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Inclusive Leadership Development for Engineering Undergraduate Students

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Dr. Patterson joined Penn State's Curriculum and Instruction team in Fall 2015. Trained in Special and Elementary Education at Boston University and Reading Specialization at Hood College, she completed her PhD work at The Ohio State University in Multicultural and Equity Studies in Education where she also earned an MA in Quantitative Research, Evaluation and Measurement. Dr. Patterson's work in the educational field began as an elementary level inclusive special educator. She is committed to preparing educators who take up a critical lens to working with children and best serving their needs while seeking ways to deconstruct inequities woven into the US's existing public school system and structure. To this end, Dr. Patterson serves as a co-coordinator for the newly (2020) established Social Justice in Education minor available to students across the University. Broadly, Dr. Patterson's research interests consider intersections between identity and education, considering the dialogic relationship that exists as the ways we think about ourselves impact our educational experiences while our educational experiences impact the ways we think about ourselves. Employing an intersectional approach to considering identity, Dr. Patterson's research examines race conjointly with a host of other contextually important and influential identity markers.

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Dr. Park is an assistant research professor in the Engineering Leadership Program at Penn State University. There is four interrelated areas of inquiry characterize Dr. Park's scholarship: engineering leadership, professional identity development, sustainability education, and psychological well-being. Particularly, he examines how possible future-self influences engineering students' learning, academic motivation, and career trajectory. The major population he primarily focuses on is STEM undergraduate and graduate students. He has received extensive qualitative and quantitative methodological training in the area of educational psychology. He acquired a Bachelor's of Science in Human Resources Management and a Masters of Educational Technology from California State University, Long Beach, and a Master's of Program Evaluation and a Doctorate of Philosophy from the University of Texas at Austin. Prior to joining the Penn State University, he worked as a research fellow and program evaluator at University of Michigan. Also he taught an "individual learning skills" as an assistant instructor in the University of Texas at Austin for five years.

Inclusive Leadership in an Engineering Leadership Course

Background

Engineering educators have seen significant changes in the Accreditation Board for Engineering and Technology (ABET) criteria starting in the early 2000. Pre-empted by workforce demands, these modifications seek to address changing workplace dynamics and globalization. One change reflects the evolution of teamwork in ABET's Criteria 3, student outcomes, which now states the importance of leadership within a team, specifically creating collaborative and inclusive environments (Commission, 2016). These newly added student outcome requirements are directly related to research signifying the positive effects of diversity and inclusion efforts on various workplace features including creativity and knowledge sharing (Bell, 2006; Bright et al., 2019; Cox & Blake, 1991), innovation (Mayer, War, & Zhao, 2018), project success (Rehman, 2020), work engagement (Choi, Tran, & Park, 2015) and financial performance in the workplace (Carter & Wagner, 2011; Herring et al., 2009).

In spite of the positive impacts to organizational bottom line and innovation that have been identified, a lack of diversity and inclusion in STEM related fields persists and is problematic for retention of members of underrepresented groups (Bendick, 2008; PCAST, 2012). Studies describe the environment in STEM fields and education as "chilly" (PCAST, 2012). This lack of belonging in group settings negatively impacts creativity and engagement in work groups, hiring practices, and retention (Hechinger et al., 2017). However, simply creating *diverse* teams does not alleviate issues related to *inclusion*. Quite the opposite is true according to research by Bendick (2008) in which he posits that organizations should be focused on the cause (lack of inclusion) and not the symptom (lack of diversity). In other words, though organizations may be successfully recruiting diverse talent into organizations, low levels of retention and promotion of racial minorities and women in the workplace indicate a lack of

inclusion within workplace cultures (Cook & Glass, 2013; Giscombe & Mattis, 2002; Hom & Ellis, 2008). With this in mind, ABET's approach to Criteria 3 specifically identifies the ability to *create inclusive environments* in engineering teams.

