# WIP: Development of a Survey to Investigate Engineering Faculty Diversity, Equity, Inclusion, and Belonging (DEIB) Practices in Graduate Research Group Environments

**Luis Delgado Jr., Penn State**

Luis R. Delgado Jr. is a Ph.D. Candidate in the Mechanical Engineering Department at Pennsylvania State University. He has a bachelor of science in Mechanical Engineering from The University of Texas at El Paso and earned a master of science degree in Civil Engineering with a minor in Public Policy from Penn State. Along with his role as a Ph.D., he is also a graduate research assistant at the Leonhard Center for Enhancement of Engineering Education at Penn State. His research interests are engineering education, diversity, equity, inclusion, and retention of underrepresented minority groups. Luis will research how diverse human talents contribute to our profession's social and global relevance.

**Catherine G. P. Berdanier, Pennsylvania State University**

Catherine G.P. Berdanier is an Associate Professor of Mechanical Engineering at Pennsylvania State University. She earned her B.S. in Chemistry from The University of South Dakota, her M.S. in Aeronautical and Astronautical Engineering and her PhD in Engineering Education from Purdue University. Her research expertise lies in characterizing graduate-level attrition, persistence, and career trajectories; engineering writing and communication; and methodological development.

# WIP: Development of a Survey to Investigate Engineering Faculty Diversity, Equity, Inclusion, and Belonging (DEIB) Practices in Graduate Research Group Environments

## Introduction

Diversity, Equity, Inclusion, and Belonging (DEIB) challenges in engineering education are more evident at the graduate level where racial and ethnic diversity remains particularly low, and PhD attrition rates are extremely high for students from marginalized backgrounds [1], [2]. Comprehending how to influence the culture of engineering education to successfully educate a diverse student body is a key and necessary component for addressing DEIB concerns within engineering. It has been suggested that engineering leaders in academia, including faculty, share the responsibility of educating themselves and others about topics surrounding DEIB. Thus, exploring engineering faculty practices about DEIB can begin to shape and reshape the academic cultures that promote, ignore, or hinder DEIB efforts.

Previous literature states that faculty are key to promoting participation in education and creating safe, equitable, and inclusive environments for student success [3]. Nonetheless, engineering faculty members who are novices to discussions of race and inequity or lack DEIB background knowledge may inadvertently adopt viewpoints, assumptions, or policies in their graduate research lab groups that inadvertently harm or cause distrust among doctoral students, especially those of different racial or ethnic backgrounds. There have been calls to address this issue in engineering (e.g., [4]), but faculty still feel unequipped to tackle DEIB within their institutions [5]. Specifically, some professors evade responsibility for cultivating their capacity to practice DEIB by directing individuals toward those they believe have more expertise (i.e., graduate college staff, minoritized colleagues) and in doing so perpetuate departmental and institutional climates that are hostile and overly burden minoritized students, staff, and faculty to do DEIB-focused work [6].

While previous engineering education studies have successfully identified and critiqued the DEIB challenges in engineering culture, they do not explore processes of change for engineering faculty or graduate engineering environments (i.e., graduate research lab). To bridge this gap in the scholarship, we must understand how engineering faculty members' perspectives and knowledge of DEIB influence their intention to promote inclusive actions in their graduate research lab groups. In this work-in-progress paper, we present an initial survey design that will contribute to the literature with a focus on how faculty implement and perceive DEIB practices in situated research group environments, in which they have full control. Outcomes from this survey will offer initial inputs associated with faculty's perceived value for, and likelihood of implementing DEIB practices and activities in their graduate research lab group. Overall, this work will highlight the explicit role of faculty as systemic gatekeepers in field-wide efforts to make graduate engineering education diverse, inclusive, and equitable.

## Theoretical Perspective

This research draws on psychological theories and models of decision-making to inform a theoretical base to explain faculty's resistance to and intention to implement DEIB practices and activities in their graduate research labs. These theories include Ajzen's [7] theory of planned behavior (TPB) and Latané and Darley's [8] five-step decision model of bystander intervention. These frameworks have been frequently used for understanding the drivers of human behavior, and their effectiveness has been confirmed in empirical studies for many different behaviors and populations (e.g., [9], [10]).

