover, participants who attended an interactive theatre sketch found that activity beneficial as well. When examining answers from the students who attended the theatre troupe to those who did not, responses were typically oriented toward aspects regarding team structure, process, and progression addressing the team dynamic.

Some students discussed cultural makeup of their groups. Most of those students indicated they would not have chosen a diverse group initially. Moreover, they also indicated that the experience was polar, in that the team structure was either helpful or hurtful in their personal and professional development as an engineer, such as diversity helped the team or the team was ineffective because of team member(s) who were apathetic. Response sets regarding this self-

reported polarization were arranged into five predominant categories: individual discovery, personal and professional growth, emergent and expansive philosophies of learning, respect and admiration of team members and self, and the complexity of a team’s structure. These were then collapsed and three themes emerged: communication, preconceived notions, and self-worth.

Communication. Coined by Greenwood (2009, p. 104), a desire to have the “hive mind”, or one in which all members thought using a general collective consciousness, was an objective for many respondents as seen in their responses. However, the path to achieving that goal was an underlying distinction between the intervention groups. Those students who did not attend any theatre sketch leaned towards a strong communication network as a principal component of an effective team dynamic whereas those who attended did not respond in the same manner. At first this may appear to be counterintuitive, but respondents noted that bias was the variable affecting team cohesion and with it came an inability to effectively communicate.

Furthermore, when examining responses regarding bias and its impact on team functionality, students with experience attending a theatre session were found to be mostly in agreeance that bias greatly diminishes a team’s capacity to accomplish goals whereas those in the opposing subgroup were mostly split on the issue.

Preconceived Notions. Between both subgroups (those who attended the theatre sketches and those who did not), students found the team experience to be productive with responses ranging from defined gains in self-growth to value added outcomes associated with the team dynamic. However, there exists a minority who did not find benefits in their experience. These students on both extremes did not appear to connect issues of diversity and inclusion to their experiences. Though not great in numbers, individuals who fit this description were inclined to provide in-depth and often emotional responses regularly utilizing assumptions of individual histories or preconceived biases as a means of explanation. For example, a respondent stated:

“Through the two out of class projects, I learned how to depend completely on myself to complete projects after all the work was shoved on me -- no one wants to work. Maybe if everyone grew up poor for the first 15 years of their life they'd have a slightly better work ethic, but what do I know?”

Self-worth. Individuals described that their unbalanced workload was either leading to academic successes or in some cases, failures. Achievements often translated in a rise in self-esteem, gains in leadership skills through the form of contingency planning, or in the skepticism of any benefits within a team structure. Personal disappointments in academic efforts were addressed in the form of self-loathing and uncertainty leading some to question their chosen line of study.

Example of Perceived Accomplishment	Example of Perceived Failure
<i>“... not everyone will hold their own on the project and should be prepared to have to carry multiple people in order to succeed. I must step up and beyond the call of duty and do things that others may not want to do”</i>	<i>“...in my eyes, both projects have been failures and I'm not sure if it's because I am the only one doing all the work, and it stresses me out to the point that I can't</i>

perform at my best, or if I'm actually just really stupid and should switch majors"

Unfortunately for either type of student, the scenario did not afford an opportunity to explore the team based setting as intended. Specifically, neither group directly referenced issues of diversity, rather the focus tended to be on oneself. Those who perceived the accomplishment were inclined to display signs of being extremely individualist (e.g., *"I stepped up"*) and did not reference diversity in the group as a value added component. Those who perceived failure blamed themselves and not the diversity or lack thereof in their group membership.

Comparison of Theatre Attending Subgroups

Students attending either theatre troupe scenario were relatively homogeneous. Individuals in both subgroups tended to view diversity through similar lenses going as far as describing bias and its relation to the components of a team.

Response related to team structure	Response related to team objective
<i>"Definitely because people's feelings toward each other in a group impact how they work together"</i>	<i>"Yes, if you are implicitly biased towards a trait a team member has it can hinder the quality of your work"</i>

Responses related to challenges and methods for success within a team based environment were nearly identical.