Creating these inclusive environments requires individuals to practice behaviors that foster individuals' feelings of belonging. Shore, Randel, Chung, and Dean (2011) go one step beyond belongingness in their definition of inclusion to include "the degree to which an employee perceives that he or she is an esteemed member of the work group through experiencing treatment that satisfies his or her needs for belongingness and uniqueness" (p. 1265). Team member perception of belongingness and uniqueness creates feelings of inclusivity within a team setting; behaviors related to these areas are described in Shore et al.'s (2011) framework for inclusion as shown in figure 1.

Figure 1

Shore et al. 2011 Inclusion Framework

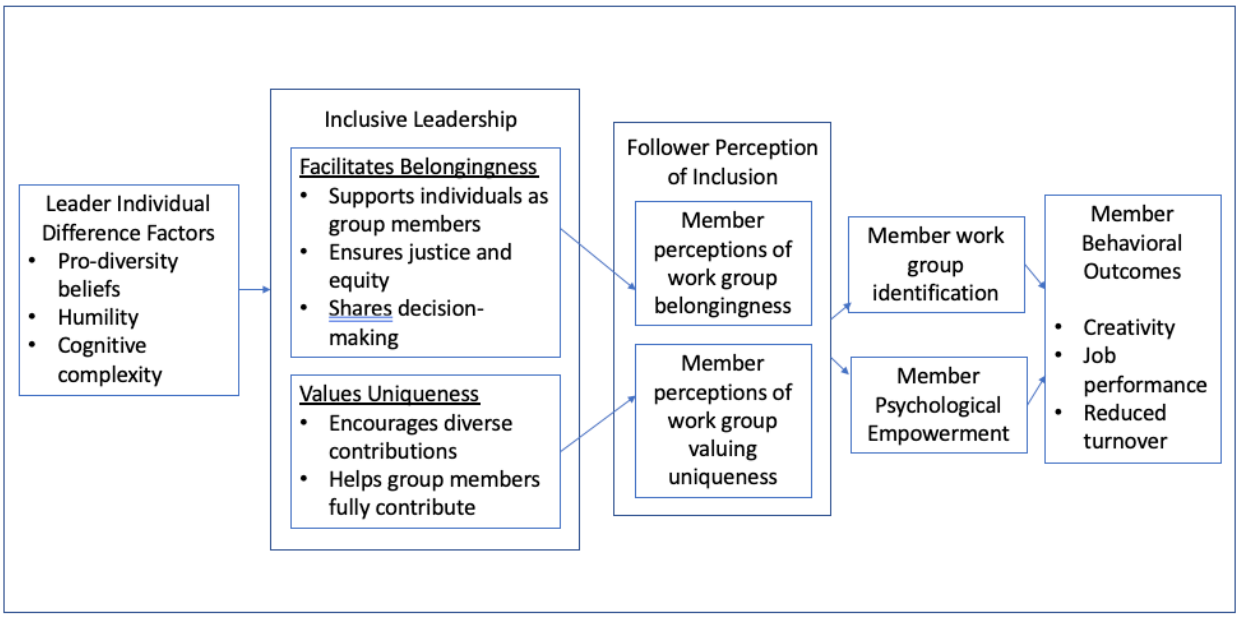
	Low Belongingness	High Belongingness
Low Value in Uniqueness	**Exclusion** Individual is not treated as an organizational insider with unique value in the work group but there are other employees or groups who are insiders.	**Assimilation** Individual is treated as an insider in the work group when they conform to organizational/dominant culture norms and downplay uniqueness.
High Value in Uniqueness	**Differentiation** Individual is not treated as an organizational insider in the work group but their unique characteristics are seen as valuable and required for group/organization success.	**Inclusion** Individual is treated as an insider and also allowed/encouraged to retain uniqueness within the work group.

From “Inclusion and Diversity in Work Groups: A Review and Model for Future Research”, by Shore, Randel, Chung, Dean, Ehrhart, and Singh, 2011, *Journal of Management,* 37(4), p. 1266. The Authors 2011.