## Research Positionality

The leading author is a first-generation Mexican American man, a first-generation college student, a Ph.D. candidate, and uses he/him/él pronouns. He has a background in mechanical engineering, engineering education, and has a knowledgeable depth of various engineering disciplines and engineering settings. My multi-disciplinarity has given me the vision and tools to be able to think about data from multiple different points of view and understand how critical humans may be to the system of engineering. My interest in working on equity and social justice issues in engineering education emerges from my own lived experiences and cultural background. I recognize that the current educational system underserves many students, in particular marginalized individuals, and that change is needed. I believe educators have the potential to be socio-political change agents, and that engineering faculty are important gatekeepers to stimulate improvements toward approaching DEIB on a larger scale. Mindful of these beliefs and the resulting positionality, I will seek to avoid biases during the coding and reporting of the data.

## Survey Design and Development

This study seeks to develop a more robust approach to understanding faculty DEIB learning and evaluating faculty DEIB practices in graduate engineering research group/lab settings. The comprehensive study design will use multiple-methods to recruit participants and collect data: (1) a quantitative survey and (2) qualitative semi-structured interviews with tenured and tenure-track engineering faculty across R1 institutions in the United States. However, in this work-in-progress paper, we present progress toward the development and validation of the survey instrument for examining engineering faculty members' DEIB practices in their graduate research lab groups.

The developed survey includes two sets of Likert scale items, one set of slider items, open-ended items, demographics items, and an item confirming their willingness to participate in an interview. The first five-point Likert response scale items asked faculty to provide their level of agreement with statements regarding inclusive research lab practices related to *recruiting, selecting, and retaining* graduate doctoral students. A total of nine items were selected and adapted from documented graduate research lab guidebooks/policies [11], [12], previous literature on creating inclusive research environments [6], [13], [14], [15], [16], [17], [18] and relevant validated questionnaires (e.g., Mentoring Competency Assessment (MCA) [19], the Cross-Cultural Counseling Inventory-Revised (CCCI-R) [20], the Inclusive Teaching Questionnaire [21], Faculty Attitudes Survey [22], and Faculty Knowledge and Interest in DEI Survey [23] ).

The second five-point Likert response scale items asks participants to provide their level of agreement to statements regarding their decision-making to promote participation in graduate engineering education and in creating safe, equitable, and inclusive lab environments for graduate students, especially those from underrepresented racial/ethnic backgrounds. Nine items were written to model the 'diversity in biology' instrument adapted by Thoman's [24] from Nickerson et al. [25] measure of bystander intervention relating to bullying and sexual harassment. The items were changed to mention "engineering," "doctoral students," "[students] from underrepresented racial/ethnic backgrounds," "graduate research lab," and/or "graduate department." The slider items ask faculty to estimate the likelihood they will implement inclusive research lab practices related to recruiting, selecting, and retaining doctoral students in the next academic year, on a scale from 0 to 100. The open-ended questions comprise of items such as:

- *What kinds of things do you do with your research group to make graduate students feel like they belong, especially those from underrepresented racial/ethnic backgrounds? Why did you initiate them? How do you evaluate them?*

The demographic items include rank/title, number of doctoral students in the graduate research lab, mentoring experience (in years), gender, race/ethnicity, engineering discipline, and whether they were first-generation and/or a low-income student. At the end of the survey, faculty can indicate their interest in participating in an interview. If they choose to participate in the interview, they will be directed to a separate survey where their contact information will be collected and stored separately from your survey responses. Faculty contact information will not be linked back to the survey responses, ensuring the anonymity of data.