Conclusion

When considering responses in aggregate, regardless of group affiliation, nearly all students identify themselves as engineers; while not always being described as efficient, participants generally agreed that a team structure is beneficial when considering final products or deliverables; and by in large, respondents found the activities to be great learning experiences when considering diversity. Meanwhile, group and subgroup differences only appeared after themes were discovered and clustered. These differences exist not only between students receiving the intervention and those who do not, but distinctions are also apparent amongst individuals who experience the interactive theatre and those who do not. Further analysis of future survey responses will no doubt either outline these delineations further or invalidate these preliminary findings. However, these findings do indicate the emergence of stark differences between the control and experimental groups lending credence that the intervention is playing a role in how students think and identify with diversity and inclusion.

To answer the broader question, these initial results indicate students who participated in the interventions did appreciate diversity more than those in the comparison section and students in the intervention sections who participated in the theatre sketches benefited more than those in the intervention who did not attend the theatre sketch. Further, despite slightly different casts on Monday and Wednesday, different suggested interventions to the sketch from the audience, and

slightly different facilitation, the responses for students who attended the theatre sketches were quite similar. Taken together, the different more potentially sustainable approach to implementing theatre sketches appears to have worked.

Limitations

Students were not randomly assigned to intervention or comparison sections; however, students were not aware of the study when they registered for courses. Also, students who attended the theatre sketches may have done so because they were more interested in issues of diversity and inclusion than students who chose not to attend the theatre sketches. Also, the facilitators were not from the department of engineering. In the second year of the grant, more engineering faculty will be trained to facilitate the theatre sketches. If engineering students perceive the need for diversity and inclusion to be imposed on them from the outside and not from within engineering, it is suspected they are less likely to adopt inclusive behaviors and ultimately change the climate in engineering.

References

- ABET Engineering Accreditation Commission (EAC) (2016), "Comparison of Proposal Submitted in 2015 to Proposal Submitted in 2016". Accessed 12-20-16.
<http://www.abet.org/wp-content/uploads/2016/08/EAC-Side-By-Side-Criteria.pdf>
- Atadero, R. E., Paguyo, C., Rambo-Hernandez, K.E., & Henderson, H. L. (2017). Building Inclusive Engineering Identities: Implications for Changing the Temperature of Engineering Culture. *European Journal of Engineering Educatio* (online first)
- Dasgupta, N., Scircle, M. M., & Hunsinger, M. (2015). Female peers in small work groups enhance women's motivation, verbal participation, and career aspirations in engineering. *Proceedings of the National Academy of Sciences*, 112(16), 4988-4993.
- Greenwood, J. D. (2009). *The Disappearance of the Social in American Social Psychology*. New York, NY: Cambridge University Press.
- Finelli, C., & Kendall-Brown, M. (2009). Using an Interactive Theatre Sketch to Improve Students' Perceptions about and Ability to Function on Diverse Teams. In *American Society for Engineering Education*. American Society for Engineering Education.
- Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *PNAS*, 101(46), 16385-16389.
- Meadows, L.A. & Sekaquaptewa, D. (2013). The Influence of Gender Stereotypes on Role Adoption in Student Teams. 120th ASEE Annual Conference and Exposition, Atlanta, 2013.
- Page, S. E. (2008). *The difference: How the power of diversity creates better groups, firms, schools, and societies*. Princeton University Press.
- Seron, C., Silbey, S. S., Cech, E., & Rubineau, B. (2016). Persistence Is Cultural Professional Socialization and the Reproduction of Sex Segregation. *Work and Occupations*, 43(2), 178-214.
- Singh, R., Fouad, N. A., Fitzpatrick, C. F., & Chang, W. H. (2014). To Stay or to Leave: Factors That Differentiate Women Currently Working in Engineering from Those Who Left the Profession. In D. Bilimoria and L. Lord (Eds). *Women in STEM Careers International Perspectives on Increasing Workforce Participation, Advancement and Leadership*. Edward Elgar Publishing, Northampton, MA.
- U.S. Department of Education. (2016). *Fact sheet: Spurring African-American STEM degree completion*. Retrieved from U.S. Department of Education website:
<https://www.ed.gov/news/press-releases/fact-sheet-spurring-african-american-stem-degree-completion>