Promoting feelings of inclusiveness requires intentional behaviors, and leaders are in a position to practice these behaviors to foster inclusive environments within teams. Their unique positions within the workplace poise leaders to be champions and drivers of inclusion through prioritization of inclusive practices. Inclusive leadership has been shown to have positive impacts on creativity and innovation in technical teams (Javed, Khan, & Quratulain, 2018; Qi, Liu, Wei, & Hu, 2019; Ye, Wang, & Guo, 2019). Early attempts towards defining inclusive leadership paired descriptions with traditional notions of leadership such as participatory styles (Nembhard & Edmondson, 2006) and leader-member exchange (Nishii & Mayer, 2009). These approaches center relational elements of inclusive leadership, specifically openness and accessibility (Carmeli, Reiter-palmon, & Ziv, 2010; Nembhard & Edmondson, 2006; Nishii & Mayer, 2009), but fall short of conceptualizing the concept (Randel et al., 2018). The definition of inclusive leadership used in this paper is: “a set of leader behaviors that are focused on facilitating group members feeling part of the group (belongingness) and retaining their sense of individuality (uniqueness) while contributing to group processes and outcomes” (Randel et al., 2018, p. 191). Randel et al.’s (2018) definition builds upon their previous conceptual model of inclusion but supports a behavioral approach to inclusive leadership and is outlined in Figure 2.

Figure 2

Randel et al., 2018 Theoretical model of inclusive leadership



From: Inclusive Leadership: "Realizing the Positive Outcomes through Belongingness and Being Valued for Uniqueness" by Randel et al. 2018, *Human Resource Management Review, 28*(2), p. 191, 2017 Elsevier Inc.

This model requires leaders to practice self-awareness and awareness of implicit biases to be effective in facilitating belongingness and in valuing the uniqueness of individuals. Implicit cognition suggests a lack of intentional control specific to judgements, impressions, and perceptions (Greenwaldt & Krieger, 2006) which can impact behaviors related to belongingness and uniqueness. These unconscious cognitive processes can result in implicit biases which are "discriminatory biases based on implicit attitudes and implicit stereotypes" (Greenwaldt & Krieger, 2006, p. 951) and can impact pro-diversity and cognitive complexity factors in the leader individual differences of Randel et al.'s (2018) inclusive leadership model. These leader individual difference factors are centered in awareness of bias that pervades behaviors which negatively impact the facilitation of belongingness and valuing uniqueness. The implicit association test (IAT) is a common measure used to aide in identification of perceptions or associations between groups (Greenwaldt & Krieger, 2006). By building awareness of

unconscious associations or unconscious biases, one can work to shift in a conscious manner towards behaviors that support inclusive leadership.

Using Randel et al.'s (2018) inclusive leadership framework an engineering leadership development program at a large northeastern university incorporated didactic and experimental learning strategies in an engineering leadership course aimed at developing inclusive leadership skills. The course provided guided opportunities for students to build knowledge of self and others, engaging students in practicing perspective taking and consciousness raising strategies to foster awareness of implicit bias. These experiences aimed to build knowledge and application of inclusive leader behaviors and approaches. Experiential learning approaches focused on self-reflection and experiences in alignment with research on effective measures for leadership development (Avolio & Vogelgesang, 2021). The purpose of this paper is to assess students' self-reported pre- and post- outcomes of perceived knowledge regarding inclusive leadership and unconscious bias and to assess changes in interest in these topics before and after course participation. This paper also seeks to understand the correlation between pre- and post- self-reports of knowledge for inclusive leadership and unconscious bias. Therefore, the research questions include:

1. Is there a difference in self-reported knowledge of inclusive leadership and unconscious bias between pre- and post-course intervention?
2. Is there a difference in self-reported interest of inclusive leadership and unconscious bias between pre- and post-course intervention?
3. How is self-reported knowledge of inclusive leadership related to self-reported knowledge of unconscious bias in pre- and post-course intervention?