**Preliminary Validity Evidence**

To ensure that the scale measures the intended construct, validity evidence is being collected. The plan to collect validity evidence derives from the *Standards for Educational and Psychological Testing* [17] developed by the American Educational Research Association (AERA), the American Psychological Association (APA), and the National Council on Measurement in Education (NCME). Principally, we obtained face and content validity evidence [26]. Both face and content validity search to decide the degree to which a construct is accurately translated into operationalization. Face validity examines the operationalization at face value to determine whether it is a good translation of the construct [26], while content validity examines the operationalization compared to the construct's relevant content area(s) (i.e., the appearance that the instrument measures what it is intended to measure) [27].

Survey items were written by the first author and then reviewed and critiqued by various groups. The authors' research lab group initially provided feedback on the survey questions' clarity and readability, and whether the items are relevant and right for measurement. This research group brings expertise in engineering, graduate engineering education, and educational psychology. Further, members of the institution's engineering Center for Teaching and Learning also gave feedback on clarity and readability and the extent to which the items captured the ideas of the constructs. This team brings experts in engineering education, faculty development, educational psychology, and inclusive pedagogy. Finally, as part of a faculty learning community (FLC), we

asked engineering faculty who have several years of mentoring graduate students to review the survey to determine if the items were understandable.

The next immediate step is to conduct pilot surveys at a historically white, large public research university located in the Eastern United States. Pilot surveys will examine the ways engineering tenure and tenure-track faculty understand the questions and terminology and their level of comfort with discussion topics. to formulate a survey that will be understandable and comfortable for them to complete. While faculty will not receive any incentive for this process, they will aid in formulating a survey that will be understandable and comfortable for faculty across the U.S. to complete. After piloting the survey, psychometric properties including item discrimination and step difficulties will be examined using Item Response Theory (IRT) Model [23], [28], [29]. Also, the internal structure as validity evidence will be inspected with Exploratory Factor Analysis (EFA), and internal consistency will be examined using Cronbach's α.

## Conclusions and Future Work

U.S. graduate education is a gendered and racialized environment in which engineering departments rarely explicitly engage in DEIB efforts. Comprehending DEIB in engineering graduate education will become even more important in the future. To contribute to this understanding, we presented an initial survey design to address overarching gaps in the literature and develop a more robust approach to understanding faculty DEIB learning and evaluating faculty DEIB practices in graduate engineering education/research lab group settings. While we have initially developed the instrument and obtained preliminary validity evidence, there is still work to be done. As mentioned above, the survey will be piloted on the engineering faculty population, and more validity evidence including psychometric properties will be enhanced once we continue to iterate on the survey.

After more validity evidence is collected, we will deploy the survey to engineering tenured and tenure-track faculty at top engineering PhD-granting universities in the United States. Quantitative data analysis will be used to evaluate the data collected through the survey. In addition to the quantitative survey, qualitative interviews will be conducted to obtain a more complete understanding of the phenomenon [30], [31], and capture more in-depth information regarding faculty practices, beliefs, and barriers to implementing DEIB practices and activities in their research labs. Overall, the comprehensive study will be helpful for those who want to better understand faculty perceptions about DEIB, and their resistance to and intention for implementing DEIB practices/activities in their graduate research labs. This work-in-progress work will carry implications for how faculty individually interact with graduate students and design graduate education/research lab DEIB practices and activities. Specifically, the study will promote a more robust approach to assessing how engineering research labs start or continue to foster DEIB beliefs and create an environment where DEIB activities can thrive.

## Acknowledgement

This material is based upon work supported by the Alfred P. Sloan Foundation under Grant No. G-2019-11435. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the sponsors.

## References


[1] H. Okahana, C. Klein, J. Allum, and R. Sowell, "STEM Doctoral Completion of Underrepresented Minority Students: Challenges and Opportunities for Improving Participation in the Doctoral Workforce," *Innov High Educ*, vol. 43, no. 4, pp. 237–255, Aug. 2018, doi: 10.1007/s10755-018-9425-3.

[2] R. Sowell, J. Allum, and H. Okahana, *Doctoral Initiative on Minority Attrition and Completion*. Washington, DC: Council of Graduate Schools, 2015.

