Board 226: Collaborative Research: The Organizational Climate Challenge: Promoting the Retention of Students from Underrepresented Groups in Doctoral Engineering Programs: Year 1

Dr. Julie Aldridge, The Ohio State University

My background and research interests are in organizational change, innovation, and leadership. My strengths are ideation and transdisciplinary teamwork. My current work focuses on organizational climate to better support the retention of engineering doctoral students from diverse groups to degree completion.

Nicole Else-Quest, University of North Carolina at Chapel Hill

Nicole M. Else-Quest is Associate Professor and Associate Chair of Women's and Gender Studies at the University of North Carolina at Chapel Hill. A first-generation college student, Dr. Else-Quest earned her Ph.D. in developmental psychology at the University of Wisconsin—Madison. She uses a combination of quantitative and qualitative methods to understand psychological gender differences, how they develop and shape participation in STEM, and how we can intervene to expand women's and girl's participation in STEM. She has written extensively on implementing intersectionality within social sciences research and adapting quantitative as well as qualitative methods to do so. Else-Quest is currently PI on two grants from the National Science Foundation, both focused on developing and implementing interventions to improve girls' and women's participation and persistence in STEM education from elementary school through doctoral training. In addition to her scholarly work, she is co-author of the undergraduate textbook, Psychology of Women and Gender: Half the Human Experience+ (Sage, 2022). She is a Fellow of the American Psychological Association and is Associate Editor of the journal Stigma and Health.

Dr. So Yoon Yoon, University of Cincinnati

Dr. So Yoon Yoon is an assistant professor in the Department of Engineering and Computing Education in the College of Engineering and Applied Science at the University of Cincinnati, OH, USA. Dr. Yoon received her Ph.D. in Gifted Education, and an M.S.Ed. in Research Methods and Measurement with a specialization in Educational Psychology, both from Purdue University, IN, USA. She also holds an M.S. in Astronomy and Astrophysics and a B.S. in Astronomy and Meteorology from Kyungpook National University, South Korea. Her work centers on elementary, secondary, and postsecondary engineering education research as a psychometrician, data analyst, and program evaluator with research interests in spatial ability, STEAM education, workplace climate, and research synthesis with a particular focus on meta-analysis. She has developed, validated, revised, and copyrighted several instruments beneficial for STEM education research and practice. Dr. Yoon has authored more than 80 peer-reviewed journal articles and conference proceedings and served as a journal reviewer in engineering education, STEM education, and educational psychology. She has also served as a PI, co-PI, advisory board member, or external evaluator on several NSF-funded projects.

Dr. Joe Roy, American Society for Engineering Education

Joseph Roy has over 15 years of data science and higher education expertise. He currently directs three national annual data collections at the ASEE of colleges of engineering and engineering technology that gather detailed enrollment, degrees awarded, research expenditures, faculty headcounts, faculty salary and retention data for the engineering community. He is PI of a NSF Advanced Technological Education funded grant to build a national data collection for engineering-oriented technician degree and certificate programs at 2-year institutions. Prior to joining the ASEE, he was the senior researcher at the American Association of University Professor and directed their national Faculty Salary Survey. He also developed a technical curriculum to train analysts for a national survey of languages in Ecuador while he was at the University of Illinois as a linguistic data analytics manager and member of their graduate faculty. He has a B.S. in Computer Science & Mathematics, a M.S. in Statistics from the University of Texas at San Antonio and a Ph.D. in Linguistics from the University of Ottawa.

The Organizational Climate Challenge: Promoting the Retention of Students from Underrepresented Groups in Doctoral Engineering Programs - Year One

Background and Theoretical Framework

The goal of this four-year project, supported by NSF Awards 2201100, 2201101, 2201102 and 2201103, is to examine doctoral students' perceptions of the factors that impact their retention to degree completion and the differences and similarities in experiencing those factors based on intersecting social categories. This project adopts an explicitly intersectional approach to the meaning and relevance of students' belonging to multiple social categories, including gender, race/ethnicity, and sexual orientation [1], considered within the context of engineering doctoral education. Drawing on organizational climate research and intersectionality theory, the project aims to use a student-centered approach to shed light on the specific organizational climate present in doctoral engineering department by engaging with students from diverse groups. We aim to answer three research questions: *1. What focused climates are present in doctoral engineering departments? 2. How do climate perceptions differ by intersecting social categories? 3. How do climate perceptions relate to organizational commitment to degree completion?*