Course Description

The three-credit course was designed as the entry-course for an undergraduate leadership development minor for a large engineering college within a public institution. The flipped course structure requires students to read content through online tools; through class discussions and a technical project, students apply and reflect on leadership concepts learned. Students learn about the concepts of inclusive leadership and unconscious bias through course content, exposure to companies committed to inclusive leadership practices through a single guest lecture, and a reflection paper on deconstructing bias. Prior to the course, faculty practiced inclusive leadership strategies through an operational agreement that students were invited to sign and discuss. The specific details of each portion of the inclusive leadership module are outlined in table 1.

Table 1

Inclusive Leadership Content for Engineering Leadership Course

Course Activity Description	**Learning Objectives**	**Assessment**
Inclusive leadership and Unconscious Bias content	• Define Inclusive leadership • Explore diversity, inclusion, and belonging • Define unconscious bias • Explore personal unconscious bias	Learning quiz Deconstructing Bias Paper
Corporate speaker on the importance of inclusive leadership in an organization	• Demonstrates the application of inclusive leadership behaviors in a corporate setting • Describes why inclusive leadership is important	Reflection questions for class participation

	• Provide examples of inclusive leadership strategies	
Deconstructing Bias Paper	• Discover unconscious bias through Implicit Bias test • Explore empathic behaviors • Research implicit bias within the context of engineering work • Explore personal bias through an interview with a person within the identified bias group • Reflect on learnings • Describe actions for ally-ship towards identified group	Paper assessed through rubric
Course operational agreement	Adapted from (Sensoy & Diangelo, 2014): • Strive for intellectual humility • Hold your opinions lightly and with humility • Let go of personal anecdotal evidence and look at broader group level patterns • Notice your own defensive reactions • Recognize how your own social positionally (race, class, gender, sex, ability) informs your perspectives • Differentiate between safety and comfort. Accept discomfort as necessary for growth.	Students were invited to discuss their commitments to the operational agreement in an online discussion board

	• Identify where your learning edge is and push.	

Course content focused on behavioral approaches to inclusive leadership by outlining six of its characteristics: commitment, courage, cognizance of bias, curiosity, cultural intelligence, and collaboration (Dillon & Bourke, 2016). Utilizing information in published articles, videos, and course content written by the instructor, students reviewed differences in the concepts of diversity, inclusion, equity, and belonging in the workplace and were exposed to biases in the workplace related to age, gender, and race.

Method

Data was collected from engineering undergraduate students through a Qualtrics online survey in the beginning and end of a course. Participant demographic information is presented in Table 2. Although 98 students completed the pre-survey and 82 completed the post-survey, only the 68 who completed both pre- and post-surveys (Men: n=49; Women: n=19) were included in study analysis. Among participants who completed both pre- and post-surveys, most were in their second (n=13), third (n=30), or fourth (n=18) year of university schooling. While there was broad racial/ethnic group representation, the majority of participants identified as White (66%) or Asian (22%).

Data Collection Procedures

Survey data was collected twice over the Fall 2020 semester, at the beginning and end of the 15-week introductory engineering leadership course. To measure students' knowledge of inclusive leadership and unconscious bias, the survey question prompt was "Please rate your level of knowledge for these listed leadership concepts." The self-rated knowledge of inclusive

leadership and unconscious bias was assessed on 5-point Likert-scale ratings (I am not familiar with this topic = 1, poor = 2, average = 3, good = 4, excellent = 5). To capture their level of interest in inclusive leadership and unconscious bias, students were asked, “To what degree are you interested in and want to learn more about these leadership topics?” The self-ratings for interest were rated on 5-point Likert-scale (not interested = 1 to very interested = 5).