[3] B. M. Gayle, D. Cortez, and R. Preiss, "Safe Spaces, Difficult Dialogues, and Critical Thinking," *ij-sotl*, vol. 7, no. 2, Jul. 2013, doi: 10.20429/ijsotl.2013.070205.

[4] M. Artiles *et al.*, "Action on Diversity: A Content Analysis of ASEE Conference Papers, 2015–2016," in *2017 ASEE Annual Conference & Exposition Proceedings*, Columbus, Ohio: ASEE Conferences, Jun. 2017, p. 27533. doi: 10.18260/1-2--27533.

[5] K. Cross and S. Cutler, "Engineering Faculty Perceptions of Diversity in the Classroom," in *2017 ASEE Annual Conference & Exposition Proceedings*, Columbus, Ohio: ASEE Conferences, Jun. 2017, p. 28253. doi: 10.18260/1-2--28253.

[6] R. J. Perez, C. K. Robbins, L. W. Harris, and C. Montgomery, "Exploring graduate students' socialization to equity, diversity, and inclusion.," *Journal of Diversity in Higher Education*, vol. 13, no. 2, pp. 133–145, Jun. 2020, doi: 10.1037/dhe0000115.

[7] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179–211, Dec. 1991, doi: 10.1016/0749-5978(91)90020-T.

[8] B. Latané and J. M. Darley, *The Unresponsive Bystander: Why Doesn't He Help?* New York, NY: Appleton-Century Crofts., 1970.

[9] T. S. Harding, M. J. Mayhew, C. J. Finelli, and D. D. Carpenter, "The Theory of Planned Behavior as a Model of Academic Dishonesty in Engineering and Humanities Undergraduates," *Ethics & Behavior*, vol. 17, no. 3, pp. 255–279, Sep. 2007, doi: 10.1080/10508420701519239.

[10] M. E. Matters, C. B. Zoltowski, A. O. Brightman, and P. M. Buzzanell, "An Engineering Faculty and an Intention to Make Change for Diversity and Inclusion: Creating Sustainable Change Efforts," *2021 CoNECD*, Jan. 2021, Accessed: Jun. 14, 2023. [Online]. Available: https://par.nsf.gov/biblio/10317482-engineering-faculty-intention-make-change-diversity-inclusion-creating-sustainable-change-efforts

[11] Evans, "The Evans Lab DEI Lab Policies," The Evans Lab: Microbial & Ecosystem Ecology. Accessed: Feb. 05, 2024. [Online]. Available: https://saraheevanslab.weebly.com/diversity-equity-and-inclusion.html

[12] S. Evans, "Evans Lab Corrective Action Plan." 2020. Accessed: Feb. 05, 2024. [Online]. Available: https://saraheevanslab.weebly.com/uploads/2/7/0/0/27009978/evans_lab_corrective_action_plan.pdf

[13] A. S. Ahmad, I. Sabat, R. Trump-Steele, and E. King, "Evidence-Based Strategies for Improving Diversity and Inclusion in Undergraduate Research Labs," *Front. Psychol.*, vol. 10, p. 1305, Jun. 2019, doi: 10.3389/fpsyg.2019.01305.

[14] B. Dewsbury and S. Seidel, "Reflections and Actions for Creating an Inclusive Research Environment," *CP Essential Lab Tech*, vol. 21, no. 1, p. e43, Dec. 2020, doi: 10.1002/cpet.43.