For this project, we intend to reintroduce organizational climate science into higher education climate research to ultimately understand how to improve outcomes in engineering doctoral education for students from historically-excluded groups. We rely on the definition of organizational climate as the shared meaning organizational members attach to the events, policies, practices, and procedures they experience and the behaviors they see being rewarded, supported, and expected [2],[3],[4],[5].

Contemporary climate research tends to have a focus on specific strategic goals or internal processes, in that it assesses *focused climates* [3]. Findings from focused climates studies have practical applications, in that they point to specific policies, practices, and behaviors comprising the climate and predicting relevant outcomes [5]. Members exist simultaneously in various subgroups or nested levels within the larger organization, and measurement of climate is best focused on a specific level that provides a frame of reference [2],[3]. In this work, we investigate climate at the department level because disciplinary, institutional, and professional contexts converge at the department level to shape graduate student experiences [6],[7],[8]. Furthermore, faculty are organizational members who work in a climate they do not create [2],[3] because they are not responsible for setting policies, and the relationship between a doctoral student and their advisor is better addressed by a different construct from organizational science, perceived supervisor support.

We combined an intersectional, student-centered approach to organizational climate to identify specific focused climates relevant to doctoral engineering student retention. The American Council on Education [9] has delineated a need for academic leaders to develop policies and best practices to promote diversity in STEM. Although findings from climate studies, grounded in organizational science, have practical applications and can guide specific policies, practices, and behaviors, "climate" research in higher education has been siloed from organizational climate advances. A meteorological metaphor of climate, starting with Hall and Sandler [10], has been used for decades to explain educational disparities with research on improving diversity outcomes in higher education organizations pointing to a negative, or "chilly" atmosphere that results in lower rates of retention to degree completion.

The result is that higher education climate research has had limited success in increasing the number of engineering doctorates obtained by women and people from other historically

excluded groups. In 2022, women earned 26.2% of the engineering doctoral degrees awarded in the U.S., with fewer than half of those women being U.S. residents. Of those degrees, American Indian women earned 0.1%, Black women earned 5.0%, multiracial women earned 5.3%, Latina women earned 9.7%, Asian American women earned 18.5%, and white women earned 61.3% [11]. Likewise, Black, Latina, and Native American women continue to face longer time-to-degree completion and a greater risk of attrition than their male counterparts [12].

Work to Date

Literature Reviews

We first conducted a literature review [13] as a preliminary assessment of the available research literature produced by the engineering education community on climate affecting the persistence or retention of engineering doctoral students from diverse backgrounds. We sought to understand doctoral student retention as an organizational climate issue and used an intersectional approach to consider the meaning and relevance of students' belonging, simultaneously, to multiple social categories, such as gender identity, sexual orientation, socioeconomic background, race/ethnicity, and disability status, within the context of engineering doctoral education as a first step to building a climate survey instrument.

The objective of this literature review was to explore how the concept of 'climate' is being used in the context of doctoral engineering student persistence, or retention, to degree completion and gather a body of evidence of climate factors. We also used intersectionality as our approach to interpreting the literature. Our review demonstrated that 1) climates are rarely directly discussed within the engineering education community, and 2) when there are studies of climate, constructs are ill-defined or derived from literature outside organizational climate science. Moreover, because those studies use survey instruments that are not validated either for the climate constructs they claim to measure or for assessment with students across multiple intersectional locations, it is difficult to draw reliable conclusions from them or translate their results to meaningfully inform policy or practice.

Next, we conducted a systematic review [14],[15] of climate in engineering doctoral programs and identified a framework of focused climates from organizational climate literature found to be associated with member retention or organizational commitment, including some pertaining specifically to diversity. Since the 1980s, research on "campus climate" has become commonplace in higher education [16],[17],[18],[19]. Unfortunately, the general campus climate approach in higher education research diverges from decades of organizational climate research and impedes systemic change to improve student outcomes because research findings are so vague that their utility and meaning are limited [20].