Table 2

Demographic Information of Participants in the Study

Demographic Categories	Frequency	Percent of Total Sample
Gender		
Total	68	100.0
Male	49	72.1
Female	19	27.9
Race/Ethnicity		
Total	68	100.0
White	45	66.2
Asian	15	22.1
Middle Eastern	2	2.9
Black	1	1.5
Hispanic	1	1.5
Native American	1	1.5
Two or More Races	2	2.9
Declined to Report	1	1.5
Grade		
Total	68	100
First-year	1	1.5
Second-year	13	19.1
Third-year	30	44.1
Fourth-year and beyond	18	26.5
Graduate	3	4.4
Other	3	4.4

Data Analysis

Two types of statistical analyses were used to answer the research questions. First, a paired t-test with equal variance to compute the significant difference in knowledge and interest of inclusive leadership and identifying unconscious bias between pre- and post-surveys was conducted at $p < 0.05$ level using SPSS 26 (N=68). Then, simple bivariate correlations were tested between knowledge of inclusive leadership and knowledge of identifying unconscious bias. These analyses were chosen due to their alignment with the goal of investigating how knowledge of inclusive leadership is related to knowledge of identifying unconscious bias.

Results

Results of pre-post tests are shown in Figure 3 and t-test significance test details are presented in Table 3, presenting the means, standard deviations, mean differences, and p-values. The mean differences between pre- and post-measures are shown in Figure 3. While the mean values of students' perceived knowledge of demonstrating inclusive leadership and identifying unconscious bias increased substantially in post-measure, the means of interest of the two items were almost the same in pre- and post-measures. In particular, the mean change of knowledge of identifying unconscious bias between pre- and post- measures was more explicitly shown. Table 2 presents a comparison for pre- and post-measures for the four categories of knowledge about inclusive leadership and unconscious bias along with Cohen's *d* values which point out the practical significance of the mean differences between pre- and post-measures of the four categories. Results indicated statistically significant mean differences between pre- and post-survey items for all four categories at $p < 0.01$. The mean differences of knowledge of inclusive leadership and identifying unconscious bias were significantly increased with large effect sizes based on Cohen's *d* values of 0.825 and 1.265 respectively. Although the mean differences of

interest were also significantly increased in a small amount, Cohen's *d* values indicated small effect sizes for the interest of inclusive leadership and unconscious bias.

Figure 3

Means of Knowledge and Interest of Inclusive Leadership Concepts for Pre- and Post-Measures

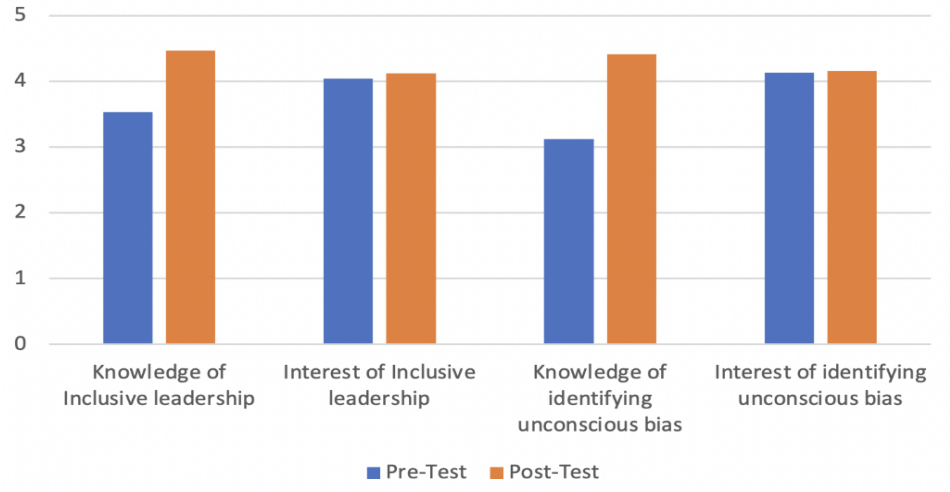


Table 3

Means and Standard Deviations (SD) of Knowledge and Interest of Inclusive Leadership Concepts for Pre- and Post-measures (N=68)