[15] N. Ruedas-Gracia, C. M. Botham, A. R. Moore, and C. Peña, “Ten simple rules for creating a sense of belonging in your research group,” *PLoS Comput Biol*, vol. 18, no. 12, p. e1010688, Dec. 2022, doi: 10.1371/journal.pcbi.1010688.
[16] A. C. Pike *et al.*, “10 Simple Rules for a Supportive Lab Environment,” *Journal of Cognitive Neuroscience*, vol. 35, no. 1, pp. 44–48, Dec. 2022, doi: 10.1162/jocn_a_01928.
[17] V. B. Chaudhary and A. A. Berhe, “Ten simple rules for building an antiracist lab,” *PLoS Comput Biol*, vol. 16, no. 10, p. e1008210, Oct. 2020, doi: 10.1371/journal.pcbi.1008210.
[18] University of Buffalo, “Creating Inclusive Research Spaces,” presented at the Blueprints for Belonging, 2017. [Online]. Available: https://www.buffalo.edu/content/dam/www/pss/pss_events/idc_conference_2017/Operationalizing_Inclusivity_Handout.pdf
[19] M. Fleming *et al.*, “The Mentoring Competency Assessment: Validation of a New Instrument to Evaluate Skills of Research Mentors,” *Academic Medicine*, vol. 88, no. 7, p. 1002, Jul. 2013, doi: 10.1097/ACM.0b013e318295e298.
[20] T. D. LaFromboise, H. L. K. Coleman, and A. Hernandez, “Development and factor structure of the Cross-Cultural Counseling Inventory—Revised,” *Professional Psychology: Research and Practice*, vol. 22, no. 5, pp. 380–388, 1991, doi: 10.1037/0735-7028.22.5.380.
[21] T. M. Addy, P. M. Reeves, D. Dube, and K. A. Mitchell, “What Really Matters for Instructors Implementing Equitable and Inclusive Teaching Approaches,” *To Improve the Academy*, vol. 40, no. 1, Sep. 2021, doi: 10.3998/tia.182.
[22] G. P. Stefanich, K. I. Norman, and J. Egelston-Dodd, *Teaching science to students with disabilities: Experiences and perceptions of classroom teachers and science educators*. Pittsburgh, PA: Association for the Education of Teachers in Science, 1996. Accessed: Jul. 25, 2023. [Online]. Available: http://heartlandscience.pbworks.com/f/AETS1.pdf
[23] S. Secules, S. E. Park, C. McCall, and M. B. Kali, “Developing a Survey for Engineering Faculty Knowledge and Interest in Diversity, Equity, Inclusion Topics,” in *2021 IEEE Frontiers in Education Conference (FIE)*, Lincoln, NE, USA: IEEE, Oct. 2021, pp. 1–5. doi: 10.1109/FIE49875.2021.9637133.
[24] D. B. Thoman, M.-J. Yap, F. A. Herrera, and J. L. Smith, “Diversity Interventions in the Classroom: From Resistance to Action,” *LSE*, vol. 20, no. 4, p. ar52, Dec. 2021, doi: 10.1187/cbe.20-07-0143.
[25] A. B. Nickerson, A. M. Aloe, J. A. Livingston, and T. H. Feeley, “Measurement of the bystander intervention model for bullying and sexual harassment,” *Journal of Adolescence*, vol. 37, no. 4, pp. 391–400, Jun. 2014, doi: 10.1016/j.adolescence.2014.03.003.
[26] Trochim, Donnelly, and A. Kanika, *Research Methods: The Essential Knowledge Base*, 2nd edition. Boston, MA: Cengage Learning, 2015.
[27] S. Zappe, S. Cutler, S. Spiegel, J. Blacklock, and D. Jordan, “Development of Self-Efficacy and Mindset Scales for Advanced Manufacturing and Data Sciences,” *In ASEE annual conference exposition*, 2022.
[28] E. Muraki, “INFORMATION FUNCTIONS OF THE GENERALIZED PARTIAL CREDIT MODEL,” *ETS Research Report Series*, vol. 1993, no. 1, Jun. 1993, doi: 10.1002/j.2333-8504.1993.tb01538.x.
[29] G. N. Masters, “A rasch model for partial credit scoring,” *Psychometrika*, vol. 47, no. 2, pp. 149–174, Jun. 1982, doi: 10.1007/BF02296272.
[30] S. Almalki, “Integrating Quantitative and Qualitative Data in Mixed Methods Research—Challenges and Benefits,” *JEL*, vol. 5, no. 3, p. 288, Jul. 2016, doi: 10.5539/jel.v5n3p288.

[31] J. W. Creswell and V. L. P. Clark, *Designing and Conducting Mixed Methods Research*. SAGE Publications, 2017.