We searched papers for indications of the climates in our framework and examined how the authors defined climate. The papers' scale items, results, and findings were examined for evidence of climate perceptions, and study sample characteristics were evaluated for level of intersectionality. We found that none of the studies in our review assessed climate using a contemporary organizational climate research approach and all tended to frame climate as a general "feel" or "atmosphere" and as simply positive or negative. However, we identified nine focused organizational climates that likely play a role in the retention of engineering doctoral students: diversity, perceived cultural diversity, authenticity, psychological safety, psychosocial safety, mastery, performance, organizational support, and sexual harassment climates. We explored how power and inequality are embedded in or emphasized by those nine climates and provided guidance for future empirical work on organizational climate in engineering doctoral

education to inform leadership efforts in promoting the retention of students from historically excluded groups. This paper presents a framework of nine focused climates and the perceptions captured or reflected in 23 sources representing 19 studies.

Climate Scale Development

Based on our identification of climate factors that might be associated with engineering doctoral student retention from the systematic review of the literature, we then collected pilot data and reported the development procedures for a multi-factor organizational climate survey for engineering doctoral student retention [21],[22]. Using an intersectional approach, we developed a scale to assess multiple focused climate factors associated with organizational commitment or member retention, many of which are particularly salient to the experiences of students from marginalized or minoritized identities.

We took several steps to create the scale, including face/content validity analysis, exploratory factor analyses for validity evidence, and internal consistency for reliability evidence. The climate survey included the climate scale with 50 items for 9 constructs and demographic items to capture the respondents' complex social identities. During summer and fall 2023, we collected our first pilot study data of 287 doctoral engineering students from 28 institutions in the U.S. The exploratory factor analysis (EFA) with the data from 287 engineering doctoral students revealed the latent factor structure of the climate scale for eight constructs indicated by 39 items. Internal consistency was good. Based on the EFA results, we planned to revise the items and add new items for the second round of data collection for the second pilot study in Year 2.

Results from studies using the finalized survey are expected to guide specific policies and inform practices and procedures that may enhance organizational performance in strategic areas such as student retention.

Interviews with Marginalized Group Students

Following up on our pilot survey data collection, we interviewed engineering doctoral students to gain insight into their perceptions of our framework's focused climates and identify other climates present in engineering departments. We are currently coding transcripts from 12 interviews with participants who identified as members of the LGBTQ+ community.

References

[1] N. M. Else-Quest and J. S. Hyde, "Intersectionality in Quantitative Psychological Research," *Psychology of Women Quarterly*, vol. 40, no. 2, pp. 155–170, Feb. 2016, doi: https://doi.org/10.1177/0361684316629797.

[2] M. G. Ehrhart, B. Schneider, and W. H. Macey, *Organizational Climate and Culture*. Routledge, 2013. doi: https://doi.org/10.4324/9781315857664.

[3] M. G. Ehrhart and B. Schneider, "Organizational Climate and Culture," *Oxford Research Encyclopedia of Psychology*, Dec. 2016, doi: https://doi.org/10.1093/acrefore/9780190236557.013.3.

[4] B. Schneider and A. E. Reichers, "On the Etiology Of Climates," *Personnel Psychology*, vol. 36, no. 1, pp. 19–39, Mar. 1983, doi: https://doi.org/10.1111/j.1744-6570.1983.tb00500.x.

[5] B. Schneider, V. González-Romá, C. Ostroff, and M. A. West, “Organizational climate and culture: Reflections on the history of the constructs in the Journal of Applied Psychology.,” *Journal of Applied Psychology*, vol. 102, no. 3, pp. 468–482, 2017, doi: https://doi.org/10.1037/apl0000090.

[6] B. J. Barnes and J. Randall, “Doctoral Student Satisfaction: An Examination of Disciplinary, Enrollment, and Institutional Differences,” *Research in Higher Education*, vol. 53, no. 1, pp. 47–75, Mar. 2011, doi: https://doi.org/10.1007/s11162-011-9225-4.