	Pre		Post		Mean Difference		
	Mean	*SD*	Mean	*SD*	(Pre-Post)	*t*	Cohen's *d*
Knowledge of Inclusive leadership	3.53	1.14	4.47	.66	-.94	-6.06***	.83
knowledge of identifying unconscious bias	3.12	1.02	4.41	.65	-1.29	-9.41**	1.27
Interest of Inclusive leadership	4.04	.98	4.12	.92	-.07	-.50***	.081
Interest of identifying unconscious bias	4.13	1.04	4.16	.96	-.03	-.19***	.029

Note. **$p \leq .01$, ***$p \leq .001$. Cohen's *d* values were interpreted as: small effect size ≤ .2, medium effect size ≤ .5, and large effect size ≤ . 8 (Cohen, 1988).

Table 4 shows the bivariate correlation results between data from pre- and post-survey regarding the level of knowledge of inclusive leadership and unconscious bias. There were significantly positive correlations between inclusive leadership and unconscious bias in each of pre- and post- survey at $p < .001$. In the pre-survey, the positive correlation result between inclusive leadership and unconscious bias represented that the likelihood of having knowledge of inclusive leadership skills was significantly intercorrelated with the likelihood of having knowledge of unconscious bias with a medium effect size ($.30 < r = .42 < .50$). The knowledge of inclusive leadership was also significantly intercorrelated with knowledge of unconscious bias in post-survey with a positive coefficient ($.50 < r = .57 < .80$). This means that knowledge of inclusive leadership is highly related with knowledge of unconscious bias in post-survey.

Overall, the correlations between knowledge of inclusive leadership and knowledge of unconscious bias reveal the positive relationship in each pre- and post-survey. The effect size of the correlation changed from a medium effect in pre-survey to large effect in post-survey.

Table 4

Correlation between Knowledge of Inclusive Leadership and Knowledge of Unconscious Bias

	Pre-Test		*Post-Test*	
	1	2	1	2
1. Inclusive leadership	-		-	
2. Unconscious bias	.424***	-	.574***	-

Note: All correlation coefficients are significant at the $**p \leq 0.01$, $***p \leq 0.001$ (2-tailed).

Discussion

The results of our analysis of pre/post self-reports show an increase in knowledge of and interest in inclusive leadership and unconscious bias for students in an entry-level engineering

leadership course. Further, we discovered a positive correlation between knowledge of inclusive leadership and unconscious bias. This observation aligns with literature supporting implicit association tests as a means for building awareness of perceptions and associations in the unconscious (Greenwald, Mcghee, & Schwartz, 1998; Greenwaldt & Krieger, 2006). For engineering leaders, knowledge of unconscious bias is a first step towards inclusive leader behaviors as outlined by Randel et al. (2018); the awareness of unconscious bias itself is a precursor to development of cognitive complexity and a diversity-focused mindset needed to fuel the creation of inclusive environments within teams. Development of these foundational elements of inclusive leadership can positively contribute to behaviors fostering belongingness and valuing uniqueness in the workplace. Future research is needed to understand nuances that make such behaviors effective as well as to understand pedagogical or training approaches poised to support these behaviors.

This study contributes to advance engineering leadership education that provides evidence of the impact of awareness of unconscious bias and inclusiveness through an experiential learning approach. Further, it lays a groundwork to understand awareness of implicit bias and its impact on engineering team performance. Engineering leaders who work to uncover bias, not only in their own ways of viewing the world and their own leadership practices but also in technical solution generation, can develop teams who value belonging and uniqueness while also generating solutions that are equitable and rooted in pro-diversity beliefs. Educators outside of engineering leadership curriculum can use this study as support for incorporating information and discussions on the importance of inclusive mindsets when working to foster creativity and diverse solutions within engineering teams. Specifically, the use of the IAT test with discussions or case studies can support these beginning stages of awareness. It is important to note that the

IAT tests have received significant scrutiny on claims that individual knowledge of bias results in action against bias, particularly toward racialized systems (Noon, 2018; Pritlove, Juando-prats, Ala-leppilampi, & Parsons, 2019).