[7] M. Greene, “Come Hell or High Water: Doctoral Students’ Perceptions on Support Services and Persistence,” *International Journal of Doctoral Studies*, vol. 10, pp. 501–518, 2015, doi: https://doi.org/10.28945/2327.

[8] J. A Gilmore, A. M Wofford, and M. A Maher, “The Flip Side of the Attrition Coin: Faculty Perceptions of Factors Supporting Graduate Student Success,” *International Journal of Doctoral Studies*, vol. 11, pp. 419–439, 2016, doi: https://doi.org/10.28945/3618.

[9] American Council on Education and K. Griffin, “Achieving Diversity at the Intersection of STEM Culture and Campus Climate American Council on Education,” 2019. Available: https://www.acenet.edu/Documents/Achieving-Diversity-Intersection-of-STEM-Culture-and-Campus-Climate.pdf

[10] R. M. Hall and B. Sandler, “The Classroom Climate: A Chilly One for Women?” 1982, Available: https://www.semanticscholar.org/paper/The-Classroom-Climate%3A-A-Chilly-One-for-Women.-Hall-Sandler/96a6ae5e304da857f5ee360bdcf72b7cb81a358f

[11] American Society for Engineering Education, “Profiles of Engineering & Engineering Technology – IRA | ASEE,” *ira.asee.org*, 2023. https://ira.asee.org/profiles-of-engineering-engineering-technology/ (accessed Jan. 29, 2024).

[12] 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,” *Innovative Higher Education*, vol. 43, no. 4, pp. 237–255, Mar. 2018, doi: https://doi.org/10.1007/s10755-018-9425-3.

[13] J.L. Aldridge, N.M, Else-Quest, J. Roy, and S.Y. Yoon, “Engineering doctoral student retention and persistence from an organizational climate and intersectional perspective: A targeted review of engineering education literature,” 2023, doi: https://doi.org/10.18260/1-2--43326.

[14] N.M. Else-Quest and J.L. Aldridge, “‘Chilly Climate?’: A Systematic Review Of Organizational Climates In Engineering Doctoral Education”, American Educational Research Association, 2024a,

[15] N.M. Else Quest and J.L. Aldridge, manuscript in review (a)

[16] S. Hurtado, A. R. Clayton-Pedersen, W. R. Allen, and J. F. Milem, “Enhancing Campus Climates for Racial/Ethnic Diversity: Educational Policy and Practice,” *The Review of Higher Education*, vol. 21, no. 3, pp. 279–302, 1998, doi: https://doi.org/10.1353/rhe.1998.0003.

[17] S. D. Nightingale, “The role of trust in perceptions of the sexual assault reporting climate for LGBQ college students.,” *Journal of Diversity in Higher Education*, Apr. 2021, doi: https://doi.org/10.1037/dhe0000317.

[18] E. T. Parker and T. L. Trolian, “Student perceptions of the climate for diversity: The role of student–faculty interactions.,” *Journal of Diversity in Higher Education*, Jul. 2019, doi: https://doi.org/10.1037/dhe0000132.

[19] R. L. Worthington, R. L. Navarro, M. Loewy, and J. Hart, “Color-blind racial attitudes, social dominance orientation, racial-ethnic group membership and college students’ perceptions of campus climate.,” *Journal of Diversity in Higher Education*, vol. 1, no. 1, pp. 8–19, 2008, doi: https://doi.org/10.1037/1938-8926.1.1.8.

[20] J. Hart and J. Fellabaum, “Analyzing campus climate studies: Seeking to define and understand.,” *Journal of Diversity in Higher Education*, vol. 1, no. 4, pp. 222–234, 2008, doi: https://doi.org/10.1037/a0013627.

[21] S.Y. Yoon, J.L. Aldridge, N.M Else-Quest and J. Roy, “Development of a Survey to Assess Climates Associated with Engineering Doctoral Student Retention with an Intersectional Approach”, American Educational Research Association, 2024b

[22] S.Y. Yoon, J.L. Aldridge, N.M. Else Quest and J. Roy, manuscript in review (b)