A commitment to utilizing this approach forces engineering educators to confront bias that is likely existent within the typical engineering classroom as they are statistically dominated by white male students. For most faculty, barriers such as a lack of awareness of training opportunities or educational research, and implications for course reviews prevent implementation of curriculum related to bias (Eastman, Miles, & Yerrick, 2019). To combat these challenges, faculty teaching the course featured in this study participated in organized training workshops as well as personal journeys to explore their own implicit bias in the areas of race, gender issues, and age (the core focuses within the course).

Key elements of successful implementation into the engineering leadership environment included creation and access of peer support and a course operational agreement that students were invited to sign that outlined inclusive pedagogical approaches and mindsets. Access to peer support during the process of building skills necessary to facilitate a course like the one described in this project could be achieved by engaging with diversity offices or other experts, participating in reading groups, or paying consultants with expertise in developing instructor capacity in the areas of diversity and inclusion. In the case of the course studied for this project, a peer group dedicated to addressing bias in engineering classrooms was created to offer support and collectively generate and refine ideas ripe for classroom implementation. A course operational agreement was adapted from Sensoy & Diangelo (2014) which explained the pedagogical approaches and strategies used in the course and emphasized supportive, engaging and transformational approaches to the class's learning environment. Students were asked to

express concurrence with the agreement's contents and reminded of this commitment throughout the course. The operational agreement outlined how instructors also committed to showing up in inclusive ways, like seeing students as unique individuals, respecting diverse ways of learning, listening to all points of view, and acknowledging the potential for shortcomings and mis-steps as a natural part of the ongoing growth process toward becoming an inclusive leader. Through this approach, faculty modeled inclusive leadership behaviors. Two specific ways students applied the operational agreement included participating in an engaging lecture from a corporate representative on the importance of diversity, inclusion, and equity in a technical work environment and writing a deconstructing bias paper that utilized the IAT self-assessment which helped students identify a particular bias and required students to have one on one discussions with individuals who identified within the IAT bias categories. In many of their papers, students discussed emotional responses to biases uncovered and demonstrated the awareness built through the assignments.

This course activity aligned with the individual difference factors outlined by Randel et.al. (2018) such as pro-diversity beliefs, which are built through activities such as engaging with other cultures, and humility, which requires openness and empathy. The authors claimed that these individual factors increase the likelihood of a leader to engage in inclusive behavior. While these are positive anecdotes and pointers towards change, this study and course fell short of following up with action items outlined in the deconstructing bias paper or behavioral changes, directions we acknowledge as important and aspirational for the study team.

Limitations and Future Implications

There are several limitations that constrain the generalization of these results. First, we used self-reported data to assess students' knowledge of inclusive leadership and unconscious

bias, a limitation that comes from having means for verifying what students claim as their level of knowledge. In particular, due to high (above 4) pre-test scores, there may have been a ceiling effect on the scores. In future study, utilizing a wider Likert scale would appropriately cope with this issue. Further, this study would be strengthened by factorized reiteration of items to capture students' development of knowledge. For example, specific inclusive leadership knowledge items are needed to further explain various aspects of inclusive leadership as well as unconscious bias. This addition would also provide an opportunity to verify self-reported understanding by matching student perceptions with their knowledge of these aspects of the topics. Further, future research can investigate the effectiveness of individual class activities that are designed to increase inclusive leadership knowledge within leadership courses (along with the impact of their conglomerate) as well as whether such increases are correlated with inclusive leadership identity development. Finally, this study lays the groundwork for future empirical investigations that would incorporate a full intervention or control design to determine the effectiveness of a leadership course in terms of various aspects of inclusive leadership development.

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